GLYPHOSATE (158)

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EXPLANATION

Glyphosate was listed in the Periodic Re-Evaluation Programme of the 34th Session of the CCPR for residue review by 2005 JMPR. It has been reviewed by the JMPR in 1986, 1987, 1994 and 1997.

Relevant data on metabolism and residue trials were submitted to the Meeting. Data to support existing CXLs and critical data required for the estimation of MRLs have been provided by the manufacturer for the following commodities: sugar beet – glyphosate tolerant, beans (dry), peas (dry), soya beans (conventional and glyphosate tolerant), olives, banana, kiwi fruit, barley, maize (conventional and glyphosate tolerant), oats, rye, sorghum, wheat, tree nuts, cotton, linseed, rape, sunflower, coffee, tea and sugarcane as well as for lactating cows, laying hens and pigs.

The Meeting received information on glyphosate metabolism and environmental fate, methods of residue analysis, freezer storage stability, national registered use patterns, supervised residue trials and national MRLs. Some information on GAP and national MRLs were submitted by Australia and The Netherlands.

IDENTITY

ISO common name: glyphosate

Chemical names

IUPAC: N-(phosphonomethyl)glycine

CA: N-(phosphonomethyl)-glycine

CAS number: [1071-83-6]

CIPAC number: 177

Synonyms/trade names: Roundup®

Structural formula

Molecular formula: $C_3H_8NO_5P$ (glyphosate)

Molecular weight: 169.1 g/mol

Physical and Chemical Properties

Endpoint	Test material/purity		References
Appearance	Pure material > 99.6% w/w	White solid	Wollerton, Husband, 1997 RJ2400B
	Technical material 96.9% w/w	White solid	Wollerton, Husband, 1997a RJ2401B
Vapour pressure	Pure material >	< 1×10^{-8} kPa (< 1×10^{-7} mm	Wollerton, Husband,

Endpoint	Test material/purity		References
	99% w/w	Hg) at 20 °C indicating glyphosate is non-volatile	1997 RJ2400B
Henry's Law constant		2×10^{-12} Pa m^3 mol^{-1}	Wollerton, Husband, 1997 RJ2400B
Melting point, freezing point or solidification point	Pure material > 99% w/w	Decomposes at 200 °C (473K)	Wollerton, Husband, 1997 RJ2400B
	Technical material 96.9% w/w	Decomposes at 200 °C (473K)	Wollerton, Husband, 1997a RJ2401B
n-Octanol/water partition co-efficient	Pure material > 99% w/w	log P_{ow} < - 1.3 at 20 °C	Wollerton, Husband, 1997 RJ2400B
Solubility in water	Pure material > 99% w/w	10 g/L in purified water. Solubility will increase with pH and be dependant upon ionic strength.	Wollerton, Husband, 1997 RJ2400B
Solubility in organic solvents		Glyphosate has low solubility in common organic solvents	
	Technical material 98.5% w/w	at 20 °C: Ethyl acetate 12 mg/L; propan-2-ol 20 mg/L; hexane 26 mg/L; toluene 36 mg/L; acetone 78 mg/L; dichloromethane, methanol	Robson, 1991 81 GLY
	Technical material 96.9% w/w	231 mg/L. heptane, octan-1-ol, xylenes, ethyl acetate, acetone, 1,2-dichloroethane: < 0.6 mg/L; acetonitrile 0.8 mg/L and methanol 10 mg/L	Wollerton, Husband, 1997a RJ2401B
Relative density	Pure material > 99% w/w	1.70 g/cm^3 at 20°C	Wollerton, Husband, 1997 RJ2400B
	Technical material 96.9% w/w	1.69 g/cm^3 at 20 °C	Wollerton, Husband, 1997a RJ2401B
Hydrolysis rate at pH 4, 7 and 9 under sterile conditions in the absence of light	[P-methylene -^{14}C] glyphosate acid (radiochemical purity 97.9 %)	Stable at pH 5, 7, and 9 and 25 °C	Bowler, 1996 RR 96-002B
Direct photo-transformation	[P-methylene -^{14}C] glyphosate acid (radiochemical purity 97.5 %)	Stable at pH 5, 7 and 9	Esser, 1996 RR96-028B
Dissociation constant	Pure material > 99%w/w	Dissociation constants at 20 °C and a constant ionic strength of 0.1 M are <2, 2.25 ± 0.02, 5.50 ± 0.02 and 10.34 ± 0.04.	Wollerton, Husband, 1997 RJ2400B

Formulations

Glyphosate is available in soluble liquid (SL) and soluble granule (SG) formulations in the ammonium, potassium and isopropylamine salt forms. In order to avoid differences due to the molecular weights of salts of glyphosate, the dosage of the active substance is expressed as acid equivalent: kg ae/ha.

Glyphosate and its metabolites were given various trivial names, systematic names and code numbers in study reports. These are summarised below.

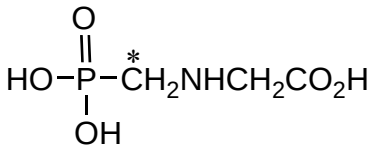
Metabolite No.	Code	Term used in evaluation	Formulae, CAS number/name, other names/codes used in study reports
1	CP67573	Glyphosate	
2	CP50435	AMPA	$H_2NCH_2PO_3H$ aminomethyl phosphonic acid
3	CP67205		$HO_2CCH_2N(CH_3)CH_2PO_3H_2$
4	CP70948	N-methyl AMPA	$CH_3N(H)CH_2PO_3H_2$ [(N-methylamino)methyl]phosphonic acid
5		Methylphosphonic acid	$CH_3PO_3H_2$
6		N-acetyl AMPA	$CH_3C(O)NHCH_2PO_3H_2$ [(acetylamino)methyl]phosphonic acid
7		N-glyceryl AMPA	[(2,3-dihydroxy-1-oxopropyl)aminomethyl]phosphonic acid
8		N-malonyl AMPA	3-oxo-3-[(phosphonomethyl)amino]propanoic acid

METABOLISM AND ENVIRONMENTAL FATE

Animal metabolism

The Meeting received animal metabolism studies for glyphosate in rats, lactating goats and laying hens; the rat studies though not reported here, confirm that the metabolism was qualitatively the same as for the lactating goat and laying hens with no additional metabolites identified.

Powles (1994 279 GLY) studied the metabolism of ^{14}C-glyphosate in lactating goats. Two lactating goats, aged *ca.* 3 years and weighing 61.5 and 70 kg respectively were given repeated doses of (^{14}C)-glyphosate by gavage at 400 mg/animal equivalent to a daily dietary intake of 200 ppm (2 kg dry matter intake/day). Goat A was given (^{14}C)-glyphosate for 5 consecutive days and the goat B was given (^{14}C)-glyphosate for 3 consecutive days. For each animal the daily dose was split and given as two doses within each 24 hour period after milk and excreta collections and before feeding.



* Denotes position of radiolabel (named (^{14}C)-glyphosate in this evaluation and as [^{14}C]-phosphonomethyl-labelled glyphosate in the toxicological evaluation

Excreta were collected from both animals at 24 hour intervals. The goats were milked twice daily and the milk was pooled to provide a daily sample for each animal. A blood sample was also taken from goat B at intervals for up to 24 hours after the initial dose. Goat A was killed *ca.* 23.5 hours after the last dose, the liver, kidneys and samples of muscle and fat were removed at necropsy. Goat B was killed when the plasma radioactivity concentration was at a maximum (*ca.* 8 hours after the final dose) and the tissues were collected for analysis.

The urine, faeces and milk collected on day 2 and tissues from goat B (given 3 daily doses) were used to identify the major radioactive residues. Samples were extracted with chloroform/hydrochloric acid (0.1M), the extracts were cleaned up by ion exchange chromatography and then analysed by TLC on cellulose or, after derivatization with 9-fluorenylmethyl chloroformate, by reverse phase HPLC. Components of the residue were identified by comparison with reference standards; residues in selected samples were isolated by preparative TLC and identified by FT-IR.

After giving 5 daily doses of (^{14}C)-glyphosate to goat A, 90% of the radioactivity was recovered in excreta, milk, tissues, cage washings and debris. The majority of the dose was eliminated in faeces (78%) and only a small proportion was excreted in urine (9.4%); less than 0.05% was present in either milk or tissues. The concentration of ^{14}C in the milk remained relatively constant after the second dose when the concentration was 0.060 mg equiv/kg. The highest ^{14}C tissue concentration was present in kidney (3.9 mg equiv/kg); lower concentrations were present in liver (0.40 mg equiv/kg) and muscle (0.035 mg equiv/kg). The concentration of ^{14}C was below the limit of detection in fat (< 0.028 mg equiv./kg).

For goat B, the concentration of ^{14}C in plasma reached a maximum 6-8 hours after the first dose. Tissue radioactivity in the kidney, liver and muscle of the goat killed *ca.*8 hours after the last of 3 daily doses was 12, 0.22 and 0.061 mg equiv/kg respectively. Radioactivity was below the limit of detection in fat < 0.036 mg equiv. /kg. The concentration of radioactivity in milk was similar to that found in the goat given 5 doses (Table 1).

Table 1. Concentration of radioactivity (mg equiv/kg) in milk of goats given daily doses of (^{14}C)-glyphosate equivalent to 200 ppm in diet (Powles 1994 279 GLY).

Time period after start of dosing (hours)	Goat A (dosed for 5 days)	Goat B (dosed for 3 days)
0-24	0.036	0.040
24-48	0.060	0.066
48-72	0.064	0.086
72-96	0.072	NA
96-138	0.041	NA

NA = Not applicable, milk not collected at this time point

The proportion of tissue radioactivity extracted by $CHCl_3$/0.1 M HCl was 78% and 76% for liver and kidneys respectively. On further clean-up on cation and anion exchange columns the proportion of tissue radioactivity prior to HPLC analysis was 39% and 45% for liver and kidneys respectively. Recoveries following clean-up could not be calculated for fat, muscle and milk because of the low amounts of radioactivity present. Unchanged glyphosate was the major component of the ^{14}C analysed by HPLC in urine (ca. 96%), faeces (> 94%), kidney (97%) and liver (96%). Glyphosate was also detected in fat, muscle and milk by TLC, but the amounts of ^{14}C in the extracts were insufficient for analysis by HPLC. Small amounts of AMPA were also detected in urine, faeces and kidney by TLC but, in each case, the presence of that metabolite could not be confirmed by HPLC. Radiovalidation studies using tissues from a metabolism study where labelled glyphosate and AMPA were fed to lactating goats revealed 65% of the ^{14}C in liver and 91% of the ^{14}C in kidney were due to glyphosate and AMPA (Bodden 1998 MSL7586, Feng and Patanella 1988 MSL7458).

Unchanged glyphosate was the only component of the residue identified by HPLC in tissues and milk.

Laying hens of the ISA strain (age 20-22 weeks; weight 1.5 ± 0.2 kg) were given repeated daily doses of (^{14}C)-glyphosate for 7 (Group A) or 5 (Group B) days (Powles, 1994a 276 GLY). Doses were administered by gavage as a solution in water; the amount given was based on a daily consumption of 150 g DM per bird containing 200 ppm glyphosate. Doses were given after egg and excreta collections and before feeding. Excreta were collected separately from each animal 24 hours after each administration and eggs were collected 3-6 hours after each dose. Egg yolk and white were separated. Blood samples were collected from each animal in group B at intervals after the first dose

and plasma was prepared by centrifugation. Hens in group A were killed 23.5 hours after the last dose; animals in group B were killed when plasma radioactivity was at a maximum at the 1st sample time which was 1 hour after the last dose. The liver and samples of muscle, fat and skin were removed from each bird at sacrifice. Radioactivity was determined in excreta, egg yolk, egg white, liver, muscle, fat and skin. For metabolite identification (Group B) tissues and representative samples of excreta, egg whites and yolks were extracted with chloroform/hydrochloric acid (0.1M), with the extracts cleaned up by ion exchange chromatography and analysed by TLC on cellulose or, after derivatization with 9-fluorenylmethyl chloroformate, by reverse phase HPLC. Components of the residue were identified by comparison with reference standards; residues in selected samples were isolated by preparative TLC and identified by FT-IR.

The overall recovery for birds in group A was 80% within 24 hours of the last dose, 76% being present in excreta (Table 2). The mean concentration of ^{14}C in egg white reached a plateau (*ca*. 0.049 mg equiv/kg) after 5 doses whilst the concentration in yolks increased throughout the dosing period and was 0.48 ± 0.065 mg equiv/kg at the end of the experiment (Table 2). Approximately 24 hours after the seventh dose the concentrations of ^{14}C in liver, skin and fat were 1.2 ± 0.36, 0.21 ± 0.16 and 0.15 ± 0.062 mg equiv/kg respectively. The residue in muscle was below the limit of detection (< 0.043 mg equiv/kg).

The concentration of ^{14}C in plasma of group B hens attained a maximum (0.48 ± 0.31 mg equiv/kg) 1 hour after the initial dose. The plasma concentration of ^{14}C then declined slowly and was still measurable in the plasma of one animal 12 hours after dosing. One hour after the final dose ^{14}C was present in liver (1.1 ± 0.39 mg equiv/kg), skin (0.36 ± 0.07 mg equiv/kg), fat (0.083 ± 0.076 mg equiv/kg) and muscle (0.041 ± 0.024 mg equiv/kg). The pattern of residues in eggs was similar to group A.

Table 2. Concentration of radioactivity (mg equiv/kg) in egg white and yolk of hens given daily doses of (^{14}C)-glyphosate equivalent to 200 ppm in diet.

Time interval after start of dosing (hr)	Group A (dosed for 7 days)		Group B (dosed for 5 days)	
	Egg white	Egg yolk	Egg white	Egg yolk
0-24	ND	ND	ND	ND
24-48	0.029 ± 0.023	ND	0.023 ± 0.010	0.006 ± 0.010
48-72	0.043 ± 0.035	0.090 ± 0.064	0.044 ± 0.008	0.075 ± 0.026
72-96	0.038 ± 0.033	0.198 ± 0.032	0.056 ± 0.006	0.164 ± 0.049
96-120	0.049 ± 0.033	0.318 ± 0.027	0.072 ± 0.001	0.228 ± 0.009
120-144	0.059 ± 0.015	0.365 ± 0.055	NA	NA
144-168	0.053 ± 0.008	0.484 ± 0.065	NA	NA

ND = Not detected,
NA = Not applicable, eggs not collected at this time point

Radioactivity in skin was quantitatively recovered following acidified aqueous extraction; recoveries for liver, fat, muscle, egg yolk and white were 72%, 75%, 81%, 52% and 69% respectively. Procedural losses/gains during the multi-stage clean-up of the extracts were such that only 14–52% of the original tissue and egg ^{14}C was accounted for by chromatography. Unchanged glyphosate was the major component detected by HPLC/TLC in excreta, liver (61% HPLC; 84–89% TLC), skin (99% HPLC; 79–95% TLC), fat (99% HPLC; 62–67% TLC), muscle (98% HPLC; 45–98% TLC), egg white (one component, radioactivity too low to quantify) and egg yolk (96% HPLC; 23–74% TLC). The presence of glyphosate in excreta, liver and skin was confirmed by FT-IR spectroscopy. Small amounts of aminomethylphosphonic acid were detected in excreta, liver and skin by TLC but, in each case could not be confirmed by HPLC. Radiovalidation studies using tissues from a metabolism study where labelled glyphosate and AMPA were fed to laying hens revealed 74% of the ^{14}C in liver and

53% of the ^{14}C in egg yolks were due to glyphosate and AMPA (Bodden 1998a MSL-7591, Feng and Patanella 1988a MSL-7420).

Plant metabolism

Glyphosate is readily degraded in soil forming $^{14}CO_2$ which may then be utilised by plants and incorporated into natural products. In order to distinguish between radioactive residues resulting from metabolism of ^{14}C-glyphosate within the plant and those from uptake of $^{14}CO_2$ formed by degradation of ^{14}C-glyphosate in the soil, the metabolism studies included application groups where the soil was covered during application, the soil was left uncovered as well as control plants, untreated or treated with non-labelled glyphosate using the same rates and timings and grown in close proximity to the ^{14}C-treated plants to monitor the amount of radioactivity due to incorporation of $^{14}CO_2$.

Soya Beans, Cotton, Wheat and Corn

Root uptake and translocation of ^{14}C-glyphosate and ^{14}C-AMPA and their metabolites in conventional soya beans, wheat, cotton, and corn grown in soil and hydroponic nutrient solutions was investigated by Rueppel & Suba (1973 FR 304). To determine the extent of uptake of glyphosate from soil, the silty clay loam soil surface of separate pots planted with corn, cotton, soya beans, and wheat were treated one week after planting with ^{14}C-glyphosate at application rates equivalent to 4.5 kg ae/ha or with ^{14}C-AMPA at 1.6 kg ae/ha. Additional containers of soil were left untreated to act as controls. The treated and untreated control pots were watered from the top twice daily for the duration of the experiment. At four, six, and eight weeks after treatment, one plant from each treated and untreated control pot was cut off 2.5 cm above the soil surface and analysed for ^{14}C-radioactivity.

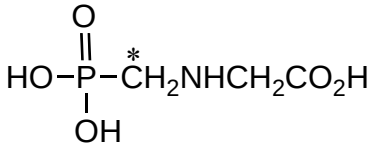
Less than 0.3% of the applied ^{14}C was taken up by the growing plants at 4, 6 and 8 weeks after application. The very low levels of ^{14}C-activity plants samples did not allow the distribution and metabolism of glyphosate in plants to be studied further using this method of treatment.

Table 3. Levels of ^{14}C, expressed in mg glyphosate/kg in corn, cotton, soybean and wheat plants grown in soil treated at the equivalent of 4.5 kg ae/ha. Rueppel & Suba (1973 FR 304).

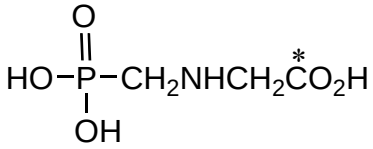
	Corn	Cotton	Soybeans	Wheat
4 weeks				
control	0.068	0.04	0.029	0.008
treated	0.21	0.26	0.20	0.20
6 weeks				
control	0.089	0.020	0.11	0.015
treated	0.14	0.21	0.29	0.18
8 weeks				
control	0.022	0.27	0.045	0.061
treated	0.079	0.42	0.076	0.35

Table 4. Levels of ^{14}C, expressed in mg AMPA/kg in corn, cotton, soybean and wheat plants grown in soil treated at the equivalent of 1.65 kg ae/ha. Rueppel & Suba (1973 FR 304).

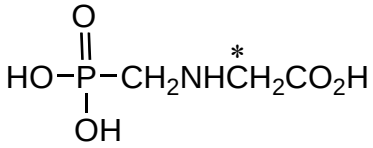
	Corn	Cotton	Soybeans	Wheat
4 weeks				
control	0.012, 0.09	0.13, 0.015	0.023, 0.013	0.022, 0.015
treated	0.021	0.024	0.094	0.075
6 weeks				
control	0.014, 0.013	0.010, 0.010	0.018, 0.010	0.035, 0.021
treated	0.032	0.044	0.053	0.084
8 weeks				
control	0.014, 0.08	0.007, 0.014	0.012, 0.09	0.019, 0.065
treated	0.031	0.032	0.041	0.058



[^{14}C]-phosphonomethyl-labelled glyphosate



Gly-1



gly-2

In a separate experiment, sublethal levels of ^{14}C-glyphosate were continuously administered from aerated hydroponic solutions to 14 day old corn, cotton, wheat, and soya bean seedlings ([^{14}C]-phosphonomethyl-labelled glyphosate for corn, cotton and wheat and $^{13/14}$C-methane, ^{14}C-methane, ^{14}C-glycine-1 and ^{14}C-glycine-2 labelled glyphosate for soya beans). At periodic intervals samples of the hydroponic solution as well as representative plant samples were removed for analysis. Untreated control plants were also maintained to check for $^{14}CO_2$ evolution and incorporation into natural products. Plants were separated into the root and aerial portions, the roots were washed with distilled water, and the plant parts extracted with water and analysed for both the amount and nature of ^{14}C-radioactivity.

The total ^{14}C-radioactivity present in samples was determined directly by combustion of homogenized plant samples. The total ^{14}C-radioactivity present in samples of hydroponic solutions and extracts of plant samples were determined by liquid scintillation counting. Radioactive components of the plant sample extracts were separated by various chromatographic techniques and identified by comparison to authentic standards using thin-layer-chromatography, column chromatography, and following derivatization ^{1}H-, ^{13}C- and ^{31}P-NMR spectroscopy, and mass spectral characterization and identification.

The results of control experiments indicated that $^{14}CO_2$ was being evolved from the ^{14}C-experiments and photosynthetically fixed by both the treated and untreated plants. The amount of ^{14}C-activity in corn, cotton, and soya beans control plants indicates that at least 5% of the total ^{14}C-uptake in treated plants occurred due to fixation of $^{14}CO_2$, and therefore represents a significant portion of the unidentified radioactivity.

With the exception of corn forage, the major ^{14}C-containing component in the aqueous extracts in all cases was parent glyphosate at 21–69% of ^{14}C in aerial parts and 7.6–57% in roots; in corn forage, comparable amounts of glyphosate and AMPA were observed. The major ^{14}C-containing degradate was ^{14}C-AMPA accounting for 4.2–28% of the total ^{14}C-activity in aerial parts and 2.8–7.4% in roots.

Several minor metabolites, which individually constituted less than 2% of the plant-contained ^{14}C-activity were also detected, and were identified as N-methyl-aminomethylphosphonic acid (N-methyl AMPA), methylphosphonic acid, and N-methyl-glyphosate, as well as several unknowns. However, it was not possible to determine if these compounds were derived from the *in vivo* plant metabolism of glyphosate. These very minor metabolites may have resulted as artefacts from very small impurities in the starting ^{14}C-glyphosate or they may have been formed in the hydroponic solutions via microbial degradation of glyphosate.

For all four crops, forage samples could be efficiently extracted with water; 70–90% of the total ^{14}C-activity was extractable. Thus, it was concluded that the isolated metabolites represent all major plant-contained metabolites. In root samples, the water extractability of ^{14}C-activity was decreased compared to forage, for root samples water extractabilities of ^{14}C-activity averaged 49%.

Table 5. Identification of ^{14}C in crops treated hydroponically with ^{14}C-glyphosate for 28 days (except wheat 10 days). Rueppel & Suba (1973 FR 304).

Crop	Label	% TRR[4]						
		H_2O extracted						Unextracted
		Glyphosate[1]	AMPA[2]	N-methyl AMPA[3]	Natural products	Unidentified	Total	
Soybean top	^{14}C-methane	69	9.0	1.1	9.0	2.3	90.5	9.5
Soybean root	^{14}C-methane	37	3.1	0.3	1.4	1.6	44	56
Soybean top	^{14}C-2-gly	49	-	-	14	20	83	17
Soybean root	^{14}C-2-gly	22	-	0.4	11	4.2	37	63
Soybean top	^{14}C-1-gly	57	-	-	4.2	14	75	25
Soybean root	^{14}C-1-gly	57	-	-	1.3	0.4	59	41
Cotton top	^{14}C-methane	62	6.8	2.0	8.2	11	90	10
Cotton root	^{14}C-methane	7.6	2.8	0.4	1.1	1.1	13	87
Maize top	^{14}C-methane	21	28	0	4.0	20	73	27
Maize root	^{14}C-methane	46	4.4	0	2.0	12	64	36
Wheat top	^{14}C-methane	55	4.2	-	1.0	8	68	32
Wheat root	^{14}C-methane	36	7.4	-	1.0	1.3	46	54

[1] identified by mass spectrum, ^{1}H- and ^{12}C-NMR and chromatographic behaviour on D-1, D-50 and Bio-Gel P-2 columns

[2] identified by chromatographic behaviour on D-1, D-50 and Bio-Gel P-2 columns and cellulose TLC

[3] N-methyl AMPA = N-methylaminomethylphosphonic acid, identified by chromatographic behaviour on D-1, D-50 and Bio-Gel P-2 columns and cellulose TLC

Note: AMPA (and N-methyl AMPA in ^{14}C-glycine-1) is not expected to be formed in the ^{14}C-glycine-1 or 2- glyphosate labelled experiments

[4] Data corrected for ^{14}C in controls.

Coffee

Malik (1975 FR 344) studied the extent of uptake and the pattern of distribution of ^{14}C-glyphosate and its metabolites into coffee plants (fruit, foliage, roots, and stems) following foliar applications, stem treatments, hydroponic solution uptake, and soil treatment.

For soil uptake experiments, seedling coffee plants (38–51 cm tall) were planted singly in plastic pots filled with Drummer silty clay loam soil. The soil surfaces of three pots were treated with ^{14}C-glyphosate (labelled in the phosphonomethylene carbon) at applications rates equivalent to 4.5 kg ae/ha. In addition, three untreated control pots were placed in close proximity to the treated pots to ascertain the amount of incorporation of $^{14}CO_2$ resulting from the microbial degradation of ^{14}C-glyphosate in the treated soil. All pots were watered daily from the top for the duration of the

experiment. At four, six, and eight weeks after treatment, one treated and one control plant were cut off approximately 2.5 cm above the soil and separately analysed for ^{14}C-radioactivity.

For the hydroponic solution uptake study, sublethal dose levels of ^{14}C-glyphosate were continuously administered from aerated hydroponic solutions to several 38–51 cm tall seedling coffee plants. Following 21 days of treatment the plants were removed from the nutrient solutions, separated into the aerial portions and roots, and the roots were washed to remove any surface ^{14}C-activity. Each sample was then separately analysed for ^{14}C-activity.

To determine the uptake and distribution of glyphosate in coffee plants following stem applications, a formulated solution containing 0.70 mg of ^{14}C-glyphosate was uniformly applied to three of the lower segments of the stem of each 51 cm tall seedling coffee plant. Five weeks after treatment the plants were removed from the nutrient solutions, separated into the leaves, untreated stems, treated stems, and roots, and each sample was separately analysed for ^{14}C-activity.

The distribution and metabolism of glyphosate following foliar applications was investigated in immature coffee plants as well as mature bean producing coffee trees. The uptake, translocation, and metabolism of glyphosate was followed in five immature coffee plants (51 cm high) growing in nutrient solution in a large hydroponic tank. Sub-herbicidal levels of a ^{14}C-glyphosate solution were applied by micro syringe to selected leaves on each plant. At four and five weeks after treatment, plants were harvested and sectioned into the roots, treated leaves, untreated leaves, and stems, and each sample was separately extracted with water and analysed for both the amount and nature of ^{14}C-radioactivity.

To study the uptake, translocation, and metabolism of glyphosate in bean-producing coffee plants four to five-year old, 2.1 to 2.4 m tall container grown coffee plants that had bloomed approximately one month prior to treatment and had set beans were used. The lower leaf surface of each of 100 leaves on ten different lower branches of the coffee tree was treated with sublethal dose level of a simulated commercial formulation of ^{13}C/^{14}C-glyphosate. At 4, 8, 12, 16, 20, and 23 weeks after treatment a random sample of beans was removed from the tree and analysed for ^{14}C-activity. In addition, leaves, which had wilted and fallen off during each four-week period were collected and analysed for ^{14}C-activity.

The total ^{14}C-activity present in samples was determined directly by combustion of homogenized and lyophilized plant samples. The total ^{14}C-activity present in aqueous extracts of plant samples was determined by liquid scintillation counting. Radioactive components of the extracts of plant samples were separated by various chromatographic techniques and identified by comparison to authentic standards using column chromatography and two-dimensional thin layer chromatography (2D-TLC). Chromatographic identifications were verified by ^{31}P-NMR and ^{13}C-NMR, and gas-chromatographic-mass-spectral and field-desorption-mass-spectral analysis of purified and derivatized compounds isolated from the aqueous plant extracts.

Only a very small amount of glyphosate was taken up by coffee plants from soil; 0.003-0.017% of the administered ^{14}C at 4-8 weeks after application at the equivalent of 4.5 kg ae/ha. The detection of ^{14}C residues in the control coffee placed in close proximity to the treated pots indicated that $^{14}CO_2$ was being evolved from the soil degradation of ^{14}C-glyphosate and photosynthetically fixed by both the treated and untreated plants and this accounted for most of the ^{14}C incorporation in treated plants.

Significant ^{14}C-activity was found in the roots of coffee plants grown in hydroponic solutions containing ^{14}C-glyphosate. Following 21 days of treatment, between 16 and 50% of the applied ^{14}C-activity was associated with the roots. In contrast, significantly less activity was found in the aerial portions of the coffee plants. The total percentage of applied ^{14}C-activity found in the aerial portions of plants grown in hydroponic solutions ranged from 0.1 to 0.2%.

The majority of the ^{14}C-glyphosate applied to the stems of coffee plants at 5 weeks after treatment remained at the site of application (87% of applied ^{14}C) with only low levels associated with untreated leaves (0.54%), stems (1.7%) and roots (0.5%).

^{14}C-Glyphosate applied to the foliage of immature coffee plants is rapidly and extensively translocated throughout the coffee trees from the treated leaves. Nonetheless, the majority of the applied ^{14}C-activity remains on the treated leaves (44 to 86% of the applied ^{14}C-activity). At three weeks after treatment with formulated ^{14}C-glyphosate, the percent of ^{14}C-activity applied to leaf surfaces that had been translocated into the coffee plants ranged from 10 to 27%. At five weeks after treatment, 28% of the applied ^{14}C-radioactivity was absorbed and translocated.

In the case of the mature, bean-producing coffee tree that received a foliar application of formulated ^{14}C-glyphosate, approximately 48% of the applied ^{14}C-activity was absorbed and translocated from the treated leaves. However, less than 2.4% of the applied ^{14}C-activity was translocated to the developing coffee beans. At 23 weeks after treatment, the percent of applied ^{14}C-activity found in the green beans and pods, ripe beans, and ripe pods was 0.94, 0.62, and 0.68%, respectively.

Aqueous extraction of the treated leaves, stems, untreated leaves, and roots released 92, 91, 72, and 96% of the plant-contained ^{14}C-activity, respectively with greater than 99% of the extracted ^{14}C-activity identified as parent glyphosate. In the case of coffee beans, aqueous extraction released 96-99% of the plant contained ^{14}C-activity. For beans harvested at four and eight weeks after treatment, greater than 99% of the extracted ^{14}C-activity was demonstrated to be parent glyphosate. The aqueous extracts of ripe beans and pods harvested 23 weeks after treatment contained 95% parent glyphosate and 5% aminomethylphosphonic acid (AMPA).

Pasture Grasses, Alfalfa and Clover

Sutherland and Banduhn (1976 FR 404) studied the metabolism of glyphosate on pasture crops. In the first experiment, ^{14}C-glyphosate (labelled in the phosphonomethylene carbon) was applied at the equivalent of 4.5 kg ae/ha to the surface of soil of pots containing three different seed mixes: fescue and alfalfa, brome grass and red clover, and timothy grass and white clover. For each grass and legume seed mixture two replicated, non-treated control pots were also established and placed side-by-side with the ^{14}C-treated pots to differentiate between the actual uptake from soil of glyphosate and its metabolites and the incorporation of $^{14}CO_2$ resulting from the microbial degradation of ^{14}C-glyphosate in the soil. The grass and legume forage from each pot was harvested at 6, 12, 18, 24, and 32 weeks after treatment and analysed for ^{14}C-activity.

For experiment two, established quackgrass was treated with a foliar application of 1.7 kg ae/ha of ^{14}C-glyphosate formulated as Roundup® herbicide. One week after treatment the quackgrass foliage, roots and soil were thoroughly mixed and then used to form a 3.8 cm deep seedbed on the top of the soil surface of two pots. One month after incorporation of the quackgrass, a mixture of fescue grass and alfalfa were seeded into each pot. The fescue and alfalfa forage were harvested from each pot at 6, 12, 18, and 24, weeks after planting and analysed for ^{14}C-activity.

For experiment three, three pots each of established fescue grass and alfalfa were treated with a foliar application of 1.1 kg ae/ha of ^{13}C/^{14}C-glyphosate, formulated as Roundup® herbicide. The treated foliage was removed one week after treatment and analysed for ^{14}C-activity. In addition, subsequent regrowth foliage was removed at 9, 15, and 23 weeks after treatment and analysed separately for ^{14}C-activity.

For the final experiment, two pots each of established fescue grass and alfalfa were treated with a foliar application of 1.1 kg ae/ha of ^{14}C-glyphosate formulated as Roundup® herbicide. The fescue and alfalfa forage was harvested one week after treatment and allowed to air dry for an additional week before the samples were separately analysed for ^{14}C-activity.

All experiments used a silt loam soil with 1.2% organic matter and a pH of 8.1. For all experiments, crops were planted in plastic pots and grown in a greenhouse.

The total ^{14}C-activity present in samples was determined directly by combustion of homogenized and lyophilized plant samples. The total ^{14}C-activity present in aqueous extracts of plant samples from experiments three and four were determined by liquid scintillation counting. Radioactive components of the extracts of plant samples were separated by various chromatographic techniques and identified by comparison to authentic standards using column chromatography, ^{13}C-NMR spectroscopy, or, following derivatization, mass spectral characterization and identification.

In all cases less than 0.09% of the applied ^{14}C-activity was found in grasses and legumes harvested at 6, 12, 18, 24, and 32 weeks after a pre-emergence treatment of ^{14}C-glyphosate at an application rate of 4.5 kg ae/ha. There was negligible uptake of ^{14}C into fescue and alfalfa forage from soil containing incorporated quackgrass which had been previously treated with glyphosate with ≤ 0.09% of the ^{14}C applied to quackgrass prior to incorporation found in fescue forage at 6, 12, 18, and 24 weeks after planting and ≤ 0.04% in alfalfa forage at the same harvest intervals.

One week after foliar treatment, fescue and alfalfa forage contained 69% and 55% of the applied ^{14}C-activity, respectively of which > 95% was water extractable. Glyphosate was the only compound detectable in the aqueous extracts. The percent of applied ^{14}C-activity in the forage of fescue and alfalfa which regrew following treatment was 0.17-0.20, 0.18-0.19 and 0.05-0.06% at 9, 15, and 23 weeks after treatment respectively.

Fescue and alfalfa forage harvested one week after a foliar application of glyphosate and allowed to air dry for one week prior to sampling contained 42 and 64% of the applied ^{14}C-activity, respectively.

Aqueous extraction released greater than 95% of the plant-contained radioactivity. For alfalfa, glyphosate was the only detectable compound in the aqueous extracts while for fescue glyphosate was the major component with approximately 3% aminomethylphosphonic acid also found. Glyphosate applied to the foliage of pasture crops just prior to harvest is not altered during the drying process necessary to produce hay.

Plant Metabolism - Glyphosate Tolerant Crops

Glyphosate binds to and blocks the activity of 5-enolpyruvyl-shikimate-3-phosphate synthase (EPSPS), an enzyme of the aromatic amino acid biosynthetic pathway. Glyphosate inhibition of EPSPS prevents the plant from synthesizing the aromatic amino acids essential for protein synthesis. EPSPS is present in all plants, bacteria, and fungi, but not animals; animals do not make their own aromatic amino acids, but obtain them from their diet.

The development of glyphosate-tolerant crops has utilised the "target-site modification" approach, whereby a glyphosate-tolerant EPSPS was identified and its expression induced in plants by genetic modification techniques. Upon glyphosate treatment, the plant remains unaffected because the continued action of the glyphosate-tolerant EPSPS enzyme (CP4-EPSPS) supplies the plant's need for aromatic amino acids, as outlined in Figure 1.

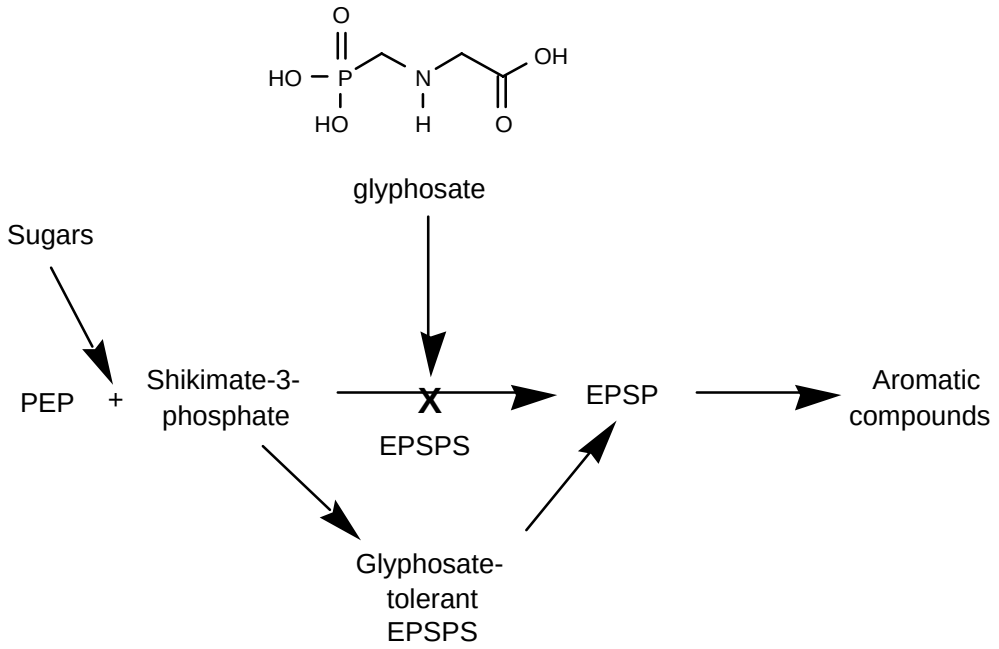


Figure 1. Target-site modification approach to glyphosate tolerance.

Metabolism studies have been completed in glyphosate tolerant soya beans, sugar beet, and cotton crops that contain the CP4-EPSPS gene. At a basic level, the metabolic profile and distribution of metabolites in these crops was not expected to change compared to non-tolerant crops, because the addition of the CP4-EPSPS gene into the plant should not affect the route of metabolism of glyphosate.

These studies used higher treatment rates of glyphosate than possible with non-tolerant crops, involved direct applications of glyphosate to plants at various stages of development, and allowed for an improved understanding of glyphosate metabolism in plants. In all cases, glyphosate was applied as a formulated solution that simulated commercial formulations.

In order to distinguish between radioactive residues resulting from metabolism of ^{14}C-glyphosate within the plant and those from uptake of $^{14}CO_2$ formed by degradation of ^{14}C-glyphosate in the soil, the plants were divided into two treatment groups. In one group the soil was covered during application to minimize contact of the test substance with the soil, and in the other group the soil was left uncovered. Additionally, control plants, untreated or treated with non-labelled glyphosate using the same rates and timings, were grown in close proximity to the ^{14}C-treated plants to monitor the amount of radioactivity due to incorporation of $^{14}CO_2$.

In soya beans, glyphosate is metabolized substantially to AMPA. AMPA can be further conjugated with natural plant constituents to give trace level metabolites, or degraded to one carbon fragments that are incorporated into natural products. None of the trace level metabolites account for greater than 2% of the total radioactive residues (TRR) in any soya bean raw agricultural commodity. Glyphosate plus AMPA account for at least 66% of the total radioactive residues in forage, hay, and grain. Glyphosate residues differ among the plant components accounting for about 90% of the TRR in forage but only about 25% of the TRR in grain. AMPA accounts for only 6.8% of the TRR in forage, but is the major ^{14}C compound in grain, accounting for up to 49% of the TRR. About 9% of the TRR in grain was shown to be due to incorporation of ^{14}C into natural products; this was contained in the oil as fatty acids, in the aqueous extract as soluble components, and in the acid hydrolysate of the extracted grain as amino acids and natural organic acids.

In glyphosate tolerant cotton, glyphosate and AMPA account respectively for 91–95% and 0.7–1.6% of the TRR in forage. TRR in cotton seed were low (0.1–0.2 mg equiv/kg) compared to those in forage residues (15–30 mg equiv/kg). Glyphosate is the major extractable radiolabeled compound (12–24 % of the TRR) and only trace levels of AMPA are present (< 2% of the TRR). A significant fraction of the residues in the seed are attributed to incorporation into natural products; 10-12% of the TRR was characterized as saponifiable fatty acids in oil and 54–75% of the TRR was characterized as unextracted natural products.

The metabolism of ^{14}C-glyphosate in tolerant sugar beet was very similar to soya beans and cotton. Glyphosate is partially metabolized to AMPA and low levels of AMPA conjugates. Glyphosate and AMPA together account for at least 99 and 81% of the TRR in roots and tops, respectively. AMPA is further converted to a limited degree to afford low levels of simple conjugates. In addition to conjugation, ^{14}C is broadly incorporated into a wide variety of natural products and plant constituents.

The results of all the studies demonstrate that the metabolic fate of glyphosate in tolerant plants is the same as in non-tolerant plants.

Glyphosate Tolerant Cotton

The nature of residues in cotton that has been genetically modified to be tolerant to glyphosate following applications of ^{14}C-glyphosate was determined by Bleeke (1997 MSL 14113). In order to distinguish between radioactive residues resulting from metabolism of ^{14}C-glyphosate within the plant and those from uptake of $^{14}CO_2$ formed by microbial degradation of ^{14}C-glyphosate in the soil, the plants were divided into two treatment groups. In one group the soil surface was covered during application to minimize contact of the test substance with the soil, and in the other group the soil was left uncovered during application. For each type of treatment, there was a ^{12}C-treated test group (control plants) adjacent to each ^{14}C-treated test group; the control plants provided a measure of the contribution of $^{14}CO_2$ uptake to the total radioactive residues in the ^{14}C-treated plants.

The treatment regimen for both test groups consisted of two sequential post-emergence applications, which were made at the 3- to 4-leaf stage (42 days after planting) and at the 5 to 6 leaf stage (51 days after planting). A formulated solution of ^{14}C-Glyphosate (labelled in the phosphonomethylene carbon,) was applied to the test groups at target rates of 0.93 kg ae/ha for the first application and 1.26 kg ae/ha for the second application. Crop samples were collected at the forage stage (78 days after planting, or 27 days after the second application) and at maturity (209 days after planting, or 158 days after the second application) to simulate normal agricultural practices. At final harvest, the plants were separated into seed, lint, and stalk fractions.

TRR in all plant samples were determined directly by combustion of homogenized plant samples. The treated forage samples were extracted with water. The treated seed samples (protected and non-protected) and the control non-protected seed sample were first extracted with hexane, then with 50% acetonitrile in water. The total radioactivity in the extracts of plant samples was determined by liquid scintillation counting. Radioactive components of the extracts of plant samples were separated by various chromatographic techniques and identified by comparison to authentic standards.

The total radioactivity found in cotton forage, stalk, lint and seed (expressed as mg/kg glyphosate equivalents) is summarized in Table 6. The TRR in forage were 15 to 30 mg/kg (glyphosate equivalents). In the seed, however, there were much lower residues of < 0.2 mg/kg. In addition, there were relatively high levels of ^{14}C in the final harvest ^{12}C-treated control seed samples, particularly in those from the non-protected plots. The level of residues in the control seed samples indicates that uptake of soil-generated $^{14}CO_2$ and its incorporation into the plant made a significant contribution to the TRR at harvest. The majority of the residue was located on the surface as shown by the ^{14}C removed by water rinse.

Table 6. Distribution of ^{14}C residues in cotton forage stalk, seed and lint samples from treated and control glyphosate resistant plants treated with two applications of [^{14}C-methyl]glyphosate at 0.93 and 1.3 kg ae/ha (Bleeke 1997 MSL 14113).

Sample	TRR (glyphosate equivalents, mg/kg)			
	Protected		Unprotected	
	^{14}C-treated	^{12}C-treated	^{14}C-treated	^{12}C-treated
Forage	30	0.008	15	0.039
Rinsed forage	7.0	NA	6.3	NA
Rinsate	16	NA	11	NA
Cotton seed	0.11	0.018	0.18	0.07
Mature stalk	0.11	0.08	0.18	0.047
Cotton lint	0.083	0.016	0.14	0.057

NA = not applicable as control of forage was not rinsed

Aqueous extracts of the treated forage samples contained > 95% of the TRR with glyphosate accounting for > 91% and AMPA < 2% of the ^{14}C. In addition, there were low levels of radioactivity (< 1% TRR) characterized as radiolabeled natural products, and one trace-level component (< 0.6% TRR) that tentatively characterized as a conjugate of glyphosate.

The seed samples were first extracted with hexane to remove the oil, then with 50% acetonitrile in water. The hexane-extracted oil contained 11 to 15% of the TRR, which was characterized as saponifiable fatty acids. The aqueous acetonitrile extracts of seed samples contained 19 to 32% of total radioactive residues. Glyphosate was the major component of the aqueous extracts (12 to 24% TRR), with only low levels of AMPA (< 2% TRR). Other components in aqueous extracts were tentatively characterized as natural products accounting for 6 to 7% TRR (Table 7).

Table 7. Characterisation of ^{14}C in cotton foliage and seed from glyphosate resistant plants treated with two applications of [^{14}C-methyl]glyphosate at 0.93 and 1.3 kg ae/ha (Bleeke 1997 MSL 14113).

	TRR (glyphosate equivalents, mg/kg)			
	Forage (PHI 27 days)		Seed (PHI 158 days)	
	Protected	Unprotected	Protected	Unprotected
TRR	30	15	0.11	0.18
Aqueous extract	30 (99)	15 (97)	0.034 (32)	0.034 (19)
Glyphosate[1]	29 (96)	14 (92)	0.025 (24)	0.022 (12)
AMPA[1]	0.20 (0.66)	0.24 (1.6)	0.001 (1.4)	< 0.002 (<1)
Conjugate[2]	0.087 (0.29)	0.082 (0.54)	-	-
Natural products[2]	0.12 (0.40)	0.13 (0.83)	0.007 (6.9)	0.011 (5.8)
Hexane extract			0.012 (11)	0.027 (15)
Saponifiable fatty acids[3]			0.011 (10)	0.022 (12)
PES[5]	0.45 (1.5)	0.71 (4.7)	0.058 (54)	0.14 (75)
Total	30 (100)	15 (102)	0.10 (97)	0.20 (109)

Figures in brackets are %TRR

[1] Identified by SAX and SCX HPLC/LSC with co-injection of authentic ^{14}C-standard

[2] tentatively assigned to a conjugate of glyphosate based on the predominance of glyphosate in the sample and the late elution time using SAX HPLC

[3] the extracted oil was saponified with methanolic KOH and extracted with ether before and after acidification of the hydrolysate.

The non-extractable residues in seeds following hexane and aqueous extractions accounted for 54 to 75% of the TRR in the treated samples, and about 75% of the TRR in the non-protected control sample. Additional extractions of the treated seed samples were carried out with a variety of solvents at room temperature, in an attempt to release the unextracted radioactivity. The most effective solvents were 0.1 N NaOH and 1% sodium lauryl sulfate, which each extracted about an additional 10% TRR from treated samples. The released ^{14}C-radioactivity in the 0.1 N NaOH extract from the treated non-protected seed (9.3% TRR, 0.017 ppm) had no detectable levels of either

glyphosate or AMPA and is proposed to be due to incorporation of ^{14}C into a variety of natural products.

Glyphosate Tolerant Soya Beans

Goure *et al.* (1994 MSL 13520) studied the metabolism of ^{14}C-glyphosate in glyphosate tolerant soya beans (CP4 EPSPS) following a single pre-emergent application and after post-emergent applications. The pre-emergent application was made at 5.4 kg ae/ha. Two different post-emergent application regimes were used. In the first soybeans were sprayed at 0.84 kg ae/ha 21 days after planting when the plants were at the V3 growth stage. In the second two applications were made, the first at 0.84 kg ae/ha applied 21 days after planting and the second at 1.7 kg ae/ha applied 43 days after planting. During the post-emergent applications, care was taken to avoid getting any radiolabeled test substance on the soil in order to minimize formation of $^{14}CO_2$ by microbial degradation of glyphosate in the soil. In addition, ^{12}C-treated control plants were grown adjacent to the ^{14}C-treated test plants to monitor the formation of $^{14}CO_2$. The control plants were treated with non-radiolabeled herbicide using the same application rates and timings as those used for ^{14}C-treated plants.

Crop samples were collected to simulate normal agricultural practices. Forage, hay, and grain samples were collected 35, 63, and 83 days after the early post-emergence application, respectively. Samples of forage and hay were ground and extracted with water. Grain samples were ground and extracted first with hexane to remove the oil, then with 50% acetonitrile in water, and finally with water; the grain aqueous extracts were combined.

The total ^{14}C-activity present in samples was determined directly by combustion of homogenized and lyophilized plant samples. The total ^{14}C-activity present in aqueous extracts of plant samples was determined by liquid scintillation counting. Radioactive components of the extracts of plant samples were separated by various chromatographic techniques and identified by comparison to authentic standards using column chromatography and following derivatization, mass spectral characterization and identification.

The total radioactivity, expressed as mg/kg glyphosate equivalents, found in soya beans forage, hay, and grain and its distribution following extraction is summarized in Table 8. Only low levels of glyphosate (< 0.01 mg/kg) and AMPA (< 0.05 mg/kg) were detected in plants that received the pre-emergence application. The majority of the ^{14}C was characterized as radiolabeled natural plant constituents most likely due to the incorporation of $^{14}CO_2$ derived from ^{14}C-glyphosate degradation in the soil.

Table 8. Total radioactive residues and distribution of residues in extracts of soya beans after pre-emergent applications of ^{14}C-glyphosate at 5.4 kg ae/ha (Goure *et al.* 1994 MSL 13520).

Extract	TRR (mg/kg as glyphosate)					
	Forage (PHI 56 days)		Hay (PHI 84 days)		Grain (PHI 104 days)	
	^{12}C-treated	^{14}C-treated	^{12}C-treated	^{14}C-treated	^{12}C-treated	^{14}C-treated
TRR	0.14	0.24	0.12	0.20	0.44	0.75
Aqueous extract	0.024 (18)	0.056 (24)	0.029 (24)	0.063 (31)	0.092 (21)	0.21 (28)
Hexane extract					0.076 (17)	0.11 (14)
Extracted solids	0.11 (84)	0.18 (73)	0.094 (78)	0.15 (74)	0.27 (60)	0.42 (56)
H_2O			0.005 (4.3)	0.009 (4.2)	0.032 (7.1)	0.017 (2.2)
Protease			0.016 (13)	0.037 (18)	0.062 (14)	0.15 (20)
Amylase			0.007 (6.1)	0.002 (1.1)	0.014 (3.3)	0.013 (1.8)
Cellulase			0.019 (16)	0.021 (10)	0.028 (6.2)	0.024 (3.2)
PES			0.038 (31)	0.074 (36)	0.088 (20)	0.097 (13)
Total	101	97	102	105	98	98

Figures in brackets are %TRR
PES = post extraction solids

The nature and magnitude of the radioactive components in forage, hay, and grain obtained from soya beans that received post-emergence applications of radiolabeled glyphosate are summarized below in Tables 9 and 10. Aqueous extraction released the majority of the total radioactivity in forage, hay, and grain samples. Glyphosate and AMPA were the major radiolabeled components present in the aqueous extracts in soya beans forage, hay, and grain accounting for greater than 95%, 66%, and 74% of the TRR, respectively for crops receiving two post-emergent sprays. The portion of the residues present as intact glyphosate was lower in samples collected at later time points, comprising approximately 90% of the TRR in forage but about 25% of the TRR in grain. AMPA accounted for only 6.8% of the TRR in forage but was the major radiolabeled compound in grain, accounting for up to 49% of the TRR. Trace level metabolites present in the aqueous extracts of grain were identified as N-glyceryl-AMPA, N-acetyl-AMPA, N-malonyl-AMPA, and N-methyl-AMPA. No single trace level metabolite accounted for greater than 2% of the TRR in any raw agricultural commodity.

The radioactive residues in the hexane-extracted soya bean oil (0.91% TRR) were shown to be radiolabeled naturally occurring fatty acids. No glyphosate or glyphosate-related metabolites were present in soya bean oil. The oil was saponified and partitioned to give a non-saponifiable ether extract (0.06% TRR), a saponifiable ether extract (0.79% TRR), and an extracted aqueous fraction (0.05% TRR). HPLC analysis of the saponifiable ether fraction showed that the major ^{14}C-containing peaks had the same retention times as oleic, palmitic, and linoleic acids, and two smaller peaks had the same retention times as linoleic and stearic acids. Isolation of the peaks followed by GC/MS analysis confirmed the identity of the fatty acids in the ^{14}C-containing HPLC fractions. Thus, most of the radioactivity in the oil was a result of the breakdown of ^{14}C-glyphosate to one carbon fragments that become incorporated into naturally occurring fatty acids.

Non-extracted ^{14}C residues were less than 8% of the TRR for all samples. Acid hydrolysis of extracted grain released 85% of the remaining radioactivity. The acid-released radioactivity was shown to be closely associated with natural products such as amino acids and organic acids derived from $^{14}CO_2$ incorporation and the *in vivo* degradation of ^{14}C-glyphosate to one carbon fragments.

The ^{12}C-treated control samples contained less than 1% of the radioactivity found in the ^{14}C-treated samples, and were not further analysed. The low levels of radioactivity in the control samples indicates that very little of the radioactivity in the ^{14}C-treated samples is due to $^{14}CO_2$ incorporation; thus, the majority of radioactivity in the ^{14}C-treated samples is due to the *in vivo* metabolism of glyphosate.

Table 9. Characterisation of ^{14}C in soybean foliage and seed from glyphosate resistant plants treated with a single post-emergent application of ^{14}C-glyphosate at 0.84 kg ae/ha (Goure *et al.* 1994 MSL 13520).

	TRR (glyphosate equivalents, mg/kg)		
	Forage (PHI 13 days)	Hay (PHI 41 days)	Grain (PHI 61 days)
TRR	0.86	0.55	0.41
Aqueous extract	0.82 (95)	0.44 (80)	0.20 (49)
Glyphosate[1]	0.76 (89)	0.35 (65)	0.041 (10)
AMPA[1,2]	0.02 (2.3)	0.029 (5.3)	0.093 (23)
N-methyl-AMPA[2]		0.003 (0.6)	
N-glyceryl-AMPA[3]			0.005 (1.2)
N-acetyl-AMPA[3]			0.004 (1.0)
N-malonyl-AMPA[3]			0.31 (1.8)
Natural products[1]	0.013 (1.5)	0.015 (2.7)	0.47 (2.7)
Hexane extract			0.16 (0.9)
Saponifiable fatty acids[4]			0.14 (0.8)
HCl extract			1.0 (5.8)
Amino acids & natural organic acids			0.90 (5.1)
PES[5]	0.040 (4.7)	0.048 (8.9)	0.14 (0.8)
Total identified	0.80 (92)	0.40 (73)	0.15 (36)

Figures in brackets are %TRR

Table 10. Characterisation of ^{14}C in soybean foliage and seed from glyphosate resistant plants treated with two post-emergent applications of ^{14}C-glyphosate at 0.84 and 1.7 kg ae/ha (Goure *et al.* 1994 MSL 13520).

	TRR (glyphosate equivalents, mg/kg)		
	Forage (PHI 13 days)	Hay (PHI 41 days)	Grain (PHI 61 days)
TRR	24	10	17
Aqueous extract	25 (104)	8.0 (77)	15 (88)
Glyphosate[1]	21 (89)	5.6 (54)	4.4 (25)
AMPA[1,2]	1.6 (6.8)	1.3 (13)	8.6 (49)
N-methyl-AMPA[2]	0.14 (0.6)	0.13 (1.3)	0.13 (0.8)
N-glyceryl-AMPA[3]		0.084 (0.8)	0.28 (1.6)
AMPA-conjugate[3]			0.18 (1.0)
N-acetyl-AMPA[3]			0.24 (1.4)
N-malonyl-AMPA[3]			0.31 (1.8)
Natural products[1]	0.62 (2.6)	0.27 (2.6)	0.47 (2.7)
Unknown		0.059 (0.6)	
Hexane extract			0.16 (0.9)
Saponifiable fatty acids[4]			0.14 (0.8)
HCl extract			1.0 (5.8)
Amino acids & natural organic acids			0.90 (5.1)
PES[5]	0.91 (3.8)	0.79 (7.6)	0.14 (0.8)
Total identified	23 (99)	7.5 (72)	16 (90)

Figures in brackets are %TRR
[1] identified by SAX-HPLC and CX-HPLC and comparison of the chromatographic properties of the metabolites and derivatized metabolites with those of the corresponding reference standards
[2]identified by CX-HPLC as well as derivatization followed by mass spectral analysis and comparison of the chromatographic properties of the metabolites and derivatized metabolites with those of the corresponding reference standards.
[3] identified by SAX-HPLC and comparison of the chromatographic properties of the metabolites and derivatized metabolites with those of the corresponding reference standards
[4] HPLC and GC/MS shows that the fatty acids present were palmitic acid, stearic acid, oleic acid, linoleic acid, and linolenic acid
[5]PES = post extraction solids

Glyphosate Tolerant Sugar Beet

Mehrsheikh (2000 MSL 16247) studied the metabolism of glyphosate on tolerant sugar beet (line 77, variety HME Empire RR). $^{13/14}C$-glyphosate was applied to box plots as a pre-emergent application one day after planting seeds at the equivalent of 0.9 kg ae/ha in experiment 1 and as two post-emergent applications for experiment 2. The post-emergent applications were made at the true 2–4 and 12–14 leaf stages 35 and 68 days after planting at rates of 1.1 kg ae/ha. The boxes were maintained under protected cover for all but the first week of the experiment. Sugar beet tops and roots were sampled at mature harvest (17–18% sugar content) 159 days after planting.

Plant samples were ground to homogeneity and portions were combusted and analysed by liquid scintillation counting to determine the distribution of total radioactive residues (TRR). The radioactive residues in ground samples were extracted with water. The total ^{14}C-activity present in aqueous extracts of plant samples was determined by liquid scintillation counting. Radioactive components of the extracts of plant samples were separated by various chromatographic techniques (SAX-HPLC, CX-HPLC, amino column HPLC, RP-paired-ion HPLC, RP-HPLC) and identified by comparison to authentic standards using column chromatography and following derivatization, mass spectral characterization and identification. Analysis of samples was 16–57 days after harvest.

The total radioactivity, expressed as mg/kg glyphosate equivalents, found in sugar beet tops and roots and its distribution following extraction is summarized in Tables 11 and 12. The total radioactive residues in sugar beet tops and roots following two sequential post-emergence applications of ^{14}C-glyphosate were 3.4 mg/kg and 1.4 mg/kg, respectively. In contrast, control sugar beet tops and roots housed near the ^{14}C-treated group contained only 0.001 mg/kg of ^{14}C-activity. Aqueous extractions of sugar beet tops and roots resulted in solubilisation of majority of the radioactive residues. Only 1.8% and 1.3% of the radioactivity remained associated with the extracted tops and roots, respectively.

Table 11. Distribution and characterisation of $^{13/14}$C in sugar beet tops and roots harvested 159 days after planting following a single pre-emergent application at 0.9 kg ae/ha. Mehrsheikh (2000 MSL 16247)

	TRR (mg/kg as glyphosate)	
Fraction	Tops	Roots
TRR	0.005	0.008
Aqueous extract	0.003 (59)	0.007 (86)
Unextracted (PES)	0.003 (50)	0.002 (20)
Total recovery	109%	106%

Table 12. Distribution and characterisation of 13/14C in sugar beet tops and roots harvested 159 days after planting, 91 days after the last of two post-emergent applications at 1.1 kg ae/ha. Mehrsheikh (2000 MSL 16247).

	TRR (mg/kg as glyphosate)	
Fraction	Tops	Roots
TRR	3.4	1.4
Aqueous extract	3.0 (87)	1.4 (103)
Glyphosate[1]	2.7 (80)	1.3 (95)
AMPA[2]	0.06 (1.8)	0.05 (3.8)
Natural products[3]	0.05 (1.4)	0.02 (1.2)
Unidentified glyphosate/AMPA acetylated conjugates[4]	0.03 (0.8)	0.01 (0.55)
Unextracted (PES)	0.062 (1.8)	0.018 (1.3)
Acid hydrolysis	0.053 (1.5)	NA
Total recovery	88%	105%

[1] glyphosate: isolated using HPLC and identified as the trifluoroethyl derivative by MS.
[2] AMPA: isolated using HPLC and identified as the trifluoroethyl derivative by MS.
[3] natural products: non-phosphonate-containing compounds not retained on Chelex® resin
[4] Glyphosate/AMPA acetylated conjugates: tentatively assigned to glyphosate and AMPA acetylated conjugates based on formation of AMPA and glyphosate on acid hydrolysis of the fraction and similarities with chromatographic and hydrolysis properties of conjugates identified in wheat metabolism study.

Environmental fate in soil

Aerobic soil degradation (glyphosate + AMPA)

Esser (1996 RR96-028B) studied the aerobic soil degradation of ^{14}C-glyphosate in the dark in a Visalia sandy loam soil (sand 71%, silt 20%, clay 8.8%, %OM 0.6; cation exchange capacity 6.2 meq/100 g; pH 8.3; bulk density 1.46 g/cm^3; 75% water holding capacity at 1/3 bar) at a concentration of 4.7 mg/kg. The soil was microbially viable throughout the study. Degradation was monitored for 31 days with samples analysed after 0, 1, 2, 3, 4, 8, 11, 14, 18, 24 and 31 days incubation. Characterisation of the ^{14}C was by HPLC with LSC detection and for selected samples by TLC.

The only major metabolite observed in this study was AMPA representing 20% of the total applied radioactivity on day 31 (Table 13). A minor metabolite designated degradate 1 was not identified. Degradation occurred via AMPA and mineralization to $^{14}CO_2$.

Table 13. Distribution and characterisation of radioactivity in various fractions following aerobic degradation of ^{14}C-glyphosate at 25 °C (Esser 1996 RR96-028B).

	% applied radioactivity										
Days of incubation	0	1	2	3	4	8	11	14	18	24	31
% in phosphate buffer extract	95	62	46	43	39	31	35	28	23	25	23
Glyphosate	93	50	27	21	15	7.2	9.2	5.9	2.0	1.8	1.3
AMPA	1.6	12	19	21	23	23	24	21	20	22	20
Degradate 1	0	0.3	0.5	0.8	0.9	1.0	1.0	1.0	0.9	1.3	1.2
Others	0.2	0.1	0.2	0.1	0.3	0.1	0.1	0.2	0.0	0.0	0.1
% in PES	2.0	6.9	5.7	5.3	5.3	7.5	6.0	5.8	6.5	6.6	5.9
% in KOH ($^{14}CO_2$)	ND	24	39	43	52	55	55	52	64	65	64

Extracted = extracted with phosphate buffer, pH 2
PES = post extraction solids and represents the soil buffer unextracted residues
KOH = radioactivity associated with 10% aqueous KOH trap solutions and thought to be due to trapped $^{14}CO_2$ as all radioactivity in the day 11 sample was precipitated with $BaSO_4$

The half-life for glyphosate under aerobic test conditions was estimated to be 5.4 days, calculated assuming pseudo-first order kinetics.

In a separate study, Galicia and Morgenroth (1993 151-GLY) studied the aerobic soil degradation of ^{14}C-glyphosate in the dark in a Les Evouettes II silt loam soil (sand 38%, silt 51%, clay 11%, %OC 1.4; cation exchange capacity 15.5 meq/100 g; pH 6.1; 40% water holding capacity) at a concentration of 2.4 mg/kg. The soil was microbially viable throughout the study. Degradation was monitored for 364 days with samples analysed after 0, 3, 7, 14, 28, 56, 84, 112, 168, 252 and 364 days incubation. Characterisation of the ^{14}C was by HPLC with LSC detection and, for selected samples, by TLC.

The only major metabolite observed in this study was AMPA representing 29% of the total applied radioactivity on day 84 and 21% at the end of the study on day 364. Two minor metabolites that exceeded 10% of the applied radioactivity were not identified and were both highly polar in nature (Table 14). It is likely that the two minor metabolites are glyphosate and AMPA bound to humic or fulvic acids co-extracted by the high pH extraction solvent employed. Degradation occurred via AMPA and mineralization to $^{14}CO_2$.

Table 14. Distribution and characterisation of radioactivity in various fractions following aerobic degradation of ^{14}C-glyphosate at 25 °C (Galicia and Morgenroth, 1993 151-GLY).

	% applied radioactivity										
Days of incubation	0	3	7	14	28	56	84	112	168	252	364
% in extract	92	83	80	75	64	54	56	50	43	40	36
Glyphosate	78	67	54	44	36	25	20	19	10	8.3	6.7
AMPA	4.0	6.3	13	13	21	22	29	28	19	18	21
Unknowns	9.9	9.5	12	19	6.7	7.1	6.8	3.7	14	13	8.2
% in PES	6.4	9.9	10	12	14	14	13	14	17	13	20
% in NaOH ($^{14}CO_2$)	ND	5.8	11	16	22	29	32	33	37	39	42

Extracted = extracted with 80% methanol, 0.5 N NH_4OH and water
PES = post extraction solids and represents the soil bound unextracted residues
NaOH = radioactivity associated with 2N NaOH trap solutions and thought to be due to trapped $^{14}CO_2$ as all radioactivity in the day 84, 252 and 364 samples were precipitated with $BaSO_4$. Negligible radioactivity was contained in the ethylene glycol trap for volatile organic compounds.

The half-life for glyphosate under aerobic test conditions was estimated to be 25 days, calculated assuming pseudo-first order kinetics.

Galicia and Flückiger (1993 157-GLY) studied the aerobic soil degradation of ^{14}C-glyphosate (methylene) in the dark in three German standard soils: Speyer 2.1 (sand), 2.2 (sand) and 2.3 (loamy sand) at a concentration of 4.8 mg/kg. The soils were microbially viable throughout the study.

Degradation was monitored for 105 days with samples analysed after 0, 7, 14, 28, 56, 84 and 105 days incubation. Characterisation of the ^{14}C was by HPLC with LSC detection and, for selected samples, by TLC (Tables 15-17).

Table 15. Distribution and characterisation of radioactivity in various fractions following aerobic degradation of ^{14}C-glyphosate at 20 °C Speyer 2.1 biomass start 12 mg C/100 g soil, at end 7.8 mg C/100 g soil (Galicia and Flückiger, 1993 157-GLY).

	% applied radioactivity						
Days of incubation	0	7	14	28	56	84	105
% in extract	91	78	82	57	55	53	48
Glyphosate	87	56	38	23	9.7	9.7	8.0
% in PES	0.3	2.3	2.5	2.0	2.5	1.6	1.6
% in NaOH ($^{14}CO_2$)	ND	12	15	20	24	25	26

Extracted = extracted with 0.5 N NH_4OH
PES = post extraction solids and represents the soil bound unextracted residues
NaOH = radioactivity associated with 2N NaOH trap solutions and thought to be due to trapped $^{14}CO_2$ as all radioactivity in the day 28 sample was precipitated with $BaSO_4$. Negligible radioactivity was contained in the ethylene glycol trap for volatile organic compounds.

Table 16. Distribution and characterisation of radioactivity in various fractions following aerobic degradation of ^{14}C-glyphosate at 20 °C Speyer 2.2 biomass start 40 mg C/100 g soil, at end 33 mg C/100 g soil (Galicia and Flückiger, 1993 157-GLY).

	% applied radioactivity						
Days of incubation	0	7	14	28	56	84	105
% in extract	97	84	83	78	73	63	63
Glyphosate	91	41	49	33	31	19	14
% in PES	0.8	6.8	7.3	7.1	7.3	4.9	8.6
% in NaOH ($^{14}CO_2$)	ND	5.8	9.0	14	19	21	24

Extracted = extracted with 0.5 N NH_4OH
PES = post extraction solids and represents the soil bound unextracted residues
NaOH = radioactivity associated with 2N NaOH trap solutions and thought to be due to trapped $^{14}CO_2$ as all radioactivity in the day 28 sample was precipitated with $BaSO_4$. Negligible radioactivity was contained in the ethylene glycol trap for volatile organic compounds.

Table 17. Distribution and characterisation of radioactivity in various fractions following aerobic degradation of ^{14}C-glyphosate at 20 °C Speyer 2.3, biomass start 37 mg C/100 g soil, at end 26 mg C/100 g soil (Galicia and Flückiger, 1993 157-GLY).

	% applied radioactivity						
Days of incubation	0	7	14	28	56	84	105
% in extract	91	59	45	33	25	22	18
Glyphosate	91	39	20	5.5	4.3	3.0	2.5
% in PES	1.4	7.7	7.0	7.0	8.6	6.0	5.0
% in NaOH ($^{14}CO_2$)	ND	31	40	50	57	59	61

Extracted = extracted with 0.5 N NH_4OH
PES = post extraction solids and represents the soil bound unextracted residues
NaOH = radioactivity associated with 2N NaOH trap solutions and thought to be due to trapped $^{14}CO_2$ as all radioactivity in the day 28 sample was precipitated with $BaSO_4$. Negligible radioactivity was contained in the ethylene glycol trap for volatile organic compounds.

The half-life for glyphosate under aerobic test conditions was estimated to be 7.5, 8.5 and 3.6 days respectively for Speyer soils 2.1, 2.2 and 2.3, calculated assuming pseudo-first order kinetics. The corresponding DT90 values were 83, >200 and 40 days respectively for the same soils.

Aqueous hydrolysis

Bowler (1996 RR 96-002B) studied the hydrolysis of 10 mg/L ^{14}C-glyphosate sterile solution in buffers at pH 5, 7 and 9 for 30 days at 25ºC. The concentration of glyphosate remained constant throughout the study period and no breakdown products were detected by HPLC or TLC.

Rotational crops – confined

No data were provided on residues in rotational crops.

METHODS OF RESIDUE ANALYSIS

The analysis of glyphosate and its major metabolite AMPA is complicated by the polar nature of both compounds and their similarity in properties to naturally occurring compounds such as amino acids. Several different analytical methods have been reported for the analysis of residues of both compounds in plant materials, animal tissues, milk and eggs.

The methods used in field trials and reported as suitable for enforcement purposes were similar. The methods generally involve aqueous extraction of residues, typically with dilute acid, clean-up on cation and anion exchange columns, separation using GC or HPLC and derivatization prior to detection. The efficiency of the aqueous extractions has been demonstrated during the metabolism studies where the majority of the total radioactive residue (TRR) was recovered in the aqueous extracts.

Method 1

The US FDA Pesticide Analytical Manual (PAM) reports a time consuming method that was used in early residue trials but has been superseded. The method involves clean-up of aqueous extracts by anion and cation exchange followed by acylation of the amino nitrogen with trifluoroacetic acid and trifluoroacetic anhydride and methylation of both the phosphonic acid (glyphosate and AMPA) and carboxylic acid groups (glyphosate). Quantification is performed by gas chromatography (GC) with a phosphorous specific flame photometric detector. For the analysed matrices the average recovery by fortification level was < 70% in several cases (Tables 18, 19). The limit of quantification, defined as the lowest level at which an acceptable recovery (70–110%) is obtained, is 0.05 mg/kg for most plant matrices.

Table 18. Method 1 Validation data for glyphosate.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Cotton hay	0.05 0.10 0.20 0.40	2 8 6 3	78-101 44-84 56-80 57-86	89 66 68 72	19 20 14 20	MSL 1283
Cotton seed	0.05 0.10 0.20 0.40	2 5 10 5	61-75 64-75 59-88 43-65	68 68 75 57	14 7 12 18	MSL 1283
Sugarcane stalks	0.05 0.10 0.20 0.40 0.80	2 4 10 7 5	100-106 57-94 56-94 52-91 51-96	103 71 74 71 68	4 22 16 22 25	MSL0264
Sugarcane raw sugar	0.05 0.10 0.20 0.40	6 2 6 8	91-114 65-74 65-109 60-100	102 69 82 73	11 10 19 18	MSL0264
Coffee beans	0.05 0.10 0.20 0.40	4 16 15 5	72-84 57-94 50-78 46-64	77 69 59 52	6 15 12 14	FR 434
Nuts	0.05 0.10 0.20 0.40	13 13 12 13	54-91 48-92 46-110 49-88	75 70 72 69	16 20 22 15	FR 442

Table 19. Method 1 Validation data for AMPA.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Cotton hay	0.05	2	67-103	85	30	MSL 1283
	0.10	10	50-78	69	12	
	0.20	7	57-81	66	13	
	0.40	3	62-72	68	8	
Cotton seed	0.05	2	92-94	93	1	MSL 1283
	0.10	6	49-89	74	19	
	0.20	12	55-82	71	10	
	0.40	6	56-69	63	8	
Sugarcane stalks	0.05	3	83-95	91	8	MSL0264
	0.10	6	61-79	67	11	
	0.20	9	61-102	78	16	
	0.40	9	69-91	77	9	
	0.80	4	59-81	71	13	
Sugarcane raw sugar	0.05	5	73-93	85	9	MSL0264
	0.10	4	51-90	72	23	
	0.20	8	57-90	74	20	
	0.40	10	54-94	76	17	
Coffee beans	0.05	4	83-104	94	10	FR 434
	0.10	16	53-86	66	16	
	0.20	16	51-85	67	17	
	0.40	4	56-66	60	7	
Nuts	0.05	12	59-104	74	19	FR 442
	0.10	14	45-77	62	15	
	0.20	12	53-83	71	12	
	0.40	13	47-92	64	20	

Method 2

Cowell *et al.* (1983) reported the analysis of glyphosate and AMPA isolated by blending samples with $CHCl_3$ and HCl with clean-up of the aqueous fraction by elution through Chelex 100 resin in the Fe(III) form. The compounds are eluted from the resin with hydrochloric acid and the iron removed using an anion exchange resin. After concentration to dryness to remove the hydrochloric acid, samples are analysed by HPLC equipped with an o-phthalaldehyde (OPA) post-column reactor and a fluorescence detector. Determination involves post-column hypochlorite oxidation and reaction of the amine product with o-phthalaldehyde and mercaptoethanol to produce a fluorescent derivative. Modifications to the method have included adding a column switching step to the HPLC quantitation to reduce low level interferences that were observed with some matrices.

The results of the recovery experiments are presented in Table 20 for glyphosate and Table 21 for AMPA. The average recovery by fortification level exceeded 70% for all matrices/fortification levels. The limit of quantification is 0.05 mg/kg for most plant matrices.

The reproducibility of this analytical method was demonstrated by an interlaboratory study involving 5 independent laboratories (Cowell *et al.*, 1986). Tables 22 (glyphosate) and 23 (AMPA) below list the average recovery and relative standard deviation data from the blind fortified samples for each matrix and laboratory.

This method has also been validated for the determination of glyphosate and AMPA in animal tissues. The validation data are summarized in Table 24 (Pijanowski 1988, Oppenhuizen and Schuette 1995).

Table 20. Method 2 Validation data for glyphosate in plants.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Dried, shelled	0.05	3	91-103	96	7	MSL17194

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
beans	0.1	4	87-95	91	4	
	1	4	85-99	94	6	
	10	3	89-95	93	4	
Corn grain	0.05	6	62-104	88	20	MSL15334
	0.1	4	80-99	86	10	
	0.5	4	61-110	91	16	
	2.5	4	82-103	89	11	
	5	4	82-86	83	2	
Corn forage	0.05	4	74-91	83	9	MSL15334
	0.1	5	75-93	83	8	
	0.5	3	82-120	97	21	
	2.5	3	78-86	83	5	
	5	5	84-98	89	7	
	10	2	87-104	95	12	
Corn stover	0.05	5	82-110	98	11	MSL15334
	0.1	5	80-103	93	11	
	0.5	4	92-104	96	5	
	2.5	4	87-114	98	12	
	5	4	75-126	95	24	
Cotton seed	0.05	7	73-106	85	17	MSL17635
	0.1	6	78-96	87	7	
	1	5	74-103	86	14	
	5	3	65-87	80	16	
	10	6	62-89	79	14	
	20	3	83-88	85	3	
	50	2	77-85	81	7	
Sorghum grain	0.05	3	79-90	85	7	MSL14918
	5	3	93-95	94	1	
	20	3	89-94	92	3	
Sorghum stover	0.05	3	84-109	95	13	MSL14918
	20	3	89-108	100	10	
	50	3	75-84	79	6	

Table 21. Method 2 Validation data for AMPA in plants.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Dried, shelled beans	0.05	3	64-72	67	6	MSL17194
	0.10	4	83-93	86	6	
	1	4	82-98	91	8	
	10	3	88-95	92	4	
Corn grain	0.05	6	67-113	92	22	MSL15334
	0.1	3	71-91	82	16	
	0.5	4	73-112	94	17	
	2.5	4	81-97	89	7	
	5	6	83-94	92	5	
Corn forage	0.05	4	62-106	84	26	MSL15334
	0.1	5	78-123	99	20	
	0.5	3	86-118	100	16	
	2.5	3	75-84	80	6	
	5	5	81-97	88	7	
	10	2	86-100	93	11	
Corn stover	0.05	5	88-119	100	14	MSL15334
	0.1	5	81-101	92	9	
	0.5	4	87-102	93	7	
	2.5	4	84-114	97	14	
	5	4	70-124	93	26	
Cotton seed	0.05	7	72-108	96	13	MSL17635
	0.1	6	85-126	101	14	
	1	5	81-90	87	4	
	5	3	88-95	92	4	

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
	10 20 50	6 3 2	64-90 84-94 78-85	80 88 82	14 6 6	
Sorghum grain	0.05 5 20	3 3 3	59-79 90-97 90-91	70 93 91	14 4 1	MSL14918
Sorghum stover	0.05 20 50	3 3 3	65-84 87-98 70-72	73 94 71	14 6 2	MSL14918

Table 22. Method 2 interlaboratory study validation data for glyphosate (Cowell *et al.* 1986).

Crop	Recovery ± RSD				
	Lab 1	Lab 2	Lab 3	Lab 4	Lab 5
Alfalfa	104 ± 19	Not completed	71 ± 26	85 ± 12	97 ± 10
Cabbage	66 ± 8.2	86 ± 14	71 ± 2.9	76 ± 9.5	74 ± 4.2
Grapes	74 ± 8.0	90 ± 6.7	72 ± 13	68 ± 16	78 ± 13
Soybeans	50 ± 29	87 ± 2.6	77 ± 18	77 ± 5.6	81 ± 14

Table 23. Method 2 interlaboratory study validation data for AMPA (Cowell *et al.* 1986).

Crop	Recovery ± RSD				
	Lab 1	Lab 2	Lab 3	Lab 4	Lab 5
Alfalfa	90 ± 15	102[1]	86 ± 4.4	101 ± 20	87 ± 2.4
Cabbage	66 ± 6.6	71 ± 4.0	72 ± 4.4	69 ± 7.5	70 ± 7.2
Grapes	66 ± 8.2	62 ± 15	72 ± 5.7	61 ± 23	75 ± 16
Soybeans	61 ± 16	103 ± 9.9	70 ± 14	85 ± 8.6	86 ± 5.2

[1]Only one sample analysed

Table 24 Method 2 Validation data for glyphosate in animal tissues.

Matrix	Fortification level (mg/kg)	N	Glyphosate Recovery (%)	AMPA recovery (%)	Reference
Beef Muscle	0.05 0.1 0.25 0.5	2	87, 88 87, 86 84, 81 89, 90	89, 78 83, 82 86, 84 86, 88	MSL7358
Beef Kidney	0.05 0.25 1 5 15	2	97, 93 91, 91 92, 90 94, 95 91, 93	103, 98 96, 92 93, 90 90, 90 90, 92	MSL7358
Beef Fat	0.05 0.1 0.25 0.5 1	2	11, 102 87, 91 98, 94 98, 94 87, 87	86, 90 91, 87 90, 90 92, 86 89, 88	MSL7358
Beef Liver	0.05 0.1 0.25 1 2.5	2	78, 60 68, 71 71, 72 78, 84 81, 80	84, 94 85, 88 81, 84 80, 87 77, 75	MSL7358
Milk	0.025 0.05 0.125 0.5 1.25	2	95, 99 94, 96 89, 89 94, 95 94, 94	94, 97 95, 98 90, 91 92, 95 90, 91	MSL7358
Pork kidney	0.05 0.1	2	87, 86 85, 85	94, 92 95, 94	MSL7358

Matrix	Fortification level (mg/kg)	N	Glyphosate Recovery (%)	AMPA recovery (%)	Reference
	0.5 1 5		99, 98 94, 96 96, 97	94, 93 94, 95 94, 93	
Pork muscle	0.05 0.1 0.25 0.5	2	79, 85 85, 87 88, 87 90, 89	79, 87 86, 86 84, 86 89, 91	MSL7358
Pork fat	0.05 0.1 0.25 0.5	2	95, 101 83, 84 89, 94 94, 90	98, 101 77, 76 75, 80 76, 75	MSL7358
Pork liver	0.05 0.1 0.25 0.5 1	2	91, 89 91, 83 80, 81 86, 86 81, 80	114, 109 91, 92 84, 82 80, 80 81, 78	MSL7358
Chicken muscle	0.05 0.1 0.25 0.5	2	90, 89 90, 95 85, 87 96, 95	86, 82 82, 91 82, 89 84, 89	MSL7358
Chicken liver	0.05 0.1 0.5 1 5	2	73, 68 68, 74 77, 78 89, 88 78, 80	79, 77 72, 78 76, 77 84, 86 77, 77	MSL7358
Chicken kidney	0.05 0.25 1 5 15	2	75, 72 83, 88 93, 92 92, 94 91, 92	94, 94 87, 93 87, 86 84, 88 90, 91	MSL7358
Chicken fat	0.05 0.1 0.25 0.5	2	88, 86 90, 89 83, 85 92, 87	88, 88 89, 88 85, 84 85, 80	MSL7358
Eggs	0.025 0.05 0.125 0.5	2 2 2 2	91, 92 92, 94 89, 92 89, 90	90, 89 90, 96 88, 89 83, 82	MSL7358

Method 3

Deutsche Forschungsgemeinschaft (DFG). 1992. Manual of Pesticide Residue Analysis, Volume II, Method 405 Glyphosate VCH Publishers Inc., New York, USA

Glyphosate and AMPA are extracted with aqueous HCl and isolated from various matrix extracts by elution through Chelex 100 resin in the Fe(III) form. The compounds are eluted from the resin with hydrochloric acid and the iron is removed using an anion exchange resin. Glyphosate and AMPA are determined separately by HPLC including post-column derivatization. In the fluorogenic step, glyphosate, which has been oxidized to a primary amine, and AMPA (no oxidation step required) react with o-phthalaldehyde and mercaptoethanol to yield a strongly fluorescent compound that is measured using a fluorescence detector.

The results of the recovery experiments are presented in Table 25 for glyphosate and Table 26 for AMPA. The average recovery was above 70% for each matrix/fortification level, with only 2 exceptions. The limit of quantification is in the range 0.03-0.06 mg/kg, depending on the crop matrix.

This method has been extensively validated for crop matrices.

Table 25. Method 3 Validation data for glyphosate

Matrix	Fortification level (mg/kg)[1]	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Cereal	0.04-0.05	4	84-106	91	11	311 GLY
whole	0.08-0.1	9	66-109	93	16	
plant	0.5	6	54-98	71	23	
(wheat,	1	7	62-83	72	11	
barley,	2	7	65-112	84	19	
oat)	5	8	60-88	74	12	
	10	10	60-104	84	14	
	20	5	85-103	92	8	
	50	4	75-106	86	17	
	100	4	80-107	94	16	
	200	4	73-106	90	15	
Cereal	0.03	5	86-109	94	10	311 GLY
grain	0.05	10	73-113	97	14	
(wheat,	0.08-0.1	6	62-116	91	20	
barley,	0.3	3	62-85	74	16	
oat)	0.5	4	72-89	80	11	
	1	9	62-112	87	20	
	2	4	62-100	81	25	
	5	11	71-108	87	14	
	10	7	63-93	81	13	
	20	3	65-90	79	16	
	50	4	66-94	83	14	
Cereal	0.05	9	61-116	100	16	311 GLY
straw	0.1	9	61-117	88	22	
(wheat,	0.2	2	78, 84	81		
barley,	0.5	2	81, 105	93		
oat)	1	11	50-114	84	22	
	5	9	69-104	80	14	
	10	10	60-95	77	15	
	20	6	61-94	76	17	
	50	6	60-86	75	12	
	100	4	71-107	84	19	
	200	4	66-83	75	9	
Grass	0.04-0.06	3	74-84	79	6	311 GLY
	0.08-0.1	4	81-128	100	22	
	0.2	2	80-83	82		
	0.5	3	75-99	89	14	
	1	5	58-101	85	20	
	5	6	59-96	82	15	
	10	10	70-91	83	11	
	20	5	67-87	79	11	
	50	6	70-102	83	13	
	100	7	66-91	82	11	
	200	2	85, 88	86		
Hay	1	2	73, 89	81		311 GLY
	10	2	94, 97	96		
	20	2	87, 109	98		
	50	2	77, 79	78		
	300	2	90, 105			
Silage	0.06	1	103	103		311 GLY
	0.1	3	73-105	91	18	
	1	2	82, 84	83		
	5	3	84-88	85	3	
	10	3	71-90	78	14	
	200	2	70, 78	74		
Flax	0.06	2	72, 107	90		311 GLY
(linseed)	0.5-0.6	2	75, 85	80		
	10	2	80, 93	86		

Matrix	Fortification level (mg/kg)[1]	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Oilseed rape seeds	0.06	4	58-104	86	24	311 GLY
	0.1	3	68-105	84	23	
	0.5-0.6	6	62-100	80	16	
	1	2	78, 78	78		
	2	2	73, 74	74		
	5-6	3	59-88	74	20	
	10	2	62-63	62		
	50-60	3	72-103	84	20	
Oilseed rape pods	0.25	1	98	-		311 GLY
	1	2	78, 80	79		
	5	2	87, 63	75		
	10	2	83, 88	85		
Peas seeds	0.05	2	83, 85	84		311 GLY
	0.1	2	87, 102	94		
	0.5	2	57, 92	74		
	1	2	88, 89	88		
	5	2	90, 91	90		
	10	3	76-85	81	6	
	100	2	82, 105	94		
Pea, haulm	0.05		59, 94, 101			311 GLY
	0.1		84, 108			
	0.5		66, 108			
	1.0		70, 73, 74, 81, 94, 101			
	2		78, 79			
	5		71, 81, 110			
	10		68, 72, 84, 88			
	20		67, 73, 82, 97			
	50		74, 95			
	100		66, 85, 90			
Winter field bean seeds	0.05	2	79, 86	82		311 GLY
	0.1	3	59-76	68	13	
	0.5	2	67, 86	76		
	1	2	68, 74	71		
	2	2	73, 79	76		
	10	2	69, 76	72		
	50	2	57, 64	60		
Winter field bean haulm	0.05		111			311 GLY
	0.1		84, 94, 108			
	0.5		91, 111			
	1		74, 79, 82, 84, 90, 91			
	5		86, 109, 111			
	10		78, 79, 80, 87, 94, 97			
	20		71, 74, 84			
	50		64, 77			
	100		68, 76, 83			
	200		72, 88			
Apples	0.06	4	68-107	84	20	311 GLY
	0.3	2	68, 77	73		
Cereal grains	0.05	11	70-105	87	14	MLL31337
	0.5	3	88-93	90	3	
	20	8	83-112	94	11	
Cereal straws	0.05	12	67-128	88	21	MLL31337
	0.5	4	70-83	76	7	
	50	2	70, 75	72		
	100	3	73-85	78	8	
	250	3	75-86	82	8	
Kiwifruit	0.05	5	102-111	108	3	MLL31678
	0.5	5	90-100	96	4	
Oilseed rape seeds	0.05	2	79, 83	81		MLL30817
	0.1	4	66-108	87	24	
	0.2	3	78-83	80	3	
	0.5	3	64-83	76	14	

[1]Recovery levels for which only one result was available were not included (except if at quantification level)

Table 26. Method 3 Validation data for AMPA.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Cereal grains	0.05 0.5 20	11 3 8	73-101 96-100 75-102	88 97 91	9 2 11	MLL31337
Cereal straw	0.05 0.5 50 100 250	11 4 2 3 3	70-108 72-92 73-81 78-89 79-85	85 80 77 83 81	14 10 7 7 4	MLL31337
Kiwifruit	0.05 0.5	5 5	89-100 88-94	93 91	5 2	MLL31678
OSR seeds	0.05 0.1 0.2 0.5	3 3 3 2	63-93 70-92 59-78 79-91	80 78 67 85	19 16 15 10	MLL30817

Method 4

Alferness and Iwata (1994) reported a method for the analysis of glyphosate and AMPA in plant and animal commodities. Glyphosate and AMPA are extracted from crops by maceration with water and the extracts partitioned with methylene chloride or chloroform to remove nonpolar co-extractives and then cleaned up over a cation exchange column. In the case of muscle, liver, kidney and eggs as well as soybean soapstock the extraction was with 0.1 M HCl/chloroform and the samples centrifuged to obtain the aqueous solution. Fat samples required an additional extraction with chloroform. Milk samples were extracted with 0.6% v/v acetic acid and the extract centrifuged to isolate the aqueous layer which is further extracted with chloroform and filtered. Small aliquots of the purified extracts are directly derivatized with a mixture of trifluoroacetic anhydride and heptafluorobutanol to produce the heptafluorobutylesters of the acid functional groups and the trifluoroacetyl derivatives of the amines. Quantitation is by capillary GC with the derivatives quantified by mass-selective detection using single ion monitoring (m/z 611 for glyphosate and m/z 446 for AMPA derivatives).

The results of the recovery experiments for plant matrices are presented in Tables 27 for glyphosate and 28 for AMPA, and for animal commodities in Table 29. The average recovery was above 70% for each matrix/fortification level. The limit of quantification is 0.05 mg/kg for all matrices.

The reproducibility of this method was demonstrated by an interlaboratory study involving 13 laboratories located in 5 countries; 12 laboratories returned valid data sets. The crops tested were field corn grain, soya forage and walnut meat at concentrations of 0.05, 0.4 and 2 mg/kg. The study used a split-level pair replication scheme with blindly coded laboratory samples. Twelve samples were analysed, including one control and 3 split-level pairs for each matrix, 1 pair at each nominal concentration. For glyphosate, the mean recovery was 91%, the average intralaboratory variance, the repeatability relative standard deviation (RSD_r), was 11% and interlaboratory variance, the reproducibility relative standard deviation (RSD_R), was 16%. For AMPA the mean recovery was 87%, the RSD_r was 16% and the RSD_R was 25% at mg/kg levels. The average recoveries, RSD_r and RSD_R are given by crop/fortification levels in Tables 30 for glyphosate and 31 for AMPA.

Table 27. Method 4 Validation data for glyphosate.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Corn grain	0.05 0.5	3 3	91-116 75-89	101 81	13 9	RR92-042B RES2
Corn forage	0.05 0.54	3 3	92-97 95-103	95 99	3 4	RR92-042B RES22
Corn fodder	0.05	3	80-86	82	4	RR92-042B RES2

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
	0.5	3	77-86	83	6	
Flax	0.05	5	95-126	110	10	Ely 2001
	0.5	5	78-101	91	9	
	5	5	79-99	88	9	
Cabbage	0.05	6	72-94	87	9	Ely 2001
	0.5	5	88-101	94	6	
	5	5	79-93	87	8	
Melon	0.05	6	84-95	90	5	Ely 2001
	0.5	5	93-113	99	9	
	5	5	83-93	90	4	
Oat grain	0.05	6	85-123	99	13	Ely 2001
	0.5	5	89-96	94	3	
	5	5	88-102	92	6	
Rye straw	0.05	6	89-126	101	14	Ely 2001
	0.5	5	92-110	100	7	
	5	5	89-94	92	2	
Coffee	0.05	6	100-115	108	5	Ely 2001
	0.5	5	101-122	108	8	
	5	5	98-123	106	10	

Table 28. Method 4 Validation data for AMPA.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Flax	0.05	5	101-115	105	5	Ely 2001
	0.5	5	83-102	94	8	
	5	5	80-103	89	10	
Cabbage	0.05	6	65-93	74	16	Ely 2001
	0.5	5	76-100	86	12	
	5	5	53-81	71	16	
Melon	0.05	6	74-108	84	15	Ely 2001
	0.5	5	87-121	98	14	
	5	5	86-95	89	4	
Oat grain	0.05	6	75-91	81	7	Ely 2001
	0.5	5	69-82	76	8	
	5	5	74-98	85	11	
Rye straw	0.05	6	70-84	76	7	Ely 2001
	0.5	5	91-106	99	6	
	5	5	68-80	72	6	
Coffee	0.05	6	76-118	104	14	Ely 2001
	0.5	5	79-91	84	5	
	5	5	87-110	94	10	

Table 29. Method 4 Validation data for animal commodities (JAFC 1984 42 (12) 2751-2759).

Matrix	N	Fortification level (mg/kg)	Glyphosate recovery		AMPA recovery	
			Mean	CV	Mean	CV
Beef muscle	6	0.03, 0.3	98	8	102	11
Kidney	6	0.1, 1	105	3	89	5
Liver	6	0.1, 1	100	5	84	9
Fat	6	0.01, 0.1	101	3	86	8
Milk	6	0.01, 0.1	95	4	85	10
Chicken eggs	6	0.01, 0.1	92	12	87	14

Table 30. Method 4 Interlaboratory study results for the determination of glyphosate.

Crop	Average residue (mg/kg)	No. of labs	Recovery (%)	RSD_r (repeatability)	RSD_R (reproducibility)	Reference
Corn grain	0.045 0.37 1.7	11 12 12	84 88 90	15 11 11	15 18 22	Alferness & Wiebe (2001)
Soya forage	0.046 0.41 1.8	12 12 12	88 97 93	17 10 8.2	20 15 16	Alferness & Wiebe (2001)
Walnut meat	0.051 0.39 1.8	10 10 9	97 92 93	9.0 6.1 11	9.0 12 20	Alferness & Wiebe (2001)

Table 31. Method 4 Interlaboratory study results for the determination of AMPA.

Crop	Average residue (mg/kg)	No. of labs	Recovery (%)	RSD_r (repeatability)	RSD_R (reproducibility)	Reference
Corn grain	0.046 0.37 1.7	11 11 11	88 89 89	24 11 14	24 23 25	Alferness & Wiebe (2001)
Soya forage	0.041 0.36 1.6	12 12 12	78 87 87	24 20 15	43 24 20	Alferness & Wiebe (2001)
Walnut meat	0.048 0.35 1.7	11 11 9	92 84 88	16 11 11	28 15 23	Alferness & Wiebe (2001)

Method 5

Method 5 developed by Royer et al. (2001 MON/GLY/2000.01) differs from the previous method in that it uses a different clean-up. For plant and animal products this method involves an extraction in acidic medium followed by purification on column chromatography on Chelex® 100 and on strong anion exchange resin (AG 1 X8), followed by derivatization and quantification by GC/MS/MS.

The results of the recovery experiments are presented in Tables 32 and 33. For all the analysed matrices, the average recovery by fortification level was in the range 70 – 110% except for AMPA in lemon at 0.5 mg/kg fortification level. For wheat straw, valid recoveries were only obtained at the 0.5 mg/kg fortification level. The limit of quantification is 0.05 mg/kg for most of the plant and animal matrices (except wheat straw).

Table 32. Method 5 Validation data for glyphosate residues in plant and animal matrices

Matrix	Fortification level (mg/kg)	N	Glyphosate			AMPA			Reference
			Recovery range (%)	Mean recovery (%)	RSD (%)	Recovery range (%)	Mean recovery (%)	RSD (%)	
Maize	0.05 0.5	5 5	72 – 108 79 – 105	85 92	17 14	72 – 99 66 – 89	81 77	14 11	MON/GLY/2000.01
Tomatoes	0.05 0.5	5 5	70 – 104 68 – 107	85 92	16 17	69 – 113 73 – 90	84 82	23 9.5	MON/GLY/2000.01
Lemon	0.05 0.5	5 5	83 – 115 82 – 107	96 92	17 13	72 – 104 64 – 121	85 105	14 23	MON/GLY/2000.01
Wheat grain	0.05 0.5	4 5	71 – 105 51 – 85	91 71	16 20	69 – 95* 80 - 125	79 98	14 18	MON/GLY/2000.01
Wheat straw	0.05 0.5	2 5	79, 87 66 – 110	83 90	- 20	79 – 96 87 - 100	88 94	- 6.1	MON/GLY/2000.01
Milk	0.05 0.5	5 5	58 – 94 75 – 122	80 100	18 18	71 – 116 55 - 115	92 83	22 28	MON/GLY/2000.01

Matrix	Fortification level (mg/kg)	N	Glyphosate			AMPA			Reference
			Recovery range (%)	Mean recovery (%)	RSD (%)	Recovery range (%)	Mean recovery (%)	RSD (%)	
Eggs	0.05	5	76 – 91	85	7.1	86 – 107	93	9.6	MON/GLY/2000.01
	0.5	5	87 – 93	90	2.7	67 – 88	77	11	
Meat	0.05	5	86 – 128	106	16	80 – 112	97	15	MON/GLY/2000.01
	0.5	5	88 – 113	100	12	76 – 127	104	20	

RSD = Relative Standard Deviation

Method 6

In method 6, glyphosate and AMPA are isolated from various matrices by elution through Chelex 100 resin in the Fe(III) form. The glyphosate and AMPA are eluted from the resin with hydrochloric acid and the iron is removed using an anion exchange resin. After concentration to dryness to remove the hydrochloric acid, samples are analysed using a two column switching HPLC equipped with a ninhydrin post column reactor and an absorbance detector.

Some matrices showed interferences from co-extractives and made the method unworkable for the given substrate. The results of recovery experiments from soybean grain and hay are presented in Tables 33 for glyphosate and 34 for AMPA. The average recovery by matrix/fortification level exceeded 70% in all cases. The limit of quantification is 0.05 mg/kg.

Table 33. Method 6 Validation data for glyphosate.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Soybean grain	0.05	5	71-107	85	20	MSL3259
	0.1	2	92-100	96	6	
	0.5	5	90-103	96	5	
	1	2	92-104	98	9	
	2	2	110-117	114	4	
	3	4	96-100	98	2	
	5	2	97-100	98	2	
	10	2	105-108	106	2	
	20	2	102-108	105	4	
Soybean hay	0.05	2	91-106	98	11	MSL3259
	0.1	2	93-98	96	4	
	0.5	2	99-100	100	1	
	1	4	93-103	98	5	
	3	2	99-101	100	1	
	10	2	104-104	104	0	
	30	2	94-97	96	2	
	100	2	102-104	103	1	
	300	2	99-100	100	1	

Table 34. Method 6 Validation data for AMPA.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Soybean grain	0.05	5	76-100	85	11	MSL3259
	0.1	2	66-67	66	1	
	0.5	5	86-98	94	6	
	1	2	90-97	94	5	
	2	2	105-105	105	0	
	3	4	94-98	96	2	
	5	2	95-98	96	2	
	10	2	102-104	103	1	
	20	2	97-98	98	1	
Soybean hay	0.05	2	87-90	88	2	MSL3259
	0.1	2	91-92	92	1	

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
	0.5	2	94-96	95	1	
	1	4	87-94	91	4	
	3	2	94-97	96	2	
	10	2	98-99	98	1	
	30	2	91-93	92	2	
	100	2	97-97	97	0	
	300	2	98-98	98	0	

Method 7

Method 7 is based on a glyphosate analytical method published as a Notice of the Environment Agency in Japan. It utilizes the same Chelex and ion exchange resin procedures for isolation of glyphosate and AMPA that is used in Methods 2 and 3, and is followed by analysis of the extract using HPLC and pre-column derivatization with 9-fluorenylmethylchloroformate (FMOC) and a fluorescence detector. This method was used in only one of the submitted residue studies (Takano and Fuji 1991). No formal validation report is available.

Two different extraction techniques were used for the tea leaves. One was a standard aqueous extraction. The second used a hot water steeping method that simulated brewing of tea. The results of recovery experiments from tea leaves are summarized in Tables 35 for glyphosate and 36 for AMPA, using both extraction techniques. While glyphosate recovery results are acceptable, the AMPA recoveries are below 70%. There was no difference in recovery using the two extraction techniques. The reported limit of detection for the method is 0.02 mg/kg.

Table 35. Method 7 Validation data for glyphosate.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Tea leaves (cold water extraction)	0.4	4	78-93	87	8	Takano and Fuji 1991
Tea leaves (hot water steeping)	0.4	4	86-90	89	2	Takano and Fuji 1991

Table 36. Method 7 Validation data for AMPA.

Matrix	Fortification level (mg/kg)	N	Recovery range (%)	Recovery mean (%)	RSD (%)	Reference
Tea leaves (cold water extraction)	0.4	4	44-68	57	18	Takano and Fuji 1991
Tea leaves (hot water steeping)	0.4	4	53-63	59	7	Takano and Fuji 1991

Stability of residues in stored analytical samples

Beans, oilseed rape, and linseed

Schultz (1997 394 GLY) studied the freezer storage stability of samples of field bean (homogenised), oilseed rape and linseed samples that were fortified with glyphosate. The fortification levels were beans, 2.6 mg/kg; oilseed rape, 0.6 mg/kg; and linseed, 5.7 mg/kg. The Day 0 samples were extracted immediately without prior deep-freezing. Samples were analysed at intervals of 0, 6, 12, 15, and 18 months after fortification. For each analysis date and from each matrix analysed the following samples were analysed: one blank, two storage stability samples, and one freshly prepared fortified blank sample.

Concentrations of glyphosate were determined in all matrices by HPLC with fluorescence detection using post column derivatization. Glyphosate was extracted with aqueous hydrochloric acid

and isolated by a Chelex-100-ligand exchange column. The LOQ for the method was 0.05 mg/kg for beans and 0.06 mg/kg for oilseed rape and linseed.

Results show (Table 37) that residues of glyphosate are stable in beans, oilseed rape, and linseed stored up to 18 months under freezer conditions (-18 °C in the dark).

Table 37. Storage stability data for residues of glyphosate in samples of beans, oilseed rape, and linseed Schultz (1997 394 GLY).

Matrix	Storage Period (Months)	Residue found mg/kg		Procedural recovery (%)
Beans	0	2.3	2.3	81
	6	2.4	2.3	89
	12	2.8	2.8	79
	15	2.7	2.8	84
	18	2.6	2.5	97
Oilseed rape	0	0.58	0.47	78
	6	0.53	0.53	85
	12	0.56	0.59	68
	15	0.63	0.70	83
	18	0.59	0.58	102
Linseed	0	5.3	5.2	86
	6	5.2	4.8	96
	12	5.0	6.0	74
	15	6.2	5.8	87
	18	5.0	5.1	87

Grain and straw samples of wheat and rye

Morgenroth (1995 325 GLY) studied the freezer storage stability of wheat grain, wheat straw, rye grain, and rye straw samples fortified at the level of 1 mg/kg glyphosate. The fortified samples together with untreated control samples were stored frozen at approximately –20 °C in the dark until analyses were performed. Samples were analysed on days 0, 190, 288, 643, and 1349; the last analysis being performed about 3.5 years after fortification. Storage time was considered from the date of fortification to the date of extraction.

Recoveries from stored samples were calculated by dividing the concentration levels found in stored samples by the actual amount fortified prior to storage. For method validation, at least one procedural recovery at a level of 0.1 mg/kg glyphosate was freshly prepared per sample series and matrix by fortifying untreated control samples with calculated amounts of glyphosate solutions. These fortified samples were analysed using the same method as the storage stability samples. The procedural recoveries were used to confirm validity of the method and to correct for sample recoveries.

Results (Table 38) show that residues of glyphosate are stable in wheat and rye matrices (grain and straw) stored up to 3.5 years under freezer conditions at-20 °C in the dark. The procedural recoveries of the storage stability samples were almost identical to that of the freshly fortified samples.

Table 38. Storage stability data for glyphosate in samples of wheat grain, wheat straw, rye grain, and rye straw maintained frozen up to 3.5 years Morgenroth (1995 325 GLY).

Matrix	Storage period (days)	Fortification (mg/kg)	Residue found (mg/kg)	Procedural recovery (%)
Wheat grain	0	1.0	-	76
	190		-	80
	288		0.74	82
	643		0.57	65
	1349		0.72	69
Wheat straw	0	1.0	0.70	87

Matrix	Storage period (days)	Fortification (mg/kg)	Residue found (mg/kg)	Procedural recovery (%)
	190		0.86	86
	288		0.82	80
	643		0.75	73
	1349		1.08	108
Rye grain	0	1.0	0.76	71
	190		1.07	88
	288		0.84	88
	643		0.73	75
	1349		0.90	68
Rye straw	0	1.0	0.94	85
	190		-	96
	288		0.82	78
	643		0.82	60
	1349		1.14	85

Pasture grasses

Hubbard (1993 456 GLY) studied pasture grasses fortified with 1 mg/kg of glyphosate or AMPA and stored at *ca*. –10 °C. Pasture grasses were analysed at intervals of 6, 10, 19, 51, 95, 187, and 362 days after fortification. Each analytical set for storage stability analysis included the following samples: a non-treated control, two concurrent freshly fortified matrix samples, and four aged (storage stability) samples. Fresh untreated samples were fortified at 0.1 mg/kg and 1 and analysed concurrently with the aged samples.

The results demonstrated (Tables 39, 40) that residues of glyphosate in samples of pasture grasses are stable up to twelve months when stored at –10 °C.

Table 39. Storage stability data for residues of glyphosate in samples of pasture grasses Hubbard (1993 456 GLY).

	Storage interval (months)	Glyphosate residue (mg/kg)	AMPA residue (mg/kg)	Glyphosate procedural recovery at 1 ppm (%)
Pasture	6	0.78, 0.93	0.10, < 0.1	86
Grasses	10	1.0, 1.1	< 0.1, < 0.1	104
	19	0.92, 0.91	< 0.1, < 0.1	91
	51	0.83, 0.70	< 0.1, < 0.1	98
	95	0.76, 0.64	< 0.1, < 0.1	83
	187	0.70, 0.77	< 0.1, 0.24	79
	362	0.85, 0.76	< 0.1, < 0.1	77

Table 40. Storage stability data for residues of AMPA in samples of pasture grasses Hubbard (1993 456 GLY).

	Storage interval (months)	AMPA	Procedural recovery at 1 ppm (%)
Pasture	6	0.63, 0.55	81
Grasses	10	0.71, 0.73	91
	19	0.69, 0.69	80
	51	0.69, 0.64	74
	95	0.54, 0.63	80
	187	0.55, 0.65	74
	362	0.76, 0.73	78

Soybean seeds and straw

Hubbard (1993a 455 GLY) studied the storage stability of soybean seed and straw samples fortified with 1 mg/kg of glyphosate or AMPA and immediately stored at about –10 °C. Soybean seed samples were analysed at intervals of 5, 14, 45, and 183 days after fortification. The soybean straw samples were analysed at intervals of 0, 15, 44, 102, 300, and 394 days after treatment. Each analytical set for storage stability analysis included the following samples: a non-treated control, two concurrent freshly fortified matrix samples, and four aged (storage stability) samples.

Tables 41 and 41 summarize the results for stability of residues of glyphosate and AMPA in soybean seeds and straw. Storage stability results were corrected for procedural recoveries. The recoveries confirm that glyphosate is stable in soybean seeds and straw up to six and thirteen months, respectively, when stored at –10 °C.

Table 41. Storage stability data for residues of glyphosate in samples of soybean seeds and straw Hubbard (1993 455 GLY).

	Storage interval (days)	Glyphosate (mg/kg)	AMPA (mg/kg)	Procedural recovery (%)
Seeds	5	0.76, 0.74	< 0.1, < 0.1	65
	14	0.74, 0.70	< 0.1, < 0.1	70
	45	0.53, 0.75	< 0.1, < 0.1	50
	183	0.86, 0.80	0.16, 0.17	66
Straw	0	0.84, 0.71	< 0.1, < 0.1	74
	15	0.76, 0.61	< 0.1, < 0.1	80
	44	0.85, 0.80	< 0.1, < 0.1	68
	102	0.71, 0.63	< 0.1, < 0.1	75
	300	0.67, 0.77	< 0.1, < 0.1	91
	398	0.72, 0.79	< 0.1, < 0.1	71

Table 42. Storage stability data for residues of AMPA in samples of soybean seeds and straw Hubbard (1993 455 GLY).

	Storage interval (days)	AMPA (mg/kg)	Procedural recovery (%)
Seeds	5	0.79, 0.78	69
	14	0.74, 0.80	86
	45	0.67, 0.77	52
	183	0.73, 0.70	72
Straw	0	0.80, 0.73	74
	15	0.62, 0.70	76
	44	0.69, 0.68	65
	102	0.52, 0.55	70
	300	0.41, 0.56	88
	398	0.61, 0.52	65

The stability of incurred glyphosate residues was determined in corn grain, soybean forage, sorghum stover, clover and tomatoes under conditions of freezer storage over periods of 2–5 years (Mueth 1991 MSL 10843). The stability of fortified samples of the same five crops was studied from 0 to 2.5 years, the period not covered by the incurred samples. Incurred residues have also been determined for alfalfa seed and potatoes over periods of two years storage at < -18 °C. Samples were analyzed with the residue *Method 2*.

Stability data of the endogenous glyphosate residues are provided in Table 43 and show that the glyphosate residues are very stable over the covered timeframes.

Table 44 provides the stability data for glyphosate and MPA from exogenous fortified samples. Fortification residues of glyphosate are stable in all five crop matrices over the 0 to 2.5

years. AMPA residues are reasonably stable in tomatoes and corn grain, but declined from original levels in clover, sorghum straw and soybean forage. After 2 years, 56, 70 and 82% of the original levels of AMPA remained in clover, sorghum stover and soybean forage respectively. After 2.5 years, the residues had declined further to 53, 37 and 60% respectively.

Table 43. Freezer storage stability data of incurred glyphosate residues in crops (Mueth 1991 MSL 10843).

Matrix	Storage period (months)	Glyphosate		AMPA	
		Residue (mg/kg)	Procedural recovery (%)	Residue (mg/kg)	Procedural recovery (%)
Corn grain	13	1.5	83	<LOQ	88
	23	1.4	82	0.19 c0.12	82
	37	1.2	69	0.12 c0.07	72
Soybean forage	32	0.75 c0.06	112	0.02	102
	57	0.50 c0.03	76	<LOQ	70
	71	0.53 c0.03	75	<LOQ	73
Sorghum stover	7	1.5 c0.2	89	0.03 c0.03	77
	45	2.2 c0.15	92	0.11 c0.04	81
	59	2.1 c0.17	74	0.13 c0.06	69
	71	1.6 c0.15	81	0.07 c0.04	81
Clover	17	3.5 c0.01	96	0.01	88
	61	3.0	81	<LOQ c0.02	83
	75	2.7 c0.03	73	<LOQ c0.02	73
Tomatoes	4	0.09	83	<LOQ	82
	48	0.08 c0.01	75	<LOQ	67
	62	0.04	78	<LOQ	69
Alfalfa seed	2	16 c0.2	87	0.2	77
	13	13 c0.27	74	0.19 c0.04	73
	25	14 c0.22	99	0.23	91
Potatoes	1	<LOQ	80	0.19	75
	2	<LOQ c0.01	103	0.23	97
	11	<LOQ	85	0.23	81
	27	<LOQ	92	0.16	90

Table 44. Storage stability of fortified glyphosate and AMPA residues in crops (samples spiked at 0.5 mg/kg for glyphosate and 0.48 mg/kg for AMPA) (Mueth 1991 MSL 10843).

Matrix	Storage period (days)	Glyphosate		AMPA	
		Procedural recovery (%)	Residue (mg/kg)	Procedural recovery (%)	Residue (mg/kg)
Corn grain	0	82	0.41	82	0.40
	34	78	0.40	74	0.35
	95	78	0.40	63	0.30
	181	61	0.31	65	0.32
	271	63	0.29	69	0.31
	376	69	0.34	72	0.30
	528	69	0.31	73	0.33
	742	72	0.35	82	0.36
	944	75	0.29	71	0.27
Soybean forage	0	76	0.38	70	0.34
	27	84	0.43	80	0.39
	92	77	0.37	79	0.37
	182	80	0.38	81	0.35
	274	78	0.38	77	0.30
	379	75	0.41	73	0.33
	531	80	0.42	80	0.35
	743	82	0.41	91	0.36
	958	80	0.29	79	0.23
Sorghum straw	0	92	0.46	81	0.39
	29	78	0.39	73	0.32
	92	85	0.42	78	0.33
	182	78	0.38	81	0.30

	274	74	0.40	76	0.26
	377	74	0.39	69	0.22
	531	84	0.41	81	0.24
	743	81	0.41	81	0.28
	958	74	0.32	69	0.12
Clover	0	81	0.40	83	0.40
	28	85	0.43	86	0.35
	96	81	0.40	70	0.29
	183	78	0.38	86	0.33
	273	78	0.35	77	0.24
	376	73	0.38	73	0.24
	530	78	0.36	79	0.24
	741	84	0.39	85	0.23
	944	98	0.52	89	0.23
Tomatoes	0	75	0.38	67	0.33
	34	78	0.40	67	0.34
	91	78	0.38	73	0.34
	188	81	0.42	73	0.41
	272	79	0.37	75	0.33
	379	78	0.39	69	0.34
	528	85	0.42	83	0.38
	735	82	0.42	82	0.36
	938	82	0.43	74	0.36

Storage Stability in Animal Commodities

Swine, dairy cow and laying hen

The freezer storage stability of glyphosate and AMPA residues in samples of pig, cow and chicken fat, muscle, liver and kidney along with cow milk and chicken eggs was studied by Manning and Mueth (1991 MSL7515). Samples were fortified with a solution of glyphosate and AMPA in ratio of 4/1 or 8/1 and stored frozen (< -20 °C). Each tissue, milk and egg samples was analyzed for glyphosate and AMPA at various storage intervals. The samples were analyzed according to *Method 2*.

The results of the analyses are listed in Table 45 for glyphosate and AMPA. The data indicate a slight decrease in the glyphosate and AMPA residues for most matrices over the course of the study. However, this decrease is statistically significant in only two matrices for glyphosate (pig liver and chicken eggs) and three matrices for AMPA (pig muscle, chicken fat and eggs).

Table 45. Storage stability of glyphosate residues in animal products Manning and Mueth (1991 MSL7515).

Matrix	Storage (days)	Fortification level glyphosate/AMPA (mg/kg)	Glyphosate		AMPA	
			Procedural recovery (%)	Residue (mg/kg)	Procedural recovery (%)	Residue (mg/kg)
Pig fat	0	0.2/0.05	82	0.16, 0.14, 0.15	83	0.042, 0.038, 0.039
	210		98	0.18, 0.19	93	0.042, 0.043
	437		96	0.16, 0.16	96	0.038, 0.034
	524		101	0.17, 0.16	91	0.034, 0.033
	794		85	0.17, 0.18	84	0.032, 0.032
Pig muscle	0	0.2/0.05	102	0.21, 0.19, 0.18	98	0.050, 0.050, 0.047
	223		91	0.17, 0.16	93	0.042, 0.041
	382		106	0.20, 0.20	96	0.040, 0.041
	467		101	0.18, 0.19	94	0.037, 0.042
	794		103	0.17, 0.17	94	0.035, 0.035
Pig liver	0	0.8/0.1	86	0.68, 0.64, 0.66	93	0.093, 0.085, 0.088

Matrix	Storage (days)	Fortification level glyphosate/AMPA (mg/kg)	Glyphosate		AMPA	
			Procedural recovery (%)	Residue (mg/kg)	Procedural recovery (%)	Residue (mg/kg)
	417		84	0.61, 0.60	78	0.062, 0.061
	468		93	0.65, 0.65	93	0.076, 0.079
	521		79	0.56, 0.56	95	0.081, 0.079
	790		90	0.56, 0.61	98	0.076, 0.081
Pig kidney	0	4/0.5	100	4.0, 4.1, 3.9	99	0.50, 0.50, 0.50
	241		97	3.8, 3.6	104	0.51, 0.46
	377		90	3.4, 3.6	97	0.47, 0.50
	469		97	3.6, 3.1	102	0.46, 0.40
	790		83	3.2, 3.6	89	0.39, 0.49
Cow fat	0	0.2/0.05	89	0.17, 0.16, 0.18	84	0.042, 0.039, 0.042
	175		95	0.18, 0.17	96	0.042, 0.038
	349		99	0.17, 0.17	94	0.039, 0.039
	436		96	0.16, 0.16	82	0.032, 0.033
	715		105	0.17, 0.20	93	0.034, 0.041
Cow muscle	0	0.2/0.05	93	0.18, 0.16, 0.18	93	0.042, 0.043, 0.044
	177		83	0.15, 0.14	98	0.042, 0.041
	300		95	0.17, 0.18	89	0.038, 0.038
	373		98	0.18, 0.18	97	0.033, 0.036
	721		96	0.18, 0.21	84	0.036, 0.041
Cow liver	0	4/0.5	98	3.9, 3.8, 3.8	93	0.47, 0.46, 0.64
	288		92	3.4, 3.3	94	0.43, 0.41
	380		96	3.5, 3.4	98	0.44, 0.43
	433		89	3.2, 3.3	100	0.44, 0.43
	717		93	3.6, 3.7	95	0.45, 0.43
Cow kidney	0	6/1.5	96	5.7, 5.5, 5.6	93	1.4, 1.3, 1.4
	181		93	5.2, 5.2	90	1.2, 1.2
	296		90	5.4, 5.3	84	1.2, 1.2
	377		95	5.4, 5.4	91	1.2, 1.2
	717		89	5.5, 5.4	78	1.3, 1.3
Milk	0	0.2/0.05	91	0.17, 0.17	94	0.041, 0.043
	137		95	0.16, 0.16	89	0.037, 0.036
	200		93	0.16, 0.16	103	0.040, 0.039
	473		110	0.19, 0.18	82	0.037, 0.034
Chicken fat	0	0.2/0.05	92	0.16, 0.18, 0.19	91	0.041, 0.046, 0.047
	368		97	0.16, 0.16	89	0.038, 0.039
	420		95	0.16, 0.16	83	0.035, 0.036
	474		96	0.16, 0.16	93	0.038, 0.039
	753		85	0.16, 0.14	76	0.033, 0.029
Chicken muscle	0	0.2/0.05	84	0.18, 0.17, 0.17	97	0.048, 0.048, 0.049
	361		93	0.18, 0.18	95	0.044, 0.044
	426		102	0.18, 0.18	104	0.047, 0.047
	483		96	0.17, 0.17	105	0.044, 0.047
	754		88	0.17, 0.15	76	0.039, 0.035
Chicken liver	0	2/0.25	89	1.8, 1.6, 1.6	81	0.20, 0.18, 0.19
	384		114	1.6, 1.6	116	0.20, 0.18
	426		93	1.6, 1.7	97	0.20, 0.20
	474		103	1.6, 1.6	109	0.21, 0.22
	747		111	1.9, 1.9	95	0.21, 0.21
Chicken kidney	0	4/0.5	94	3.7, 3.7, 3.6	105	0.51, 0.52, 0.51
	19		98	3.9, 3.9	96	0.49, 0.50
	132		92	3.7, 3.5	99	0.48, 0.44
	390		105	4.1, 4.3	91	0.45, 0.46
Chicken eggs	0	0.2/0.05	89	0.18, 0.17, 0.18	97	0.049, 0.045, 0.048
	368		90	0.16, 0.16	89	0.040, 0.040

Matrix	Storage (days)	Fortification level glyphosate/AMPA (mg/kg)	Glyphosate		AMPA	
			Procedural recovery (%)	Residue (mg/kg)	Procedural recovery (%)	Residue (mg/kg)
	431		91	0.16, 0.16	94	0.042, 0.042
	755		91	0.073, 0.082	78	0.017, 0.018
	852		66	0.064, 0.063	71	0.017, 0.017

USE PATTERN

Information on registered uses was made available to the Meeting and those uses of relevance to this evaluation, based on label information, are summarized in Table 46.

Table 46. Table of use-patterns.

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
Alfalfa	USA	SL	Broadcast (ground or aerial)	Before emergence.		0.43-4.3	28 - 374			
				Pre-emergence, pre-transplanting	-	0.21-4.2	11-151			Do not harvest or feed treated vegetation for 8 weeks following pre-emergent/pre-planting application.
			Spot sprays	30-day intervals.		0.43-4.3	28 - 374	2-38		No more than 10% of field may be treated (some labels). Following spot treatment or selective equipment use, allow 14 days before grazing domestic livestock or harvesting forage grasses and legumes. Some labels state 3 days
			Wiper applications					180 – 540		No more than 10% of field may be treated. Following spot treatment or selective equipment use, allow 14 days before grazing domestic livestock or harvesting forage grasses and legumes. Some labels state 3 days
			Pre-harvest		1	1.7	28 - 374			1.5 (before grazing or harvesting). 6.7 kg ae/ha total annual maximum for all treatments.
Alfalfa	Canada	SL	Boom or boomless	Before or after seeding but before crop emerges		4.3	100-300	1.4-4.3		
			Wipers and wicks	Before or after seeding but before crop emerges		0.36	2	18		
			Rollers	Before or after seeding but before crop emerges		0.18-0.36	10	1.8-3.6		

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
			Broadcast			0.9-1.8	50-100	0.9-3.6	-	Application occurs typically 3-7 days before last cut before rotation or forage renovation
Banana	Brazil	SL		After emergence of crop and weed		0.18-4.3	40 - 400		30	
Banana	USA	SL	Broadcast (ground or aerial)	Before planting or transplanting or for renovation		0.43 – 4.3	28 - 374			8.8 kg ae/ha total annual maximum for all treatments.
			Broadcast (ground)				28 - 234	0.12 – 1.7	1	
			Directed Sprays or Spot sprays			0.43 – 4.3	28 - 374	2-38	1	
			Shielded Sprayer			0.43 – 4.3	187 - 280		1	
			Wiper Applications					180-540	1	
			Bananacide					540 (1 mL/5 cm diameter)		No food may be harvested from treated plants.
Barley	Netherlands	SL	Broadcast	Pre-harvest		2.2	200-400	0.55-1.1	7	Apply when cereal crop is fully ripened: - flag leaf is fully folded around stem, the cereal kernel is at dough stage and contains < 30% moisture, the straw is fully yellow
Barley	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	
				Pre-harvest, < 30% gain moisture	-1	0.54-1.4	40-250	0.22-10	7 (14 in dull weather)	
Beans	Canada	SL	Boom or boomless	Before or after seeding but before crop emerges		4.3	100-300	1.4-4.3		
			Wipers and wicks	Before or after seeding but before crop emerges		0.36	2	18		
			Rollers	Before or after seeding but before crop emerges		0.18-0.36	10	1.8-3.6		
				Pre-harvest when crop has < 30% grain moisture content		0.9	50-100	0.9-1.8	- (typically 7-14)	stems are green to brown in colour; pod are mature (yellow to brown in colour) 80-90% leaf drop (original leaves
Beans	Netherlands	SL	Broadcast	Pre-harvest		2.2	200-400	0.55-1.1	7	

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
Beans (field)	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	
				Pre-harvest, < 30% gain moisture	1	1.1-1.4	40-250	0.44-10	7	
Beans	USA	SL	Broadcast	Pre-emergent /pre-transplanting		0.43-4.3			-	
Cereals (other)	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	
				Pre-harvest, < 30% gain moisture	1	0.54	40-250	0.22-1.4	7-14	
Coffee	USA	SL	Broadcast (ground or aerial)	Before planting or transplanting or for renovation		0.43 – 4.3	28 - 374			8.8 kg ae/ha total annual maximum for all treatments.
			Broadcast (ground).			0.12 – 1.7	28 - 234		28	
			Directed Sprays or Spot sprays			0.43-4.2	28 - 374	2 – 38	28	
			Shielded Sprayer			0.42-4.3	187 - 280		28	
			Wiper Applications					180 – 540	28	
Cotton	USA	SL	Broadcast (ground or aerial)	Before emergence		0.43 – 4.2	28 - 374			6.7 kg/ha total annual maximum for all treatments.
			Spot sprays	Before boll opening				2 – 38		No more than 10% of field may be spot treated.
			Hooded Sprayers, Recirculating Sprayers			0.43 – 4.2	187 - 280		7	
			Wiper applications.					180 – 540	7	
			Broadcast	Pre-harvest		0.83-1.7	38-76 g 11-38 a		7	Do not feed or graze treated cotton forage or hay following pre-harvest application. Do not apply more than 1.7 kg ae/ha pre-harvest. Max 0.83 kg ae/ha by air
Cotton, glyphosate tolerant varieties	USA	SL	Broadcast (ground or aerial)	Before emergence		0.43 – 4.2	28 - 374			Seasonal total not to exceed 6.7 kg ae/ha.
			Over-the-Top spray or post-directed / other selective equipment	From emergence to 60% boll crack		1.7	28 - 187			Total Over-the-Top and Selective Equipment up to 5.1 kg ae/ha per season.
			Over-the-Top spray or post-directed	From 60% boll crack until 7 days before harvest		1.7	28 - 187		7	Total Over-the-Top and Selective Equipment up to 5.1 kg ae/ha per season.

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
Grasses	USA	SL	Broadcast	Before emergence		0.43 – 4.3	28 - 374			6.7 kg ae/ha total yearly maximum. Do not harvest or feed treated vegetation for 8 weeks following pre-emergence application. No waiting period for livestock feeding if application is < 0.43 kg ae/ha.
			Spot sprays	30-day intervals.		<2.5	28 - 374	2 – 38		No more than 1/10th of any acre should be treated at one time. Applications may be made at 30 day intervals. Remove domestic livestock before application and wait 14 days after spot spray application before grazing or harvesting
			Wiper applications	When crop established				180 – 540	.	No more than 1/10th of any acre should be treated at one time. Applications may be made at 30 day intervals. Remove domestic livestock before application and wait 14 days after wiper application before grazing or harvesting
			Broadcast	Renovation		0.43-4.3	28-374			For rates <2.3 kg ae/ha no grazing or harvesting interval is required. For higher rates, remove domestic livestock before application and wait 8 weeks after application before grazing or harvesting
Kiwi Fruit	Italy	SL	Spray weeds around base of plants, between rows			4.3			-	
Lentils	Canada	SL	Boom or boomless	Before or after seeding but before crop emerges		4.3	100-300	1.4-4.3		
			Wipers and wicks	Before or after seeding but before crop emerges		0.36	2	18		
			Rollers	Before or after seeding but before crop emerges		0.18-0.36	10	1.8-3.6		
			Broadcast	Pre-harvest when crop has < 30% grain moisture content		0.9	50-100	0.9-1.8	- (typically 7-14)	lowermost pods (bottom 15%) are brown and seeds rattle
Linseed (flax)	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
				Pre-harvest, < 30% gain moisture	1	1.1-1.4	80-250	0.44-5	14-28	
Maize	USA	SL	Broadcast (ground or aerial)	Before emergence		0.43 – 4.2	28 - 560			6.7 kg ae/ha total annual maximum for all treatments.
			Spot sprays	Before silking				2 – 38		No more than 10% of field may be spot treated.
			Hooded Sprayers	> 30 cm tall.		0.87	187 - 280			No more than 2.5 kg ae/ha per season. Do not graze or feed corn forage or fodder following hooded sprayer applications
			Wiper applications	When crop established				180 – 540		
			Pre-harvest	< 35% gain moisture		2.5	28 – 187		7	
Maize, glyphosate tolerant varieties	USA	SL	Broadcast	Pre-emergence	-	4.2	19-76g 11-57a			Do not exceed 4.2 kg ae/ha/year for pre-pant/pre-emergence application. Allow a minimum of 50 days between application and harvest of corn forage.
			Broadcast	From emergence to 8 leaf stage	-	0.62-0.83	19-76g 11-57a			Do not exceed 1.7 kg ae/ha/year for in-crop application from emergence to 8 leaf (V8)
			Broadcast to 4 leaf, directed from 5 leaf to layby	Post-emergent	4	0.83	19-76g 11-57a			Do not exceed 3.3 kg ae/ha/year for in-crop application
			Broadcast	Post – emergent to crop 76 cm high	-	1.7	19-76g 11-57a			Allow a minimum of 50 days between application and harvest of corn forage or grain.
			Broadcast	Pre-harvest, < 35% grain moisture	-	0.87	19-76g 11-57a		7 days	Combined applications must not exceed 6.6 kg ae/ha/year.
Mustard	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	
				Pre-harvest, < 30% gain moisture	1	1.1-1.4	80-250	0.44-5	8-10	
Oats	Canada	SL	Boom or boomless	Before or after seeding but before crop emerges		4.3	100-300	1.4-4.3		
			Wipers and wicks	Before or after seeding but before crop emerges		0.36	2	18		
			Rollers	Before or after seeding but before crop emerges		0.18-0.36	10	1.8-3.6		

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
			Broadcast	Pre-harvest when crop has < 30% grain moisture content		0.9	50-100	0.9-1.8	- (typically 7-14)	
Oats	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	
				Pre-harvest, < 30% gain moisture	1	0.54-1.4	40-250	0.22-10	7 (14 in dull weather)	
Olives	Spain	SL	Directed Sprays or Spot sprays around trees or in row middles.	Trees 3 – 4 years old (some labels)		1.4 2.5 2.2 4.3			7 for fruit on ground - 1 day 7 days	
Olives	Italy	SL	Directed Sprays or Spot sprays around trees or in row middles.			4.3			-	
Peas	Canada	SL	Boom or boomless	Before or after seeding but before crop emerges		4.3	100-300	1.4-4.3		
			Wipers and wicks	Before or after seeding but before crop emerges		0.36	2	18		
			Rollers	Before or after seeding but before crop emerges		0.18-0.36	10	1.8-3.6		
				Pre-harvest when crop has < 30% grain moisture content		0.9	50-100	0.9-1.8	- (typically 7-14)	majority of pods (75-80%) are brown
Peas	Netherlands	SL	Broadcast	Pre-harvest		2.2	200-400	0.55-1.1	7	
Peas	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	
				Pre-harvest, < 30% gain moisture	1	1.1-1.4	40-250	0.44-10	7	
Peas	USA	SL	Broadcast	Pre-emergent /pre-transplanting		0.43-4.3			-	
Rape	Canada	SL	Boom or boomless	Before or after seeding but before crop emerges		4.3	100-300	1.4-4.3		

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
			Wipers and wicks	Before or after seeding but before crop emerges		0.36	2	18		
			Rollers	Before or after seeding but before crop emerges		0.18-0.36	10	1.8-3.6		
			Broadcast	Pre-harvest when crop has < 30% grain moisture content		0.9	50-100	0.9-1.8	- (typically 7-14)	pods are green to yellow; most seeds are yellow to brown
Rape	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	
				Pre-harvest, < 30% gain moisture	1	1.1-1.4	200-250	0.44-0.7	14-21	
Sorghum (Milo)	USA	SL	Broadcast (ground or aerial)	Before emergence		0.43 – 4.2	28 - 560			6.7 kg ae/ha total annual maximum for all treatments.
			Spot sprays	Before heading				2 – 38		<10% of field may be treated.
			Hooded Sprayers between rows	> 30 cm tall, where equipment can avoid crop contact		0.87	187 - 280			Do not feed foliage to livestock following hooded sprayer application. No more than 2.5 kg ae/ha per season.
			Wiper applications					180 – 540	40	Do not feed foliage to livestock after wiper application.
			Broadcast	Apply at < 30% grain moisture		1.7			7	Max 0.83 kg ae/ha by air
Soya beans	USA	SL	Broadcast (ground or aerial)	Before emergence		0.43 – 4.2	28 - 374			6.7 kg ae/ha total annual maximum for all treatments.
			Spot sprays	Prior to initial pod set.				2 – 38		No more than 10% of field may be spot treated.
			Hooded, Shielded, or Recirculating Sprayers			0.43 – 4.2	187 - 280		7	
			Wiper or Sponge applications					180 – 540	7	
			Broadcast	Apply after all pods set and lost all green colour	-	0.21--4.2	11-151		7	Do not graze or harvest treated crop for livestock feed within 25 days of last pre-harvest application or if the application rate is < 0.74 kg ae/ha 14 days. Do not apply more than 5 kg ae/ha for pre-harvest application. Max 0.83 kg ae/ha by air

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
Soya beans, glyphosate tolerant varieties	USA	SL	Broadcast	Pre-plant/pre-emergent		4.2	19-76g 11-57a			Do not exceed 4.2 kg ae/ha/year for pre-pant/pre-emergence application.
			Broadcast to 4 leaf, directed from 5 leaf to layby	Post-emergent		1.7	19-76g 11-57a			Do not exceed 2.5 kg ae/ha/year for in-crop application
			Broadcast	Pre-harvest		0.83	19-76g 11-57a		14	Do not exceed 0.83 kg ae/ha/year pre-harvest. Combined applications must not exceed 6.7 kg ae/ha/year. Allow a minimum of 14 days between final application and harvest or feeding of soyabean grain, forage and hay.
Sugar beet, glyphosate tolerant varieties	USA	SL	Broadcast (ground or aerial)	Before emergence		0.43 – 4.2	28 - 374			Do not exceed 4.2 kg ae/ha/season for pre-emergence applications
			Broadcast (ground or aerial)	Emergence to 8 leaf		1.3				Do not exceed 3.8 kg ae/ha per season for application between crop emergence and harvest
			Broadcast (ground or aerial)	8-leaf stage to canopy closure.		0.87	28 - 187		30	Do not exceed 3.8 kg ae/ha per season for application between crop emergence and harvest. Do not exceed 6.7 kg ae/ha/season for combined applications
Sugarcane	USA	SL	Foliar spray	Pre-emergence, pre-transplanting	-	0.21--4.2	38-151			Do not harvest or feed treated vegetation for 8 weeks following application. Total application should not exceed 8.7 kg ae/ha/year for sugarcane. Do not feed or graze treated sugarcane forage following application
				Spot application				2 – 38		
				3 to 10 weeks before harvest		0.49 0.84			21 – 35 28-70	Do not feed or graze treated sugarcane.
Sunflower	Hungary	SL	Pre-harvest	< 20–30 % gain moisture		0.72 1.8	50 - 60		6 21	Straw from treated crop must not be used for animal feed
Tea	Japan	SL	Inter-row spray		1	0.9-2.3	250-500		7	
Tree Nuts	USA	SL	Broadcast (ground or aerial)	Before planting or transplanting		0.43 – 4.2	28 - 374			8.8 kg/ha total annual maximum for all treatments.
			Broadcast (ground)			0.12 – 1.7	28 - 234		21	
			Directed Sprays or Spot sprays			0.43 – 4.3	28 - 374	2-38	3	

Crop	Country	Form.	Application type	Growth stage	No	Rate kg ae/ha	water L/ha	Conc. kg ae/hL	PHI days	
			Shielded Sprayer			0.43 – 4.3	187 - 280		3	
			Wiper Applications					180-540	3	
Wheat	Netherlands	SL	Broadcast	Pre-harvest		2.2	200-400	0.55-1.1	7	Apply when cereal crop is fully ripened: - flag leaf is fully folded around stem, the cereal kernel is at dough stage and contains < 30% moisture, the straw is fully yellow
Wheat	UK	SL		Pre-emergence	1	0.54	80-250	022-0.68	-	
				Pre-harvest, < 30% gain moisture	1	0.54-1.4	40-250	0.22-10	7 (14 in dull weather)	

RESIDUES RESULTING FROM SUPERVISED TRIALS

The results for the residue trials are shown in Tables 47 – 88 and are reviewed in the order of the Codex Alimentarius Classification of Foods and Feeds.

Table 47 Olives (Greece, Italy and Spain)
Table 48 Bananas (Brazil)
Table 49 Bananas (Honduras, Panama, Colombia and Ecuador)
Table 50 Kiwifruit (Italy)
Table 51 Beans, dry (Belgium, Denmark, UK and the USA)
Table 52 Peas, dry (Belgium, Canada, Denmark, the UK and the USA)
Table 53 Lentils (Canada)
Table 54 Soya beans (the USA)
Table 55 Soya beans; glyphosate tolerant (the USA)
Table 56 Sugar beet; glyphosate tolerant (the USA)
Table 57 Barley (Belgium, France, the UK)
Table 58 Maize, conventional (USA)
Table 59 Maize, glyphosate tolerant (USA)
Table 60 Oats (Canada, Denmark, the UK)
Table 61 Rye (Denmark)
Table 62 Sorghum (the USA)
Table 63 Wheat (Belgium, France and the UK)
Table 64 Sugarcane (USA)
Table 65 Tree nuts; almonds, pecans, macadamias and walnuts (USA)
Table 66 Cottonseed (USA)
Table 67 Cottonseed; glyphosate tolerant (USA)
Table 68 Cottonseed; glyphosate tolerant (USA)
Table 69 Linseed (UK)
Table 70 Mustard seed (UK)
Table 71 Rape seed (Belgium, Canada, Denmark, Finland, France, Sweden and the UK)
Table 72 Sunflower (Hungary)
Table 73 Coffee (Brazil, Columbia, Costa Rica and the USA)
Table 74 Tea (China, India, Sri Lanka and Japan)
Table 75 Alfalfa (Canada, USA)
Table 76 Grass pasture (USA)
Table 77 Bean fodder (Belgium, UK)

Residue trials

The limits of detection of glyphosate and AMPA are typically 0.05 mg/kg. When glyphosate and AMPA were summed, AMPA was converted to glyphosate equivalents (AMPA mg/kg × 1.523). All numerical figures for glyphosate application rates (kg ae/ha) or residue levels (mg/kg) are expressed as glyphosate acid equivalents (molecular weight 169 amu), and do not include any mass amounts for the salt cation (e.g. isopropylamine).

If AMPA residues are < 0.05, they are not summed with glyphosate, because they are typically much less than glyphosate residues. If both glyphosate and AMPA are < LOQ, then sum is < LOQ of glyphosate. The exception is where there is evidence that AMPA residues are comparable to glyphosate residues such as for soyabeans in which case the residues are summed and if both glyphosate and AMPA residues are < LOQ, the sum is less than the combined LOQs for glyphosate and AMPA.

Table 47. Residues in Olives: Directed Ground Spray Application.

Location (year) variety	Application				Sample	PHI (days)	Residues (mg/kg)			Report/ reference
	Form	N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Enofyta, Biotia, Greece (1995) Megaron	SL	1	1.4		Fruit (G)	1	0.21			RJ2217B
					Fruit (T)	1	< 0.05			RJ2217B
					Fruit (G)	7	< 0.05			RJ2217B
					Fruit (T)	7	< 0.05			RJ2217B
					Fruit (G)	13	< 0.05			RJ2217B
					Fruit (T)	13	< 0.05			RJ2217B
		1	4.8		Fruit (G)	1	0.23			RJ2217B
					Fruit (T)	1	0.17			RJ2217B
					Fruit (G)	7	0.39			RJ2217B
					Fruit (T)	7	< 0.05			RJ2217B
					Fruit (G)	13	< 0.05			RJ2217B
					Fruit (T)	13	< 0.05			RJ2217B
Enofyta, Biotia, Greece (1995) Manaki	SL	1	1.4		Fruit (G)	1	< 0.05			RJ2217B
					Fruit (T)	1	< 0.05			RJ2217B
					Fruit (G)	7	< 0.05			RJ2217B
					Fruit (T)	7	< 0.05			RJ2217B

Location (year) variety	Application				Sample	PHI (days)	Residues (mg/kg)			Report/ reference
	Form	N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
					Fruit (G)	13	< 0.05			RJ2217B
					Fruit (T)	13	< 0.05			RJ2217B
		1	4.8		Fruit (G)	1	0.17			RJ2217B
					Fruit (T)	1	< 0.05			RJ2217B
					Fruit (G)	7	0.14			RJ2217B
					Fruit (T)	7	< 0.05			RJ2217B
					Fruit (G)	13	< 0.05			RJ2217B
					Fruit (T)	13	< 0.05			RJ2217B
Greece (1996) Megaritiki	SL	1	4.8	1.2	Fruit (G)	7	0.11			RJ2397B
					Fruit (T)	7	< 0.05			RJ2397B
		1	4.8	0.97	Fruit (G)	6	0.07			RJ2397B
					Fruit (T)	6	< 0.05			RJ2397B
					Fruit (G, w)	6	< 0.05			RJ2397B
					Virgin Oil	6	< 0.05			RJ2397B
					Cake	6	< 0.05			RJ2397B
					Solvent extr. Oil	6	< 0.05			RJ2397B
					Solvent extr. Cake	6	< 0.05			RJ2397B
Ariccia, Roma, Italy (1996) Rosciola	SL	1	4.8	1.2	Fruit (G)	7	0.30			RJ2383B
					Fruit (T)	7	< 0.05			RJ2383B
Borgo Mezzanone, Foggia, Italy (1996) Coratina	SL	1	4.8	1.6	Fruit (G)	7	0.15			RJ2383B
					Fruit (T)	7	< 0.05			RJ2383B
					Fruit (G, w)	7	0.06			RJ2383B
					Virgin oil	7	< 0.05			RJ2383B
					Cake	7	0.05			RJ2383B
					Solvent extr. oil	7	< 0.05			RJ2383B
					Solvent extr. Cake	7	< 0.05			RJ2383B
Cori, Latina, Italy (1995) Frantoio	SL	1	1.4	0.48	Fruit (G)	1	< 0.05			RJ2218B
					Fruit (T)	1	< 0.05			RJ2218B
					Fruit (G)	7	0.07			RJ2218B
					Fruit (T)	7	< 0.05			RJ2218B
					Fruit (G)	14	0.05			RJ2218B
					Fruit (T)	14	< 0.05			RJ2218B
		1	4.8	1.6	Fruit (G)	1	0.66			RJ2218B
					Fruit (T)	1	< 0.05			RJ2218B
					Fruit (G)	7	0.27			RJ2218B
					Fruit (T)	7	< 0.05			RJ2218B
					Fruit (G)	14	0.19			RJ2218B
					Fruit (T)	14	< 0.05			RJ2218B
Borgo Mezzanone, Foggia, Italy (1995) Coratina	SL	1	1.4	0.72	Fruit (G)	1	0.05			RJ2218B
					Fruit (T)	1	< 0.05			RJ2218B
					Fruit (G)	6	0.16			RJ2218B
					Fruit (T)	6	< 0.05			RJ2218B
					Fruit (G)	13	< 0.05			RJ2218B
					Fruit (T)	13	0.06			RJ2218B
		1	4.8	2.4	Fruit (G)	1	0.10			RJ2218B
					Fruit (T)	1	< 0.05			RJ2218B
					Fruit (G)	6	0.12			RJ2218B
					Fruit (T)	6	< 0.05			RJ2218B
					Fruit (G)	13	< 0.05			RJ2218B

Location (year) variety	Application				Sample	PHI (days)	Residues (mg/kg)			Report/ reference
	Form	N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
					Fruit (T)	13	< 0.05			RJ2218B
Francavilla, Puglia, Italy (1993) Nardo	SG	1	1.4	0.72	Fruit (T) Fruit (T) Fruit (G) Fruit (G) Raw oil Raw oil	6 13 6 13 6 13	< 0.05 0.08 0.3 0.5 0.5 0.6 0.2 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 (3) < 0.05 (2) < 0.05 < 0.05	< 0.05 0.08 0.3 0.5 0.5 0.6 0.2 < 0.05 < 0.05	MLL30319 corrected recovery 80% gly and 59% AMPA fruit, 92% gly 78% AMPA oil
San Casciano, Toscana, Italy (1993) Leccino	SL	1	1.4	0.48	Fruit (T) Fruit (T) Fruit (G) Fruit (G) Raw oil Raw oil	7 14 7 14 7 14	< 0.05 < 0.05 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 0.05 < 0.05 < 0.05 < 0.05	MLL30319 corrected recovery 80% gly and 59% AMPA fruit, 92% gly 78% AMPA oil
Cartaojal, Malaga, Spain (1995) Hojiblanca	SL	1	2.2	0.54	Fruit (T) Fruit (T) Fruit (G) Fruit (G) raw oil refin. oil	0 7 0 7 7 7	< 0.05 < 0.05 9.2 0.1 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 9.2 0.1 < 0.05 < 0.05	MLL30469
		1	2.2	0.54	Fruit (T) Fruit (T) Fruit (G) Fruit (G) raw oil refin. oil	0 14 0 14 14 14	< 0.05 < 0.05 <u>12</u> 0.1 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 <u>12</u> 0.1 < 0.05 < 0.05	MLL30469
		1	2.2	0.54	Fruit (T) Fruit (T) Fruit (G) Fruit (G) raw oil refin. oil	0 28 0 28 28 28	< 0.05 < 0.05 9.8 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 9.8 < 0.05 < 0.05 < 0.05	MLL30469
La Carlotta, Cordoba, Spain (1995) Picual	SL	1	2.2	0.54	Fruit (T) Fruit (T) Fruit (G) Fruit (G) raw oil refin. oil	0 7 0 7 7 7	< 0.05 < 0.05 4.2 0.1 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 4.2 0.1 < 0.05 < 0.05	MLL30469
		1	2.2	0.54	Fruit (T) Fruit (T) Fruit (G) Fruit (G) raw oil refin. oil	0 14 0 14 14 14	< 0.05 < 0.05 5.8 0.1 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 5.8 0.1 < 0.05 < 0.05	MLL30469
		1	2.2	0.54	Fruit (T) Fruit (T) Fruit (G) Fruit (G) raw oil refin. oil	0 28 0 28 28 28	< 0.05 < 0.05 <u>12</u> < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 <u>12</u> < 0.05 < 0.05 < 0.05	MLL30469
Villa del Rio, Cordoba, Spain (1995) Picual	SL	1	2.2	0.54	Fruit (T) Fruit (T) Fruit (G) Fruit (G) raw oil refin. oil	0 7 0 7 7 7	< 0.05 < 0.05 5.9 0.5 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05	< 0.05 < 0.05 5.9 0.5 < 0.05 < 0.05	MLL30469

Location (year) variety	Application				Sample	PHI (days)	Residues (mg/kg)			Report/ reference
	Form	N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
		1	2.2	0.54	Fruit (T)	0	< 0.05	< 0.05	< 0.05	MLL30469
					Fruit (T)	14	< 0.05	< 0.05	< 0.05	
					Fruit (G)	0	12	< 0.05	12	
					Fruit (G)	14	0.1	< 0.05	0.1	
					raw oil	14	< 0.05	< 0.05	< 0.05	
					refin. oil	14	< 0.05	< 0.05	< 0.05	
		1	2.2	0.54	Fruit (T)	0	< 0.05	< 0.05	< 0.05	MLL30469
					Fruit (T)	28	< 0.05	< 0.05	< 0.05	
					Fruit (G)	0	9.3	< 0.05	9.3	
					Fruit (G)	28	< 0.05	< 0.05	< 0.05	
					raw oil	28	< 0.05	< 0.05	< 0.05	
					refin. oil	28	< 0.05	< 0.05	< 0.05	
Ubeda, Jaen, Spain (1995) Picual	SL	1	2.2	0.54	Fruit (T)	0	< 0.05	< 0.05	< 0.05	MLL30469
					Fruit (T)	7	< 0.05	< 0.05	< 0.05	
					Fruit (G)	0	6.0	< 0.05	6	
					Fruit (G)	7	0.9	< 0.05	0.9	
					raw oil	7	< 0.05	< 0.05	< 0.05	
					refin. oil	7	< 0.05	< 0.05	< 0.05	
		1	2.2	0.54	Fruit (T)	0	< 0.05	< 0.05	< 0.05	MLL30469
					Fruit (T)	14	< 0.05	< 0.05	< 0.05	
					Fruit (G)	0	6.7	< 0.05	6.7	
					Fruit (G)	14	0.9	< 0.05	0.9	
					raw oil	14	< 0.05	< 0.05	< 0.05	
					refin. oil	14	< 0.05	< 0.05	< 0.05	
		1	2.2	0.54	Fruit (T)	0	< 0.05	< 0.05	< 0.05	MLL30469
					Fruit (T)	28	< 0.05	< 0.05	< 0.05	
					Fruit (G)	0	6.4	< 0.05	6.4	
					Fruit (G)	28	< 0.05	< 0.05	< 0.05	
					raw oil	28	< 0.05	< 0.05	< 0.05	
					refin. oil	28	< 0.05	< 0.05	< 0.05	
Pedrera, Seville, Spain (1990) Hojiblanca	SL	1	0.36	0.18	Olives	1	0.7			MLL30297
					Olives	7	0.9			
					Olive oil	1	< 0.05			
					Olive oil	7	< 0.05			
Puebla de Cazalla, Spain (1990) Verdial	SL	1	0.36	0.18	Olives	1	0.9			MLL30297
					Olives	7	1.0			
					Olive oil	1	< 0.05			
					Olive oil	7	< 0.05			
Torreblascopedro, Jaen, Spain (1992) Picual	SL	1	0.36	0.18	Olives	0	1.2	< 0.05	1.2	MLL30297
					Olives	32	0.6	< 0.05	0.6	
					Olive oil	0	< 0.05	< 0.05	< 0.05	
					Olive oil	32	< 0.05	< 0.05	< 0.05	
Sierrayegua, Malaga, Spain (1992) Hojiblanca	SL	1	0.36	0.18	Olives	0	0.2	< 0.05	0.2	MLL30297
					Olives	24	0.2	< 0.05	0.2	
					Olive oil	0	< 0.05	< 0.05	< 0.05	
					Olive oil	24	< 0.05	< 0.05	< 0.05	
Linares, Jaen, Spain (1992) Picual	SL	1	0.36	0.18	Olives	0	0.1	< 0.05	0.1	MLL30297
					Olives	30	1.2	< 0.05	1.2	
					Olive oil	0	< 0.05	< 0.05	< 0.05	
					Olive oil	30	< 0.05	< 0.05	< 0.05	
Cordoba, Cordoba, Spain (1992) Picual	SL	1	0.36	0.18	Olives	0	0.06	< 0.05	0.06	MLL30297
					Olives	41	0.3	< 0.05	0.3	
					Olive oil	0	< 0.05	< 0.05	< 0.05	
					Olive oil	41	< 0.05	< 0.05	< 0.05	
Santaella Cordoba, Spain, (1977) Nevadillo	SL	2	2.2 4.3		Table Olives Table Olives	20	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II

Location (year) variety	Application				Sample	PHI (days)	Residues (mg/kg)			Report/ reference
	Form	N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Santaella Cordoba, Spain, (1977) Lechin	SL	2	2.2 4.3		Table Olives Table Olives	20	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
Santaella Cordoba, Spain, (1977) Hojiblanca	SL	2	2.2 4.3		Table Olives Table Olives	20	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
Santaella Cordoba, Spain, (1977) Ocal	SL	2	2.2 4.3		Table Olives Table Olives	20	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
Seville, Spain (1977) Gordal	SL	2	2.2 4.3		Table Olives Table Olives	27	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
Seville, Spain (1977) Manzanilla	SL	2	2.2 4.3		Table Olives Table Olives	27	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
Aguilarde, La Frontera, Cordoba, Spain (1977) Hojiblanco	SL	2	2.2 4.3		Olive Oil Olive Oil	30	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
Aguilarde, La Frontera, Cordoba-Spain (1977) Picudo	SL	2	2.2 4.3		Olive Oil Olive Oil	30	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
Aguadulce, Seville, Spain (1977) Hojiblanca	SL	2	2.2 4.3		Olive Oil Olive Oil	32	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
El Fontanal, Montilla, Cordoba, Spain (1977) Hojiblanco	SL	2	2.2 4.3		Olive Oil Olive Oil	54	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
El Fontanal, Montilla, Cordoba, Spain (1977) Nevadillo	SL	2	2.2 4.3		Olive Oil Olive Oil	54	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
La Canaleja Montilla, Cordoba, Spain (1977) Lechin	SL	2	2.2 4.3		Olive Oil Olive Oil	38	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
La Canaleja Montilla, Cordoba-Spain (1977) Hojiblanco	SL	2	2.2 4.3		Olive Oil Olive Oil	38	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II
Uterera, Seville-Spain (1977) Lechin	SL	2	2.2 4.3		Olive Oil Olive Oil	30	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	A20-II

(G) = fruit harvested from the ground; (T) = fruit harvested from the tree; (G, w) = fruit harvested from the ground and washed

Table 48. Residues in Bananas: Directed Ground Spray Application (Brazil) using 480 g ae/L (isopropylamine salt) SL formulation.

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ Reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Brotas, São Paulo, Brazil (2002) Nanica	SL	1	2.2	2.2	Banana	30	< 0.05	< 0.05	< 0.05	57/2003
		1	4.3	4.3	Banana	30	< 0.05	< 0.05	< 0.05	57/2003
Taiacu, São Paulo, Brazil (2002) Nanica	SL	1	2.2	2.2	Banana	15	< 0.05	< 0.05	< 0.05	61/2003
		1	4.3	4.3	Banana	15	< 0.05	< 0.05	< 0.05	61/2003
Campinas, São Paulo, Brazil (2000) Nanica	SL	1	2.2	2.2	Banana	30	< 0.02	< 0.02	< 0.02	5385
		1	4.3	4.3	Banana	30	< 0.02	< 0.02	< 0.02	5385
Paulinia, São Paulo, Brazil (2002) Nanica	SL	1	2.2	2.2	Banana	30	< 0.05	< 0.05	< 0.05	37/2002
		1	4.3	4.3	Banana	30	< 0.05	< 0.05	< 0.05	37/2002
Avaré, São Paulo, Brazil (2001) Nanica	SL	1	2.2	1.0	Banana	43	< 0.05	< 0.05	< 0.05	53/2002
		1	4.3	2.1	Banana	43	< 0.05	< 0.05	< 0.05	53/2002

Table 49. Residues in Bananas: Injection, Pre-plant and Directed Ground Spray Applications of a 360 g ae/L SL formulation of glyphosate (Honduras, Panama, Colombia, and Ecuador).

Location (year) variety	Type	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Honduras (1977) Valery	INJ	1	60 ml*		Pulp	420	< 0.05	< 0.05	< 0.05	MSL00694
					Peel		< 0.05	< 0.05	< 0.05	
	PD	5	5×3.4		Pulp	1	< 0.05	< 0.05	< 0.05	MSL00694
					Pulp	8	< 0.05	< 0.05	< 0.05	
					Pulp	15	< 0.05	< 0.05	< 0.05	
					Pulp	22	< 0.05	< 0.05	< 0.05	
					Peel	1	< 0.05	< 0.05	< 0.05	
					Peel	8	< 0.05	< 0.05	< 0.05	
					Peel	15	< 0.05	< 0.05	< 0.05	
					Peel	22	< 0.05	< 0.05	< 0.05	
	PD	5	5×7.7		Pulp	1	< 0.05	< 0.05	< 0.05	MSL00694
					Pulp	8	< 0.05	< 0.05	< 0.05	
					Pulp	15	< 0.05	< 0.05	< 0.05	
					Pulp	22	< 0.05	< 0.05	< 0.05	
					Peel	1	< 0.05	< 0.05	< 0.05	
					Peel	8	< 0.05	< 0.05	< 0.05	
					Peel	15	< 0.05	< 0.05	< 0.05	
					Peel	22	< 0.05	< 0.05	< 0.05	
	INJ PRE PD	6	60 mL* 3.4 4×3.4		Pulp Peel	78	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
	INJ PRE PD	6	60 mL* 7.7 4×7.7		Pulp Peel	78	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
Panama (1977) Valery	INJ	1	60 mL*		Pulp	391	< 0.05	< 0.05	< 0.05	MSL00694
					Peel		< 0.05	< 0.05	< 0.05	

Location (year) variety	Type	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PD	5	5×3.4		Pulp	1	< 0.05	< 0.05	< 0.05	MSL00694
					Pulp	8	0.11	< 0.05	0.11	
					Pulp	15	< 0.05	< 0.05	< 0.05	
					Pulp	22	< 0.05	< 0.05	< 0.05	
					Peel	1	< 0.05	< 0.05	< 0.05	
					Peel	8	< 0.05	< 0.05	< 0.05	
					Peel	15	< 0.05	< 0.05	< 0.05	
					Peel	22	< 0.05	< 0.05	< 0.05	
	PD	5	5×7.7		Pulp	1	< 0.05	< 0.05	< 0.05	MSL00694
					Pulp	8	0.09	< 0.05	0.09	
					Pulp	15	0.09	< 0.05	0.09	
					Pulp	22	0.10	< 0.05	0.1	
					Peel	1	< 0.05	< 0.05	< 0.05	
					Peel	8	< 0.05	< 0.05	< 0.05	
					Peel	15	< 0.05	< 0.05	< 0.05	
					Peel	22	< 0.05	< 0.05	< 0.05	
	INJ PRE PD	6	60 mL* 3.4 4×3.4		Pulp Peel	56	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
	INJ PRE PD	6	60 mL* 7.7 4×7.7		Pulp Peel	56	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
Colombia (1977) Cavendish	INJ	1	60 mL*		Pulp Peel	357	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
	PD	5	5×3.4		Pulp	1	< 0.05	< 0.05	< 0.05	MSL00694
					Pulp	7	< 0.05	< 0.05	< 0.05	
					Pulp	14	0.05	< 0.05	0.05	
					Pulp	21	< 0.05	< 0.05	< 0.05	
					Peel	1	< 0.05	< 0.05	< 0.05	
					Peel	7	< 0.05	< 0.05	< 0.05	
					Peel	14	< 0.05	< 0.05	< 0.05	
					Peel	21	< 0.05	< 0.05	< 0.05	
	PD	5	5×7.7		Pulp	1	0.12	< 0.05	0.12	MSL00694
					Pulp	7	0.05	< 0.05	0.05	
					Pulp	14	< 0.05	< 0.05	< 0.05	
					Pulp	21	< 0.05	< 0.05	< 0.05	
					Peel	1	< 0.05	< 0.05	< 0.05	
					Peel	7	< 0.05	< 0.05	< 0.05	
					Peel	14	< 0.05	< 0.05	< 0.05	
					Peel	21	< 0.05	< 0.05	< 0.05	
	INJ PRE PD	6	60 mL* 3.4 4×3.4		Pulp Peel	21	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
	INJ PRE PD	6	60 mL* 7.72 4×7.7		Pulp Peel	21	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
Ecuador (1977) Cavendish	INJ	1	60 mL*		Pulp Pee	399	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
	PD	1	3.4		Pulp	2	< 0.05	< 0.05	< 0.05	MSL00694
					Pulp	8	0.07	< 0.05	0.07	
					Pulp	15	< 0.05	< 0.05	< 0.05	
					Pulp	22	< 0.05	< 0.05	< 0.05	
					Peel	2	< 0.05	< 0.05	< 0.05	
					Peel	8	< 0.05	< 0.05	< 0.05	
					Peel	15	< 0.05	< 0.05	< 0.05	
					Peel	22	< 0.05	< 0.05	< 0.05	

Location (year) variety	Type	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PD	5	5×7.7		Pulp	2	< 0.05	< 0.05	< 0.05	MSL00694
					Pulp	8	0.16	< 0.05	0.16	
					Pulp	15	< 0.05	< 0.05	< 0.05	
					Pulp	22	< 0.05	< 0.05	< 0.05	
					Peel	2	< 0.05	< 0.05	< 0.05	
					Peel	8	< 0.05	< 0.05	< 0.05	
					Peel	15	< 0.05	< 0.05	< 0.05	
					Peel	22	< 0.05	< 0.05	< 0.05	
	INJ PRE PD	6	60 mL* 3.4 4×3.4		Pulp Peel	59	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694
	INJ PRE PD	6	60 mL* 7.7 4×7.7		Pulp Pee	59	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL00694

Treatment types are: INJ = direct injection into stem to remove old plants prior to planting new crop; PRE = pre-planting; PD = post-directed. In treatments that included injection application, the residues were measured in bananas from newly planted crop, not in plants that were injected.
* 60 mL of a 25% solution of Roundup

Table 50. Residues in Kiwifruit: Directed Ground Spray Application (Italy).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Castel, Bolognese, Italy (2001) Hayward	SL	2	1.4 3.1	0.54 1.2	fruit	104	< 0.05	< 0.05	< 0.05	MLL31678
Zevio, Italy (2001) Hayward	SL	2	1.4 2.7	0.54 1.1	fruit	108	< 0.05	< 0.05	< 0.05	MLL31678
Montefiascone, Italy (2001) Hayward	SL	2	1.5 2.6	0.58 1.0	fruit	104	< 0.05	< 0.05	< 0.05	MLL31678
Lagnasco, Italy (2001) Hayward	SL	2	1.5 3.0	0.59 1.2	fruit	104	< 0.05	< 0.05	< 0.05	MLL31678
Emilia Romagna, Italy (2001) Haywood	SL	1	2.8		Flesh	14	< 0.05			01JH133
					Whole fruit	14	< 0.05			01JH133
Cisterna di Latina, Latina, Italy (2001) Haywood	SL	1	3.0	0.74	Flesh	14	< 0.05			01JH034
					Whole fruit	14	< 0.05			01JH034
Valeggio sul Mincio, Verona, Italy (2001) Haywood	SL	1	2.9	0.72	Flesh	14	< 0.05			01JH131
					Whole fruit	14	< 0.05			01JH131
Trecenta, Rovigo, Italy (2001) Haywood	SL	1	2.9	0.96	Flesh	14	< 0.05			01JH132

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
					Whole fruit	14	< 0.05			01JH132

Table 51. Residues in Dry Beans: Pre-harvest Application.

Location (year) variety		Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
5380 Franc-Waret, Belgium (1995) Mars	K	1	1.4	0.72	Seed	0 7	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MLL30463
Gothab, Denmark (1982)	C	1	1.4	0.48	seed	19	< 0.05	< 0.05	< 0.05	MLL30109
Gammerodgard, Denmark (1982)	C	1	1.4	0.45	seed	9 21	< 0.05 0.17	< 0.05 < 0.05	< 0.05 0.17	MLL30109
Wilson, Derbyshire, UK (1995) Mars	K	1	1.4	0.72	Seed	0 7	0.23 0.47	< 0.05 < 0.05	0.23 0.47	MLL30463
Wheaton Aston, Staffordshire, UK (1995) Sirrocco	K	1	1.4	0.72	Seed	0 7	0.28 0.14	< 0.05 < 0.05	0.28 0.14	MLL30463
Womesley, Doncaster, UK (1995) Victor	K	1	1.4	0.72	Seed	0 7	0.21 0.34	< 0.05 < 0.05	0.21 0.34	MLL30463
Isley Walton, Derbyshire, UK (1992) Banner	C	1	1.4	0.70	Seed	7	0.18 c0.06			GLY 140
		1	0.72	0.36	Seed	7	0.13 c0.06			GLY 140
Thorne, South Yorkshire, UK (1992) Troy	C	1	1.4	0.70	Seed	7	1.8			GLY 140
		1	0.72	0.36	Seed	7	0.8			GLY 140
Terling, North Chelmsford, Essex, UK (1992) Punch	C	1	1.4	0.70	Seed	7	0.2			GLY 140
		1	0.72	0.36	Seed	7	0.1			GLY 140
Kings Newton, Derbyshire, UK (1993) Boxer	C	1	1.4	0.70	Seed	7	0.11			GLY 264, GLY 305
		1	0.72	0.36	Seed	7	0.11			GLY 264, GLY 305
Sancton, Humberside, UK (1993) Boxer	C	1	1.4	0.70	Seed	7	0.16			GLY 264, GLY 305
		1	0.72	0.36	Seed	7	0.13			GLY 264, GLY 305
Neston, UK (1986) Banner	A	1	2.9	3.6	seed	7	0.1			MLL30180
	A	1	2.9	1.2	seed	7	0.1			MLL30180
	B	1	2.9	1.2	seed	7	0.2			MLL30180
	C	1	2.9	1.2	seed	7	0.2			MLL30180
	D	1	2.9	1.2	seed	7	0.1			MLL30180

Location (year) variety		Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Stamford, UK (1980) Maris Bead	C	1	1.4	0.65	seed	7	0.12	< 0.05	0.12	MLL30109
	C	1	2.9	1.3	seed	7	0.22	< 0.05	0.22	MLL30109
St. Ives, Cambridgeshire, UK (1982) Herro	C	1	1.4	0.72	seed	7	0.16	< 0.05	0.16	MLL30109
	C	1	2.9	1.4	seed	7	0.32	< 0.05	0.32	MLL30109
Thornhough, UK (1982) Minden	C	1	0.72	0.33	seed	10	0.23 c0.05	< 0.05	0.23 c0.05	MLL30109
	C	1	1.4	0.65	seed	10	0.33 c0.05	< 0.05	0.33 c0.05	MLL30109
	C	1	2.9	1.3	seed	10	0.53 c0.05	< 0.05	0.53 c0.05	MLL30109
Hemingford, UK (1982) Throws As	C	1	0.72	0.33	seed	9	0.08	< 0.05	0.08	MLL30109
	C	1	1.4	0.65	seed	9	0.16	< 0.05	0.16	MLL30109
	C	1	2.9	1.3	seed	9	0.22	< 0.05	0.22	MLL30109
Wayne County, New York USA (2001) Montcalm	N	2	4.2 0.86	4.5 0.90	seed	7	0.10	< 0.05	0.10	MSL17194
	N	2	4.2 1.7	4.5 1.8	seed	7	0.19	< 0.05	0.19	MSL17194
Kent County, Michigan USA (2001) Cranberry	N	2	4.3 0.83	4.9 1.0	seed	7	< 0.05	< 0.05	< 0.05	MSL17194
	N	2	4.2 1.68	4.9 2.1	seed	7	< 0.05	< 0.05	< 0.05	MSL17194
Ottawa County, Michigan (2001) Navy - Avanti	N	2	4.2 0.84	5.2 1.0	seed	7	0.09	< 0.05	0.09	MSL17194
	N	2	4.2 1.7	5.1 2.0	seed	7	0.21	< 0.05	0.21	MSL17194
Freeborn County, Minnesota USA (2001) Navy – Norstar	N	2	4.2 0.85	4.0 0.83	seed	7	0.11	< 0.05	0.11	MSL17194
	N	2	4.3 1.7	4.0 1.6	seed	1 7	0.19	< 0.05	0.19	MSL17194
York County, Nebraska USA (2001) Navy – Great Northern	N	2	4.20 0.83	4.0 0.78	seed	7	0.32	< 0.05	0.32	MSL17194
	N	2	4.17 1.6	3.9 1.6	seed	1 2 7 13 20	0.96 0.43 0.52 1.8 1.6	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05	0.96 0.43 0.52 1.8 1.6	MSL17194
Hall County, Nebraska USA (2001) Navy – Great Northern	N	2	4.2 0.83	4.0 0.82	seed	7	1.6	< 0.05	1.6	MSL17194
	N	2	4.2 1.7	4.0 1.6	seed	7	10	0.12	10	MSL17194

Location (year) variety		Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Foster County, North Dakota USA (2001) Maverick	N	2	4.2 0.83	5.3 0.80	seed	7	0.30	< 0.05	0.30	MSL17194
	N	2	4.2 1.7	5.3 1.6	seed	7	0.53	< 0.05	0.53	MSL17194
Eddy County, North Dakota USA (2001) Othello	N	2	4.2 0.84	5.3 0.80	seed	7	0.37	< 0.05	0.37	MSL17194
	N	2	4.2 1.6	5.4 1.6	seed	7	0.63	< 0.05	0.63	MSL17194
McHenry County North Dakota USA (2001) Othello	N	2	4.2 0.82	5.3 0.80	seed	7	0.68	< 0.05	0.68	MSL17194
	N	2	4.2 1.7	5.3 1.6	seed	7	0.32	< 0.05	0.32	MSL17194
Weld County, Colorado USA (2001) Montrose	N	2	4.2 0.87	4.0 0.83	seed	7	0.19	< 0.05	0.19	MSL17194
	N	2	4.3 1.7	4.0 1.6	seed	7	2.6	< 0.05	2.6	MSL17194
Cache County, Utah USA (2001) Othello	N	2	4.2 0.85	4.5 0.94	seed	7	0.13	< 0.05	0.13	MSL17194
	N	2	4.2 1.7	4.5 1.9	seed	7	0.20	< 0.05	0.2	MSL17194
Tulare County, California USA (2001) California Blackeye #5	N	2	4.2 0.85	4.5 0.91	seed	7	0.38 c0.06	< 0.05	0.38	MSL17194
	N	2	4.2 1.7	4.5 1.8	seed	7	0.80 c0.06	< 0.05	0.8	MSL17194
Payette County, Idaho USA (2001) Othello	N	2	4.2 0.87	4.0 0.82	seed	7	0.07	< 0.05	0.07	MSL17194
	N	2	4.2 1.7	4.0 1.6	seed	7	0.06	< 0.05	0.06	MSL17194

Denmark 1982 and UK 1980 and 1982 trial residue values are corrected for recovery of 72% for glyphosate and 81% for AMPA.
All SL formulations. Formulation A = MON 8795 240 g ae/L SL; Formulation B = MON 8762 + surfactant MON 8137; Formulation C = Roundup® 360 g ae/L SL; Formulation D = MON 8762 480 g ae/L SL; Formulation K = MON 52776 360 g ae/L SL; Formulation N = 500 g/L SL as the isopropylamine salt = 370 g ae/L.

Table 52. Residues in Dry Peas: Pre-harvest Application.

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Venurne, Belgium (1982) Finale	C	1	1.1	0.36	Seed	17	0.6 c0.1 0.9 c0.1	< 0.05 < 0.05	0.6 c0.1 0.9 c0.1	MLL30131
Franc-Waret, Belgium (1995) Baccara	K	1	1.4	0.72	Seed	0 7	0.24 0.17	< 0.05 < 0.05	0.24 0.17	MLL30464

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Clive, Alberta Canada (1988) Princess	C	1	0.67	0.61	Seed	12	0.84	< 0.05	0.84	MSL9398
		1	0.90	0.82	Seed	12	0.82	< 0.05	0.82	MSL9398
Clive, Alberta Canada (1988) Tara	C	1	0.67	0.61	Seed	12	1.6	< 0.05	1.6	MSL9398
		1	0.90	0.82	Seed	12	1.4	< 0.05	1.4	MSL9398
Clive, Alberta Canada (1988) Trapper	C	1	0.67	0.61	Seed	16	4.2	< 0.05	4.2	MSL9398
		1	0.90	0.82	Seed	16	8.9	< 0.05	8.9**	MSL9398
Lacombe, Alberta Canada (1988) Alaska	C	1	0.67	0.61	Seed	14	1.2	< 0.05	1.2	MSL9398
		1	0.90	0.82	Seed	14	0.50	< 0.05	0.50	MSL9398
Torring, Jutland, Denmark (1983)	C	1	0.72	0.24	Seed	12	0.8 c0.2	< 0.05	0.8 c0.2	MLL30131
		1	1.1	0.36	Seed	12	1.7	< 0.05	1.7	MLL30131
		1	1.8	0.48	Seed	12	2.5	< 0.05	2.5	MLL30131
Gothab, Skandeborg, Denmark (1982)	C	1	1.4	0.44	Seed	6	0.5	< 0.05	0.5	MLL30131
Alborg, Børge Mortensen, Denmark (1982)	C	1	1.4	0.44	Seed	4	1.8	< 0.05	1.8	MLL30131
Kingsbury, Staffordshire, UK (1995) Princess	K	1	1.4	0.72	Seed	0 7	0.23 0.17	< 0.05 < 0.05	0.23 0.17	MLL30464
Banbury, Oxfordshire, UK (1995) Princess	K	1	1.4	0.72	Seed	0 7	0.13 0.13	< 0.05 < 0.05	0.13 0.13	MLL30464
Scunthorpe, Humberside, UK (1995) Montana	K	1	1.4	0.72	Seed	0 7	0.13 0.16	< 0.05 < 0.05	0.13 0.16	MLL30464
Wilson, Derbyshire, UK (1992) Guido	C	1	1.4	0.72	Seed	7	1.8			GLY 141, GLY 222
		1	0.72	0.36	Seed	7	0.8			GLY 141, GLY 222
Goole, Humberside, UK (1992) Solara	C	1	1.4	0.72	Seed	7	2.4 c0.8			GLY 141, GLY 222
		1	0.72	0.36	Seed	7	< 0.05 c0.8			GLY 141, GLY 222

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Market Weighton, Yorkshire, UK (1992) Baroness	C	1	1.4	0.72	Seed	7	1.7			GLY 141, GLY 222
		1	0.72	0.36	Seed	7	0.06			GLY 141, GLY 222
Wilson, Derbyshire, UK (1992) Guido	C	1	1.4	0.72	seed	7	2.1			GLY 143, GLY 221
		1	0.72	0.36	seed	7	1.4			GLY 143, GLY 221
UK Felsted, Essex UK (1986) Progreta	A	1	2.88	3.6	seed	9	0.5			MLL30131
	A	1	2.88	1.15	seed	9	0.3			MLL30131
	B	1	2.88	1.15	seed	9 9	0.7			MLL30131
	C	1	2.88	1.15	seed	9	0.4			MLL30131
	D	1	2.88	1.15	seed	9	0.4			MLL30131
UK Hemmingford, Cambridge UK (1986) Bunting	A	1	2.88	3.6	seed	8	0.1			MLL30131
	A	1	2.88	1.15	seed	8	0.1			MLL30131
	B	1	2.88	1.15	seed	8	0.1			MLL30131
	C	1	2.88	1.15	seed	8	0.1			MLL30131
	D	1	2.88	1.15	seed	8	0.3			MLL30131

Formulation A = MON 8795; Formulation B = MON 8762 + cationic surfactant MON 8137; Formulation C = Roundup® 360 g ae/L SL; Formulation D = MON 8762

**samples were threshed twice due to mechanical failures. Grain was in contact with straw for an extended period and that may have resulted in contamination of the grain.

Table 53. Residues in Lentils: Pre-harvest Application (Canada).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Legal, Alberta Canada (1988) Laird	C	1	0.67	0.61	Seed	13	1.4	< 0.05	1.4	MSL9398
		1	0.90	0.82	Seed	13	3.0	< 0.05	3.0	MSL9398
Gray, Saskatchewan Canada (1988) Laird	C	1	0.67	0.67	Seed	12	< 0.05	< 0.05	< 0.05	MSL9398
		1	0.90	0.90	Seed	12	< 0.05	< 0.05	< 0.05	MSL9398
		1	1.80	1.80	Seed	12	< 0.05	< 0.05	< 0.05	MSL9398

Table 54. Residues in Conventional Soyabeans: Pre-harvest Application (USA) with glyphosate 480 SL formulation as the isopropylamine salt (360 g ae/L).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Clinton Co., Illinois USA (1993) Asgrow 4715	PH	1	5.0	2.5	Seed	7	0.22	< 0.05	0.22	MSL13283
Des Moines Co., Iowa USA (1993) Kennedy IV	PH	1	5.0	2.4	Seed	7	1.6	< 0.05	1.6	MSL13283
Redwood Co., Minnesota USA (1993) CX 264	PH	1	5.1	2.4	Seed	8	0.12	< 0.05	0.12	MSL13283
Shelby Co., Missouri USA (1993) Linford	PH	1	5.0	2.8	Seed	7	0.16	< 0.05	0.16	MSL13283
Fayette Co., Ohio USA (1993) GL 2910	PH	1	5.0	2.8	Seed	8	0.68	0.07 c0.11	0.79	MSL13283
Crittenden Co., Arkansas USA (1993) Manokin	PH	1	5.0	2.4	Seed	7	0.56	< 0.05	0.56	MSL13283
St Landry Parish, Louisiana USA (1993) Hartz 5164	PH	1	5.0	3.0	Seed	9	0.94	0.06 c0.07	1.0	MSL13283
Fayette Co., Tennessee USA (1993) Hutcheson	PH	1	5.0	2.4	Seed	7	3.0	0.11 c0.08	3.2	MSL13283
Oglethorpe Co., Georgia USA (1993) Bryan	PH	1	5.1	2.5	Seed	7	0.24	0.07 c0.08	0.35	MSL13283
Wicomico Co., Maryland USA (1993) Stafford	PH	1	5.0	3.2	Seed	7	0.14	< 0.05 c0.08	0.14	MSL13283
Banks, Mississippi USA (1979)	RCS RCS PH	3	2.1 2.1 0.84	1.7 1.2 0.45	seed	15	9.2	1.5	11	MSL3259
	RCS RCS PH	3	2.1 2.1 1.7	1.7 1.2 0.90	seed	15	12	1.3	14	MSL3259
	RCS RCS PH	3	2.1 2.1 3.4	1.7 1.2 1.8	seed	15	11	1.8	14	MSL3259
	RCS RCS PH	3	2.1 2.1 5.0	1.7 1.2 2.70	seed	15	17	1.8	20	MSL3259
Banks, Mississippi USA (1979)	RCS RCS PH	3	2.1 2.1 0.84	1.7 1.2 0.22	seed	9	13	1.9 c0.05	16	MSL3259
	RCS RCS PH	3	2.1 2.1 1.7	1.7 1.2 0.45	seed	9	10	1.5 c0.05	12	MSL3259

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	RCS RCS PH	3	2.1 2.1 3.4	1.7 1.2 0.90	seed	9	6.4	1.0 c0.05	7.9	MSL3259
	RCS RCS PH	3	2.1 2.1 5.0	1.7 1.2 1.4	seed	9	2.6	0.46 c0.05	3.3	MSL3259
Bruins, Arkansas USA (1979)	RCS RCS PH	3	2.5 2.5 0.84	NS NS 0.45	seed	7 16 7 16	0.59 c0.40 0.71 c0.38	0.38 c0.25 0.46 c0.25	1.2 1.4	MSL3259
	RCS RCS PH	3	2.5 2.5 1.7	NS NS 0.45	seed	7 16	0.94 c0.40 1.1 c0.38	0.50 c0.25 0.52 c0.25	1.7 1.9	MSL3259
	RCS RCS PH	3	2.5 2.5 3.4	NS NS 0.45	seed	7 16	1.2 c0.40 0.79 c0.38	0.46 c0.25 0.36 c0.25	1.9 1.3	MSL3259
	RCS RCS PH	3	2.5 2.5 5.0	NS NS 0.45	seed	7 16	0.52 c0.40 0.40 c0.38	0.24 c0.25 0.18 c0.25	0.89 0.67	MSL3259
Bruins, Arkansas USA (1979)	RCS RCS PH	3	2.5 2.5 0.84	NS NS 0.45	seed	10	0.43 c0.39	0.27 c0.23	0.84	MSL3259
	RCS RCS PH	3	2.5 2.5 1.7	NS NS 0.45	seed	10	0.39 c0.39	0.24 c0.23	0.76	MSL3259
	RCS RCS PH	3	2.5 2.5 3.4	NS NS 0.45	seed	10	0.82 c0.39	0.46 c0.23	1.5	MSL3259
	RCS RCS PH	3	2.5 2.5 5.0	NS NS 0.45	seed	10	0.52 c0.39	0.3 c0.23	0.98	MSL3259
Adel, Iowa USA (1979)	RCS RCS RCS PH	4	5.0 5.0 5.0 0.84	2.7 2.7 2.7 0.45	seed	11	< 0.05 c0.09	< 0.05	< 0.05 c0.09	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 1.7	2.7 2.7 2.7 0.90	seed	11	0.09 c0.09	< 0.05	0.09 c0.09	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 3.4	2.7 2.7 2.7 1.8	seed	11	0.14 c0.09	< 0.05	0.14 c0.09	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 5.0	2.7 2.7 2.7 2.7	seed	11	0.69 c0.09	< 0.05	0.69 c0.09	MSL3259
Adel, Iowa USA (1979)	RCS RCS RCS PH	4	5.0 5.0 5.0 0.84	2.7 2.7 2.7 0.45	seed	8 8	0.06	< 0.05	0.06	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 1.7	2.7 2.7 2.7 0.90	seed	8 8	0.10	< 0.05	0.10	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 3.4	2.7 2.7 2.7 1.8	seed	8 8	0.19	< 0.05	0.19	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 5.0	2.7 2.7 2.7 2.7	seed	8 8	0.45	< 0.05	0.45	MSL3259

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Princeton, Kentucky USA (1979)	RCS RCS RCS PHI	4	5.0 5.0 5.0 0.84	NS NS NS 0.36	seed	11 25	1.9 1.3 c1.0	0.58 0.46 c0.36	2.8 2.0	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 1.7	NS NS NS 0.72	seed	11 25	3.0 1.7 c1.0	0.64 0.59 c0.36	4.0 2.6	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 3.4	NS NS NS 1.4	seed	11 25	8.8 0.36 c1.0	0.64 0.24 c0.36	9.8 0.73	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 5.0	NS NS NS 2.2	seed	11 25	6.2 6.2 c1.0	1.3 1.3 c0.36	8.2 8.2	MSL3259
Princeton, Kentucky USA (1979)	RCS RCS RCS PH	4	5.0 5.0 5.0 0.84	NS NS NS 0.36	seed	13	2.8	0.76	4.0	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 1.7	NS NS NS 0.72	seed	13	3.4	0.86	4.7	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 3.4	NS NS NS 1.44	seed	13	5.4	1.2	7.2	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 5.0	NS NS NS 2.2	seed	13	3.1	0.71	4.2	MSL3259

Type of applications: RCS = Recirculating sprayer; PH = pre-harvest

Table 55. Residues in Glyphosate Tolerant Soya bean (USA) following application of a 410 SL formulation of glyphosate present as the isopropylamine salt (360 g ae/L).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Clarence, Missouri USA (1992) 40-3	PRE LPO	2	6.4 0.84	6.7 0.89	Seed	104	1.8	2.6	5.8	MSL13462
	PRE EPO	2	6.4 0.63	6.7 0.42	Seed	140	0.06	0.08	0.18	MSL13462
	PRE LPO	2	6.4 1.7	6.7 1.8	Seed	104	2.7	3.6	8.2	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.7 1.3 0.89	Seed	104	1.6	2.3	5.1	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	6.7 1.3 0.89 0.45	Seed	34	1.3	1.6	3.7	MSL13462
Elko, South Carolina USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.8 0.52	Seed	97	0.69	0.95	2.1	MSL13462

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO	2	6.4 0.63	3.8 0.40	Seed	98	0.55	0.78	1.7	MSL13462
	PRE LPO	2	6.4 1.7	3.8 1.0	Seed	97	2.3	2.8	6.6	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.8 0.54 0.52	Seed	97	2.1	2.7	6.2	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	3.8 0.54 0.52 0.52	Seed	10	2.6	3.5	7.9	MSL13462
Emporia, Virginia, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.9 0.64	Seed	97	0.25	0.28	0.68	MSL13462
	PRE EPO	2	6.4 0.63	4.9 0.48	Seed	110	0.57	0.70	1.6	MSL13462
	PRE LPO	2	6.4 1.7	4.9 1.3	Seed	97	1.0	1.0	2.5	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.9 0.64 0.64	Seed	97	1.4	1.4	3.5	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	4.9 0.64 0.64 0.64	Seed	16	1.8	1.9	4.7	MSL13462
Goldsboro, North Carolina, USA (1992) 40-3	PRE LPO	2	6.4 0.84	6.9 0.89	Seed	89	1.4	2.0	4.4	MSL13462
	PRE EPO	2	6.4 0.63	6.9 0.67	Seed	101	0.38	0.43	1.0	MSL13462
	PRE LPO	2	6.4 1.7	6.9 1.79	Seed	89	4.4	4.5	11	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.9 0.89 0.89	Seed	89	3.0	3.4	8.2	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	6.9 0.89 0.89 0.89	Seed	13	3.2	3.9	9.1	MSL13462
Greenville, Mississippi, USA (1992) 40-3	PRE LPO	2	6.4 0.84	6.8 0.72	Seed	75	0.9	1.3	2.9	MSL13462
	PRE EPO	2	6.4 0.63	6.8 0.53	Seed	77	0.51	0.85	1.8	MSL13462
	PRE LPO	2	6.4 1.7	6.8 1.4	Seed	75	1.7	2.7	5.8	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.8 0.70 0.72	Seed	75	3.3	5.0	11	MSL13462

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	6.8 0.70 0.72 0.83	Seed	10	2.0	3.0	6.6	MSL13462
Hickory Withe, Tennessee, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.4 0.45	Seed	81	0.74	1.3	2.7	MSL13462
	PRE EPO	2	6.4 0.63	3.4 0.34	Seed	94	0.26	0.54	1.1	MSL13462
	PRE LPO	2	6.4 1.7	3.4 0.89	Seed	81	3.0	5.4	11	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Seed	81	1.0	1.7	3.6	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	3.4 0.45 0.45 0.45	Seed	13	2.6	4.6	9.6	MSL13462
La Center, Kentucky, USA (1992) 40-3	PRE LPO	2	6.4 0.84	5.9 0.83	Seed	108	0.16	0.20	0.46	MSL13462
	PRE EPO	2	6.4 0.63	5.9 0.59	Seed	116	< 0.05	< 0.05	< 0.13	MSL13462
	PRE LPO	2	6.4 1.7	5.9 1.7	Seed	108	0.31	0.40	0.92	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.79 0.83	Seed	108	0.14	0.18	0.41	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	5.9 0.79 0.83 0.86	Seed	13	0.34	0.48	1.1	MSL13462
Martinsville, Indiana, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.5 0.45	Seed	133	0.67	1.1	2.3	MSL13462
	PRE EPO	2	6.4 0.63	3.5 0.37	Seed	139	0.10	0.19	0.39	MSL13462
	PRE LPO	2	6.4 1.7	3.5 0.90	Seed	133	1.8	2.7	5.9	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.5 0.50 0.45	Seed	133	1.1	1.7	3.7	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	3.5 0.50 0.45 0.45	Seed	53	2.3	1.6	4.7	MSL13462
New Holland, Ohio, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.2 0.57	Seed	103	0.09	0.11	0.26	MSL13462
	PRE EPO	2	6.4 0.63	4.2 0.39	Seed	126	0.09	0.09	0.23	MSL13462

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE LPO	2	6.4 1.7	4.2 1.1	Seed	103	0.16	0.14	0.37	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.2 0.53 0.57	Seed	103	0.14	0.12	0.32	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	4.2 0.53 0.57 0.57	Seed	18	1.0	0.11	1.2	MSL13462
Proctor, Arkansas, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.4 0.45	Seed	66	0.56	0.74	1.7	MSL13462
	PRE EPO	2	6.4 0.63	3.4 0.34	Seed	73	0.42	0.50	1.2	MSL13462
	PRE LPO	2	6.4 1.7	3.4 0.89	Seed	66	2.3	3.3	7.3	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Seed	66	2.3	3.0	6.9	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	3.4 0.45 0.45 0.45	Seed	11	3.6	2.6	7.6	MSL13462
Rosa, Louisiana, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.4 0.55	Seed	69	0.22	0.47	0.94	MSL13462
	PRE EPO	2	6.4 0.63	4.4 0.42	Seed	70	0.21	0.49	0.96	MSL13462
	PRE LPO	2	6.4 1.7	4.4 1.1	Seed	69	0.68	1.1	2.4	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.4 0.56 0.55	Seed	69	1.0	1.6	3.4	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	4.4 0.56 0.55 0.55	Seed	13	5.3	1.5	7.6	MSL13462
Sandusky, Illinois, USA (1992) 40-3	PRE LPO	2	6.4 0.84	5.9 0.83	Seed	108	0.32	0.26	0.72	MSL13462
	PRE EPO	2	6.4 0.63	5.9 0.59	Seed	116	0.15	< 0.05	0.23	MSL13462
	PRE LPO	2	6.4 1.7	5.9 1.7	Seed	108	1.9	2.1	5.1	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.79 0.83	Seed	108	0.31	0.26	0.71	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	5.9 0.79 0.83 0.86	Seed	13	0.84	0.72	1.9	MSL13462

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Sedan, Kansas, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.6 0.89	Seed	80	2.3	3.2	7.2	MSL13462
	PRE EPO	2	6.4 0.63	4.6 0.67	Seed	90	0.26	0.35	0.79	MSL13462
	PRE LPO	2	6.4 1.7	4.6 1.8	Seed	80	5.6	7.6	17	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.6 0.89 0.89	Seed	80	2.4	3.6	7.9	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	4.6 0.89 0.89 0.89	Seed	15	2.4	3.9	8.3	MSL13462
Sheridan, Indiana, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.6 1.4	Seed	138	< 0.05	0.05	< 0.13	MSL13462
	PRE EPO	2	6.4 0.63	3.6 0.34	Seed	151	< 0.05	0.12	< 0.23	MSL13462
	PRE LPO	2	6.4 1.7	3.6 0.99	Seed	138	0.11	0.10	0.26	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.6 0.45 0.50	Seed	138	0.21	0.21	0.53	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	3.6 0.45 0.50 0.45	Seed	52	2.9	0.32	3.4	MSL13462
Shoffner, Arkansas, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.4 0.45	Seed	81	0.70	1.3	2.7	MSL13462
	PRE EPO	2	6.4 0.63	3.4 0.34	Seed	83	0.41	0.71	1.5	MSL13462
	PRE LPO	2	6.4 1.7	3.4 0.90	Seed	81	1.9	2.8	6.2	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Seed	81	1.5	2.4	5.2	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	3.4 0.45 0.45 0.45	Seed	13	1.8	2.7	5.9	MSL13462
Steele, Missouri, USA (1992) 40-3	PRE LPO	2	6.4 0.84	5.9 0.79	Seed	97	1.0	1.1	2.7	MSL13462
	PRE EPO	2	6.4 0.63	5.9 0.58	Seed	106	0.11	< 0.05	< 0.19	MSL13462
	PRE LPO	2	6.4 1.7	5.9 1.6	Seed	97	1.9	2.0	4.9	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.83 0.78	Seed	97	0.57	0.56	1.4	MSL13462

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE	4	6.4	5.9	Seed	14	2.7	1.8	5.4	MSL13462
	EPO		0.84	0.83						
	LPO		0.84	0.78						
	PH		0.84	0.86						
Winterville, Georgia, USA (1992) 40-3	PRE	2	6.4	4.0	Seed	66	1.3	1.9	4.2	MSL13462
	LPO		0.84	0.50						
	PRE	2	6.4	4.0	Seed	74	0.72	1.2	2.5	MSL13462
	EPO		0.63	0.39						
	PRE	2	6.4	4.0	Seed	66	1.9	2.6	5.9	MSL13462
	LPO		1.7	0.99						
	PRE	3	6.4	4.0	Seed	66	2.0	3.1	6.7	MSL13462
	EPO		0.84	0.53						
	LPO		0.84	0.50						
	PRE	4	6.4	4.0	Seed	10	2.0	3.0	6.6	MSL13462
	EPO		0.84	0.53						
	LPO		0.84	0.50						
	PH		0.84	0.50						
York, Nebraska, USA (1992) 40-3	PRE	2	6.4	6.8	Seed	91	< 0.05	0.07	< 0.16	MSL13462
	LPO		0.84	0.90						
	PRE	2	6.4	6.8	Seed	108	< 0.05	< 0.05	< 0.13	MSL13462
	EPO		0.63	0.68						
	PRE	2	6.4	6.8	Seed	91	0.16	0.21	0.48	MSL13462
	LPO		1.7	1.8						
	PRE	3	6.4	6.8	Seed	91	0.07	0.11	0.24	MSL13462
	EPO		0.84	0.90						
	LPO		0.84	0.90						
	PRE	4	6.	6.8	Seed	12	3.7	0.42	4.3	MSL13462
	EPO		0.84	0.90						
	LPO		0.84	0.90						
	PH		0.84	0.89						
Carlyle, Illinois USA (1993) 40-3	PRE	2	6.4	6.1	Seed	90	1.1	1.9	4.0	MSL13464
	LPO		0.84	0.55						
	PRE	3	6.4	6.13	Seed	90	1.1	1.8	3.8	MSL13464
	EPO		0.84	0.56						
	LPO		0.84	0.55						
	PRE	4	6.4	6.13	Seed	12	0.93	1.5	3.2	MSL13464
	EPO		0.84	0.56						
	LPO		0.84	0.55						
	PH		0.84	0.56						
Carman, Illinois USA (1993) 40-3	PRE	2	6.4	3.39	Seed	93	0.28	0.40	0.89	MSL13464
	LPO		0.84	0.45						
	PRE	3	6.4	3.39	Seed	93	0.24	0.39	0.83	MSL13464
	EPO		0.84	0.45						
	LPO		0.84	0.45						
	PRE	4	6.4	3.39	Seed	16	0.16	0.27	0.57	MSL13464
	EPO		0.84	0.45						
	LPO		0.84	0.45						
	PH		0.84	0.45						
Conklin, Michigan USA (1993) 40-3	PRE	2	6.4	4.23	Seed	94	0.40	0.54	1.2	MSL13464
	LPO		0.84	0.53						

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE	3	6.4	4.23	Seed	94	0.50	0.71	1.6	MSL13464
	EPO		0.84	0.53						
	LPO		0.84	0.53						
	PRE	4	6.4	4.23	Seed	15	1.7	0.96	3.2	MSL13464
	EPO		0.84	0.53						
	LPO		0.84	0.53						
	PH		0.84	0.55						
Danville, Iowa USA (1993) 40-3	PRE	2	6.4	3.39	Seed	90	0.11	0.16	0.35	MSL13464
	LPO		0.84	0.45						
	PRE	3	6.4	3.39	Seed	90	0.18	0.19	0.47	MSL13464
	EPO		0.84	0.45						
	LPO		0.84	0.45						
	PRE	4	6.4	3.39	Seed	12	0.37	0.27	0.78	MSL13464
	EPO		0.84	0.45						
	LPO		0.84	0.45						
	PH		0.84	0.45						
Faiborn, Ohio USA (1993) 40-3	PRE	2	6.4	3.60	Seed	90	1.4	2.8	5.7	MSL13464
	LPO		0.84	0.43						
	PRE	3	6.4	3.60	Seed	90	0.62	1.1	2.3	MSL13464
	EPO		0.84	0.41						
	LPO		0.84	0.43						
	PRE	4	6.4	3.60	Seed	12	0.97	1.6	3.4	MSL13464
	EPO		0.84	0.41						
	LPO		0.84	0.43						
	PH		0.84	0.62						
Grangeburg, Alabama USA (1993) 40-3	PRE	2	6.4	3.32	Seed	106	0.33	0.08	0.45	MSL13464
	LPO		0.84	0.45						
	PRE	3	6.4	3.32	Seed	116	0.30	0.58	1.2	MSL13464
	EPO		0.84	0.45						
	LPO		0.84	0.44						
	PRE	4	6.4	3.32	Seed	14	0.44	0.46	1.1	MSL13464
	EPO		0.84	0.45						
	LPO		0.84	0.44						
	PH		0.84	0.44						
Hills, Minnesota USA (1993) 40-3	PRE	2	6.4	6.72	Seed	95	0.42	0.48	1.2	MSL13464
	LPO		0.84	0.87						
	PRE	3	6.4	6.72	Seed	95	0.60	0.61	1.5	MSL13464
	EPO		0.84	0.83						
	LPO		0.84	0.87						
	PRE	4	6.4	6.72	Seed	11	0.58	0.60	1.5	MSL13464
	EPO		0.84	0.83						
	LPO		0.84	0.87						
	PH		0.84	0.88						
Lamberton, Minnesota USA (1993) 40-3	PRE	2	6.4	3.41	Seed	75	1.6	1.3	3.6	MSL13464
	LPO		0.84	0.45						
	PRE	3	6.4	3.41	Seed	75	3.5	3.3	8.5	MSL13464
	EPO		0.84	0.45						
	LPO		0.84	0.45						

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE	4	6.4	3.41	Seed	12	2.8	2.5	6.6	MSL13464
	EPO		0.84	0.45						
	LPO		0.84	0.45						
	PH		0.84	0.45						
Martinsville, Indiana USA (1993) 40-3	PRE	2	6.4	3.47	Seed	86	< 0.05	< 0.05	< 0.13	MSL13464
	LPO		0.84	0.83						
	PRE	3	6.4	3.47	Seed	91	0.48	1.1	2.2	MSL13464
	EPO		0.84	0.83						
	LPO		0.84	0.76						
	PRE	4	6.4	3.47	Seed	11	0.56	1.2	2.4	MSL13464
	EPO		0.84	0.83						
	LPO		0.84	0.76						
	PH		0.84	0.76						
New Holland, Ohio USA (1993) 40-3	PRE	2	6.4	3.66	Seed	87	0.53	1.0	2.1	MSL13464
	LPO		0.84	0.43						
	PRE	3	6.4	3.66	Seed	87	1.9	3.4	7.1	MSL13464
	EPO		0.84	0.47						
	LPO		0.84	0.43						
	PRE	4	6.4	3.67	Seed	10	0.57	1.1	2.2	MSL13464
	EPO		0.84	0.47						
	LPO		0.84	0.43						
	PH		0.84	0.63						
Renner, South Dakota USA (1993) 40-3	PRE	2	6.4	6.58	Seed	96	0.98	1.2	2.8	MSL13464
	LPO		0.84	0.82						
	PRE	3	6.4	6.58	Seed	96	1.4	1.7	4.0	MSL13464
	EPO		0.84	0.84						
	LPO		0.84	0.82						
	PRE	4	6.4	6.58	Seed	11	1.4	1.6	3.8	MSL13464
	EPO		0.84	0.84						
	LPO		0.84	0.82						
	PH		0.84	0.84						
Richland, Iowa USA (1993) 40-3	PRE	2	6.4	3.78	Seed	95	0.25	0.38	0.83	MSL13464
	LPO		0.84	0.49						
	PRE	3	6.4	3.78	Seed	95	0.21	0.33	0.71	MSL13464
	EPO		0.84	0.48						
	LPO		0.84	0.49						
	PRE	4	6.4	3.78	Seed	10	0.42	0.54	1.2	MSL13464
	EPO		0.84	0.48						
	LPO		0.84	0.49						
	PH		0.84	0.47						
Salisbury, Maryland USA (1993) 40-3	PRE	2	6.4	4.73	Seed	106	0.06	< 0.05	< 0.14	MSL13464
	LPO		0.84	0.57						
	PRE	3	6.4	4.73	Seed	106	0.10	0.21	0.42	MSL13464
	EPO		0.84	0.59						
	LPO		0.84	0.57						
	PRE	4	6.4	4.73	Seed	12	0.27	0.21	0.59	MSL13464
	EPO		0.84	0.59						
	LPO		0.84	0.57						
	PH		0.84	0.59						

Location (year) variety	Form	Application N	Application kg ae/ha	Application kg ae/hL	Sample	PHI (days)	Residues (mg/kg) glyphosate	Residues (mg/kg) AMPA	Residues (mg/kg) Total	Report/ reference
Sheridan, Indiana USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.45 0.75	Seed	88	1.5	2.2	4.9	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.45 0.89 0.75	Seed	88	0.57	0.92	2.0	MSL13464
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	3.45 0.89 0.75 0.69	Seed	11	0.43	0.68	1.5	MSL13464
Steele, Missouri USA (1993) 40-3	PRE LPO	2	6.4 0.84	5.50 0.58	Seed	90	0.05	0.05	0.13	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	5.45 0.59 0.76	Seed	76	0.33	0.48	1.1	MSL13464
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	5.50 0.59 0.75 0.62	Seed	10	0.51	0.33	1.0	MSL13464
Webster City, Iowa USA (1993) 40-3	PRE LPO	2	6.4 0.84	4.52 0.52	Seed	99	0.24	0.25	0.62	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	4.52 0.57 0.52	Seed	99	0.48	0.51	1.3	MSL13464
	PRE EPO LPO PH	4	6.4 0.84 0.84 0.84	4.52 0.57 0.52 0.55	Seed	10	0.7	0.6	1.6	MSL13464

Application type: PRE = pre-emergence; EPO = early post-emergence; LPO = late post-emergence; PH = pre-harvest

Table 56. Residues in Glyphosate tolerant sugar beet root (USA) following application of an SL formulation of glyphosate (410SL as the isopropylamine salt = 360 g ae/L).

Location (year) variety	Type	Application N	Application kg ae/ha	Application kg ae/hL	PHI (days)	Residues (mg/kg) glyphosate	Residues (mg/kg) AMPA	Residues (mg/kg) Total	Report/ reference
Clay county, Minnesota, USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.4 0.86 0.85 0.85	4.20 0.84 0.84 0.84	59	0.69	< 0.05	0.69	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.85 0.86 1.7	3.36 0.84 0.84 1.68	28	8.6	0.25	9.0	MSL14542
Polk, Minnesota USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.1 0.81 0.87 0.83	2.40 0.48 0.48 0.48	58	0.06	< 0.05	0.06	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.82 0.83 1.7	1.92 0.48 0.48 0.96	31	8.5	0.17	8.8	MSL14542

Location (year) variety	Type	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Renville, Minnesota USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.3 0.84 0.83 0.84	3.36 0.48 0.48 0.48	56	1.0	< 0.05	1.0	MSL14542
	PRE 2-4 12-14 PH	4	3.2 0.84 0.82 1.7	2.69 0.48 0.56 0.96	28	6.8	0.17	7.1	MSL14542
Saginaw, Michigan, USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.1 0.84 0.84 0.83	2.10 0.42 0.42 0.42	70 95	0.05 < 0.05	< 0.05 < 0.05	0.05 < 0.05	MSL14542
	PRE 2-4 12-14 PH	4	3.3 0.85 0.83 1.7	1.68 0.42 0.42 0.84	31 56	6.5 6.0	0.11 0.05	6.7 6.1	MSL14542
Richland, North Dakota USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.1 0.83 0.84 0.84	2.80 0.56 0.56 0.56	52 59 66 73 80	2.4 2.7 2.1 1.5 1.9	0.07 < 0.05 0.08 0.08 0.09	2.5 2.7 2.2 1.6 2.0	MSL14542
	PRE 2-4 12-14 PH	4	3.3 0.84 0.84 1.7	2.24 0.56 0.56 1.12	22 29 36 43 50	8.1 7.0 5.3 5.0 6.4	0.16 0.09 0.15 0.15 0.19	8.3 7.1 5.5 5.2 6.7	MSL14542
Scottsbluff, Nebraska USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.1 0.82 0.81 0.83	2.10 0.42 0.42 0.42	59 98	0.06 < 0.05	< 0.05 < 0.05	0.06 < 0.05	MSL14542
	PRE 2-4 12-14 PH	4	3.2 0.82 0.83 1.7	1.68 0.42 0.42 0.84	29 68	4.8 2.9	0.07 0.05	4.9 3.0	MSL14542
Hockley, Texas USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.3 0.83 0.85 0.84	2.80 0.56 0.56 0.56	59 92	0.42 0.21	< 0.05 < 0.05	0.42 0.21	MSL14542
	PRE 2-4 12-14 PH	4	3.5 0.84 0.85 1.7	2.24 0.56 0.56 1.12	29 62	7.7 3.9	0.19 0.09	8.0 4.0	MSL14542
Weld, Colorado, USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.3 0.85 0.87 0.84	2.40 0.48 0.56 0.56	63	0.24	0.05	0.32	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.84 0.85 1.7	1.92 0.48 0.56 1.12	31	3.2	0.10	3.4	MSL14542
Stanislaus, California USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.2 0.86 0.86 0.86	2.10 0.37 0.37 0.37	61 99	0.46 0.23	0.07 < 0.05	0.57 0.23	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.87 0.83 1.8	1.49 0.37 0.42 0.75	31 69	6.8 4.7	0.46 0.31	7.5 5.2	MSL14542
Stanislaus, California USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.4 0.87 0.83 0.82	1.87 0.37 0.42 0.42	62 99	0.41 0.23	< 0.05 0.13	0.41 0.43	MSL14542

Location (year) variety	Type	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	PRE 2-4 12-14 PH	4	3.4 0.83 0.83 1.7	1.68 0.42 0.42 0.84	32 69	7.5 2.5	0.54 0.26	8.3 2.9	MSL14542
Power, Idaho USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.3 0.90 0.86 0.86	2.80 0.56 0.56 0.56	60	0.21	< 0.05	0.21	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.90 0.84 1.6	2.24 0.56 0.56 0.56	29	3.3	0.15	3.5	MSL14542
Twin Falls, Idaho USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.2 0.84 0.85 0.85	2.80 0.56 0.56 0.56	58	0.14	0.05	0.22	MSL14542
	PRE 2-4 12-14 PH	4	3.3 0.86 0.88 1.7	2.24 0.56 0.56 1.12	30	8.1	0.15	8.3	MSL14542

The first application is a pre-emergent application. Subsequent applications are in-crop post-emergent applications, 2-4 leaf stage, 4-8 leaf stage, 12-14 leaf stage and pre-harvest rescue.

Table 57. Residues in Barley grain: Pre-harvest Application (United Kingdom and France).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Franc Warret, Belgium (1999) Marilor	C	1	2.2		0 7 14	29 10 10	0.05 0.13 0.15	29 10 10	MLL31337
	G	1	2.2		0 7 14	20 9.5 7.7	< 0.05 0.11 0.12	20 9.7 7.9	MLL31337
Franc Warret, Belgium (1998) Marilor	C	1	2.2		0 7 14	16 20 7.8	< 0.05 0.12 < 0.05	16 20 7.8	MLL30815
	H	1	2.2		0 7 14	12 14 7.5	< 0.05 0.12 < 0.05	12 14 7.5	MLL30815
Ansoville, Loiret, France (1999) Esterel	E	1	2.1	0.67	7	6.3			RJ2907B
	F	1	2.12	0.69	7	5.5			RJ2907B
Coupigny, Seine-et-Marne, France (1999) Esterel	E	1	2.0	0.68	7	1.3			RJ2907B
	F	1	2.1	0.69	7	1.5			RJ2907B
Duras Aquitaine, France (1999) Intro	C	1	2.2		0 7 14	10 8.5 3.0	< 0.05 0.07 < 0.05	10 8.6 3.0	MLL31337
	G	1	2.2		0 7 14	19 5.5 7.1	< 0.05 < 0.05 0.07	19 5.5 7.2	MLL31337
St Paul les Romans, Rhône-Aples, France (1999) Platine	C	1	2.2		0 7 14	19 19 15	0.09 0.20 0.22	19 19 15	MLL31337

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	G	1	2.2		0 7 14	9.3 19 12	< 0.05 0.19 0.20	9.3 19 12	MLL31337
Ploudalmézeau, Bretagne, France (1999) Scarlett	C	1	2.2		0 7 14	15 16 1.8 c0.11	0.08 0.22 0.10	15 16 2.0	MLL31337
	G	1	2.2		0 7 14	16 19 4.8 c0.11	0.08 0.21 0.16	16 19 5.0	MLL31337
Levroux, Centre, France (1999) Scarlett	C	1	2.2		0 7 14	12 4.4 4.8	< 0.05 < 0.05 0.08	12 4.4 4.9	MLL31337
	G	1	2.2		0 7 14	16 3.8 5.5	0.06 < 0.05 0.08	16 3.8 5.6	MLL31337
Favières, Lorraine, France (1999) Emeraude	C	1	2.2		0 7 14	12 12 14	< 0.05 0.13 0.20	12 12 14	MLL31337
	G	1	2.2		0 7 14	19 11 10	0.06 0.14 0.15	19 11 10	MLL31337
Duras Aquitaine, France (1998) Express	C	1	2.1		0 7 15	21 5.2 2.6	0.08 0.06 < 0.05	21 5.3 2.6	MLL30815
	H	1	2.0		0 7 15	13 6.7 4.7	< 0.05 0.06 0.06	13 6.8 4.8	MLL30815
St Paul les Romans, Rhône-Alpes, France (1998) Deborah	C	1	2.4		0 7 15	18 15 14	0.07 0.17 0.2	18 15 14	MLL30815
	H	1	2.2		0 7 15	21 12 9.9	0.08 0.16 0.16	21 12 10	MLL30815
Ploudalmézeau, Bretagne, France (1998) Intro	C	1	2.1		0 7 14	9.9 12 19	< 0.05 0.11 0.16	9.9 12 19	MLL30815
	H	1	2.1		0 7 14	9.3 9.9 0.93	< 0.05 0.13 < 0.05	9.3 10 0.93	MLL30815
Levroux, Centre, France (1998) Nevada	C	1	2.2		0 9 14	17 5.8 4.2	0.05 0.05 0.05	17 5.9 4.3	MLL30815
	H	1	2.2		0 9 14	15 5.9 4.0	< 0.05 0.05 < 0.05	15 6.0 4.0	MLL30815
Favières, Lorraine, France (1998) Scarlet	C	1	2.1		0 7 14	22 1.8 1.4	0.06 < 0.05 < 0.05	22 1.8 1.4	MLL30815
	H	1	2.3		0 7 14	17 2.0 2.2	0.06 < 0.05 < 0.05	17 2.0 2.2	MLL30815
Villeneuve, South France (1998) Sunrise [winter barley]	I	1	2.1	1.1	0 7 14	10 2.5 1.6	< 0.05 0.051 < 0.05	10 2.6 1.6	GLY 528

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	J	1	2.1	1.1	0 7 14	10 2.9 2.1	0.070 0.069 0.058	10 3.0 2.2	GLY 528
Bron, France (1998) Cameo [spring barley]	I	1	2.3	1.1	0 7 14	10 6.1 3.8 c0.087	0.072 0.074 0.083	10 6.2 3.9	GLY 528
	J	1	2.3	1.1	0 7 14	7.2 4.6 7.9 c0.087	< 0.05 0.074 0.097	7.2 4.7 8.0	GLY 528
Berstheim, Alsace, France (1998) Nevacla	I	1	2.1	1.1	7	13 c0.047			GLY 418
	J	1	2.1	1.1	7	11 c0.047			GLY 418
	J	1	1.7	0.81	7	6.2 c0.047			GLY 418
Vayres sur Essonne, La Ferte-Alais, France (1991) Volga	K	1	1.1	0.54	8	1.0	< 0.05	1.0	MLL30281
	K	1	2.2	1.1	8	1.8	< 0.05	1.8	MLL30281
	L	1	1.0	0.53	8	0.07	< 0.05	0.07	MLL30281
	L	1	2.1	1.0	8	2.8	< 0.05	2.8	MLL30281
	C	1	2.2	1.1	8	1.6	< 0.05	1.6	MLL30281
Champmotteux, Maisse, France (1991) Natacha	K	1	1.1	0.54	7	1.2	< 0.05	1.2	MLL30281
	K	1	2.2	1.1	7	1.6	< 0.05	1.6	MLL30281
	L	1	1.0	0.53	7	1.1	< 0.05	1.1	MLL30281
	L	1	2.1	1.0	7	2.2	< 0.05	2.2	MLL30281
	C	1	2.2	1.1	7	3.3	< 0.05	3.3	MLL30281
Sept Sauly, Reims, France (1991) Volga	K	1	1.1	0.54	7	4.3	0.06	4.4	MLL30281
	K	1	2.2	1.1	7	5.4	0.08	5.5	MLL30281
	L	1	1.0	0.53	7	3.2	< 0.05	3.2	MLL30281
	L	1	2.1	1.0	7	4.4	0.06	4.5	MLL30281
	C	1	2.2	1.1	7	7.2	0.07	7.3	MLL30281
Verneuil sur Serre, Laon, France (1991) Natacha	K	1	1.1	0.54	7	4.4	0.06	4.5	MLL30281
	K	1	2.2	1.1	7	5.9	0.09	6.0	MLL30281
	L	1	1.0	0.53	7	2.8	< 0.05	2.8	MLL30281
	L	1	2.1	1.0	7	4.0	0.06	4.1	MLL30281
	C	1	2.2	1.1	7	9.6	0.09	9.7	MLL30281
Denton, Lincolnshire, UK (1999) Gleam	E	1	2.0		7	6.3		6.3	RJ2907B
	F	1	2.1		7	5.1		5.1	RJ2907B
Elford, Staffordshire, UK (1999) Regina	E	1	2.0	0.68	7	8.1		8.1	RJ2907B
	F	1	2.1	0.69	7	8.4		8.4	RJ2907B
Normanton, UK (1982) Igri	C	1	1.4	0.56	9	3.3	< 0.01	3.3	MLL30087
Lechdale, UK (1982) Igri	C	1	1.4	0.70	12	1.6	< 0.05	1.6	MLL30087

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
East Lothians, UK (1982) Igri	C	1	1.4	0.70	6	4.4	< 0.05	4.4	MLL30087
Bossal, UK (1982) Igri	C	1	1.4	0.54	8	11	0.09	11	MLL30087
Cottenham, UK (1982) Triumph	C	1	1.4	0.70	7	1.4	< 0.05	1.4	MLL30087

Formulation C = Roundup® 360 g ae/L SL; Formulation E = 337 g ae/L SL (trimesium salt); Formulation F = 347 g ae/L SL; Formulation G = MON 78294 450 g ae/L SL; Formulation H = MON 14420 680 g ae/kg SG; Formulation I and J both 360 g ae/L SL formulations; Formulation K = MON52776 360 g ae/L SL; Formulation L = MON44068 420 g ae/kg SG

Table 58. Residues in Conventional Maize grain: Pre-harvest Application (USA).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Greene Co., Iowa, USA (1997) DR592SR	SL	1	2.5	1.3	7	≤ 0.05	< 0.05	≤ 0.05	MSL14917
Guthrie Co., Iowa, USA (1997) 2547	SL	1	2.5	1.4	7	0.06	< 0.05	0.06	MSL14917
Jefferson Co., Iowa, USA (1997) 34RO6	SL	1	2.6	1.6	7	≤ 0.05	< 0.05	≤ 0.05	MSL14917
Clinton Co., Illinois, USA (1997) Pioneer 3394	SL	1	2.5	1.5	7	≤ 0.05	< 0.05	≤ 0.05	MSL14917
Jersey Co., Illinois, USA (1997) Pioneer 3394	SL	1	2.5	1.3	7	0.09	< 0.05	0.09	MSL14917
Burt Co., Nebraska, USA (1997) P34RO6 B+	SL	1	2.5	1.3	7	≤ 0.05	< 0.05	≤ 0.05	MSL14917
York Co., Nebraska, USA (1997) 3394	SL	1	2.5	1.2	6	0.05	< 0.05	0.05	MSL14917
Wayne Co., New York, USA (1997) Agway 266	SL	1	2.6	1.2	7	3.0	< 0.05	3.0	MSL14917
Wilson Co., North Carolina USA (1997) Pioneer 3163	SL	1	2.7	1.2	7	0.06	< 0.05	0.06	MSL14917
Monmouth, Illinois USA (1993) Asgrow 707/623	SL	1	2.5	1.6	6	0.07	0.08	0.19	MSL13654
Fishers, Indiana USA (1993) Select 3720	SL	1	2.5	1.9	7	≤ 0.05	< 0.05	≤ 0.05	MSL13654
Danville, Iowa USA (1993) Querna 7670	SL	1	2.5	1.2	7	≤ 0.05	0.13	≤ 0.25	MSL13654
Lexington, Kentucky, USA (1993) Pioneer 3320	SL	1	2.5	1.7	7	0.05	0.06	0.14	MSL13654

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Conklan, Michigan USA (1993) Pioneer 3563	SL	1	2.6	1.5	6	< 0.05	< 0.05	< 0.05	MSL13654
Lamberton, Minnesota USA (1993) Pioneer 3563	SL	1	2.5	1.2	6	0.19	< 0.05	0.19	MSL13654
Leonard, Missouri USA (1993) C-G-4490	SL	1	2.5	1.4	6	< 0.05	< 0.05	< 0.05	MSL13654
York, Nebraska USA (1993) Pioneer 3162	SL	1	2.5	2.4	6	< 0.05	< 0.05	< 0.05	MSL13654
New Holland, Ohio USA (1993) Madison Seed GL 235	SL	1	2.5	1.4	6	0.54	< 0.05	0.54	MSL13654
Valley Springs, South Dakota USA (1993) Pioneer 3563	SL	1	2.5	2.3	7	< 0.05	< 0.05	< 0.05	MSL13654
Uvalde, Texas USA (1993) Pioneer 3245	SL	1	2.5	1.2	6	< 0.05	0.12	< 0.23	MSL13654
Delavan, Wisconsin USA (1993) RK 702	SL	1	2.5	1.3	7	< 0.05	< 0.05	< 0.05	MSL13654

410SL as isopropylamine salt = 300 g ae/L

Table 59. Residues in Glyphosate Tolerant Maize following application of glyphosate SL formulation as the isopropylamine salt (360 g ae/L).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Chula, Tift County, Georgia USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.86 0.85 0.84	2.1 0.42 0.48 0.67	68	0.09	< 0.05	0.09	MSL15334
	PRE EPO LPO DN	4	3.4 0.86 0.86 1.7	2.1 0.42 0.48 1.34	68	0.11	< 0.05	0.11	MSL15334
	PRE EPO LPO	3	4.3 0.87 1.7	2.1 0.42 0.96	74	0.28	< 0.05	0.28	MSL15334
Richland, Jefferson County Iowa USA (1999) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.84	2.1 0.42 0.42 0.42	77	0.05	< 0.05	0.05	MSL15334
	PRE EPO LPO DN	4	3.5 0.85 0.85 1.7	2.1 0.42 0.42 0.84	77	0.06	< 0.05	0.06	MSL15334
	PRE EPO LPO	3	4.2 0.86 1.7	2.1 0.42 0.84	85	0.05	< 0.05	0.05	MSL15334

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Webster City, Hamilton County, Iowa USA (1998) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.84	2.8 0.56 0.56 0.48	98	0.07	< 0.05	0.07	MSL15334
	PRE EPO LPO DN	4	3.3 0.84 0.84 1.7	2.8 0.56 0.56 0.96	98	0.07	< 0.05	0.07	MSL15334
	PRE EPO LPO	3	4.3 0.85 1.7	2.8 0.56 1.12	107	0.12	< 0.05	0.12	MSL15334
Bagley, Guthrie County Iowa USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.88 0.84 0.80	2.1 0.42 0.42 0.48	96	0.06	< 0.05	0.06	MSL15334
	PRE EPO LPO DN	4	3.5 0.87 0.84 1.6	2.1 0.42 0.42 0.96	96	0.08	< 0.05	0.08	MSL15334
	PRE EPO LPO	3	4.2 0.88 1.7	2.1 0.42 0.84	105	0.14	< 0.05	0.14	MSL15334
Berkley, Boone County Iowa USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.88 0.85 0.80	2.1 0.42 0.42 0.48	93	< 0.04	< 0.05	< 0.04	MSL15334
	PRE EPO LPO DN	4	3.4 0.87 0.84 1.6	2.1 0.42 0.42 0.96	93	0.08	< 0.05	0.08	MSL15334
	PRE EPO LPO	3	4.2 0.88 1.7	2.1 0.42 0.84	103	0.04	< 0.05	0.04	MSL15334
Dow, Jersey County, Illinois USA (1998) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.85	2.4 0.48 0.48 0.48	77	0.04 c0.09	< 0.05 c0.1	0.04 c0.09	MSL15334
	PRE EPO LPO DN	4	3.4 0.85 0.86 1.6	2.4 0.48 0.48 0.96	77	0.26 c0.09	< 0.05 c0.1	0.26 c0.09	MSL15334
	PRE EPO LPO	3	4.2 0.85 1.7	2.4 0.48 0.96	84	0.18 c0.09	< 0.05 c0.1	0.18 c0.09	MSL15334
Carlyle, Clinton County Illinois USA (1998) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.82	2.8 0.56 0.48 0.56	84	0.04	< 0.05	0.04	MSL15334
	PRE EPO LPO DN	4	3.4 0.84 0.85 1.6	2.8 0.56 0.48 1.12	84	0.10	< 0.05	0.10	MSL15334
	PRE EPO LPO	3	4.2 0.86 1.7	2.8 0.56 0.96	93	< 0.04	< 0.05	< 0.04	MSL15334
Wyoming,, Stark County Illinois USA (198) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.84	2.4 0.56 0.67 0.67	101	0.04	< 0.05	0.04	MSL15334
	PRE EPO LPO DN	4	3.4 0.84 0.84 1.7	2.4 0.56 0.67 1.34	101	0.04	< 0.05	0.04	MSL15334

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	PRE	3	4.2	2.4	108	0.06	< 0.05	0.06	MSL15334
	EPO		0.86	0.56					
	LPO		1.7	1.34					
Noblesville, Hamilton County Indiana, USA (1998) GA21	PRE	4	4.2	2.1	91	< 0.04	< 0.05	< 0.04	MSL15334
	EPO		0.84	0.42					
	LPO		0.85	0.42					
	DN		0.82	0.48					
	PRE	4	3.4	2.1	91	0.04	< 0.05	0.04	MSL15334
	EPO		0.85	0.42					
	LPO		0.85	0.42					
	DN		1.7	0.96					
	PRE	3	4.2	2.1	102	0.09	< 0.05	0.09	MSL15334
	EPO		0.85	0.42					
	LPO		1.7	0.96					
	DN								
Williamston, Ingham County Michigan USA (1998) GA21	PRE	4	4.1	2.8	88	< 0.04	< 0.05	< 0.04	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		0.84	0.56					
	PRE	4	3.3	2.8	88	< 0.04	< 0.05	< 0.04	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		1.7	1.12					
	PRE	3	4.2	2.8	98	< 0.04	< 0.05	< 0.04	MSL15334
	EPO		0.84	0.56					
	LPO		1.7	1.12					
Conklin, Ottawa County Michigan USA (1998) GA21	PRE	4	4.2	2.4	94	0.07	< 0.05	0.07	MSL15334
	EPO		0.84	0.48					
	LPO		0.84	0.48					
	DN		0.84	0.48					
	PRE	4	3.4	2.4	94	0.12	< 0.05	0.12	MSL15334
	EPO		0.84	0.48					
	LPO		0.85	0.48					
	DN		1.7	0.96					
	PRE	3	4.2	2.4	104	0.15	< 0.05	0.15	MSL15334
	EPO		0.84	0.48					
	LPO		1.7	0.96					
Campbell, Wilkin County Minnesota USA (1998) GA21	PRE	4	4.3	2.1	75	0.07	< 0.05	0.07	MSL15334
	EPO		0.85	0.84					
	LPO		0.85	0.84					
	DN		0.84	0.84					
	PRE	4	3.4	2.1	75	0.07	< 0.05	0.07	MSL15334
	EPO		0.85	0.84					
	LPO		0.85	0.84					
	DN		1.7	1.68					
	PRE	3	4.2	2.1	86	0.07	< 0.05	0.07	MSL15334
	EPO		0.85	0.84					
	LPO		1.7	1.68					
Hollandale, Freeborn County Minnesota USA (1998) GA21	PRE	4	4.0	2.8	91	0.19	< 0.05	0.19	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		0.84	0.56					
	PRE	4	3.2	2.8	85	0.07	< 0.05	0.07	MSL15334
	EPO		0.86	0.56					
	LPO		0.87	0.56					
	DN		1.7	1.12					
	PRE	3	4.1	2.8	102	0.23	< 0.05	0.23	MSL15334
	EPO		0.86	0.56					
	LPO		1.7	1.12					

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Rose Hill, Sampson County North Carolina USA (1998) GA21	PRE	4	4.1	2.8	67	0.28	< 0.05	0.28	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		0.84	0.56					
	PRE	4	3.3	2.8	67	0.25	< 0.05	0.25	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		1.7	1.12					
	PRE	3	4.1	2.8	71	0.33	< 0.05	0.33	MSL15334
	EPO		0.84	0.56					
	LPO		1.7	1.12					
York, York County Nebraska (1998) GA21	PRE	4	4.2	2.8	75	0.31	< 0.05	0.31	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		0.85	0.56					
	PRE	4	3.3	2.8	75	0.25	< 0.05	0.25	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		1.67	1.12					
	PRE	3	4.2	2.8	81	0.08	< 0.05	0.08	MSL15334
	EPO		0.84	0.56					
	LPO		1.7	1.12					
Osceola, Polk County Nebraska (1998) GA21	PRE	4	4.2	2.1	70	0.05	< 0.05	0.05	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		0.84	0.84					
	PRE	4	3.3	2.1	70	0.05	< 0.05	0.05	MSL15334
	EPO		0.84	0.56					
	LPO		0.84	0.56					
	DN		1.7	1.68					
	PRE	3	4.2	2.1	78	0.11	< 0.05	0.11	MSL15334
	EPO		0.84	0.56					
	LPO		1.7	1.12					
New Holland, Fayette County Ohio USA (1998) GA21	PRE	4	4.1	2.4	84	0.19	< 0.05	0.19	MSL15334
	EPO		0.84	0.42					
	LPO		0.85	0.48					
	DN		0.84	0.67					
	PRE	4	3.3	2.4	84	0.19	< 0.05	0.19	MSL15334
	EPO		0.85	0.42					
	LPO		0.85	0.48					
	DN		1.7	1.34					
	PRE	3	4.2	2.4	88	0.42	< 0.05	0.42	MSL15334
	EPO		0.84	0.42					
	LPO		1.7	0.96					
Germansville, Leigh Co. Pennsylvania USA (1998) GA21	PRE	4	4.3		102	0.08	0.05	0.16	MSL15334
	EPO		0.85						
	LPO		0.86						
	DN		0.86						
	PRE	4	3.4	2.1	102	0.09	< 0.05	0.09	MSL15334
	EPO		0.85	0.42					
	LPO		0.85	0.42					
	DN		1.7	1.68					
	PRE	3	4.3	2.1	110	0.12	< 0.05	0.12	MSL15334
	EPO		0.86	0.42					
	LPO		1.7	0.84					
Britton, Marshall County South Dakota USA (1998) GA21	PRE	4	4.2	4.2	101	0.08	< 0.05	0.08	MSL15334
	EPO		0.84	0.84					
	LPO		0.84	0.84					
	DN		0.84	0.56					
	PRE	4	3.3	4.2	101	0.09	< 0.05	0.09	MSL15334
	EPO		0.84	0.84					
	LPO		0.84	0.84					
	DN		1.7	1.12					

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	PRE EPO LPO	3	4.2 0.84 1.7	4.2 0.84 1.68	106	0.10	< 0.05	0.10	MSL15334
Buffalo Springs, Clay County Texas USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.86 0.85 0.85	2.8 0.48 0.56 0.67	46	0.49	< 0.05	0.49	MSL15334
	PRE EPO LPO DN	4	3.4 0.86 0.84 1.7	2.8 0.48 0.56 1.34	46	0.52	< 0.05	0.52	MSL15334
	PRE EPO LPO	3	4.3 0.86 1.7	2.8 0.48 1.12	54	0.83	< 0.05	0.83	MSL15334
Verona, Dane County Wisconsin USA (1998) GA21	PRE EPO LPO DN	4	4.2 0.85 0.87 0.86	3.4 0.56 0.48 0.48	99	0.07	< 0.05	0.07	MSL15334
	PRE EPO LPO DN	4	3.2 0.82 0.82 1.7	3.4 0.56 0.48 0.96	99	0.06	< 0.05	0.06	MSL15334
	PRE EPO LPO	3	4.2 0.84 1.7	3.4 0.56 0.96	111	0.07	< 0.05	0.07	MSL15334
Delavan, Walworth County Wisconsin USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.82 0.84 0.85	2.4 0.48 0.48 0.67	102	0.10	< 0.05	0.10	MSL15334
	PRE EPO LPO DN	4	3.4 0.85 0.82 1.7	2.4 0.48 0.48 1.34	102	0.09	< 0.05	0.09	MSL15334
	PRE EPO LPO	3	4.1 0.84 1.6	2.4 0.48 0.96	110	0.12	< 0.05	0.12	MSL15334

Treatment types include: PRE = pre-emergence; EPO = early post-emergence; LPO = late post-emergence; DN = drop nozzle.

Table 60. Residues in Oat grain: Pre-harvest Application.

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Elm Creek Manitoba, Canada (2001) Triple Crown	C	1	0.90	-	7	0.70, 0.42	< 0.05, < 0.05	0.70, 0.42	CER 01307/01
	M	1	0.90	-	7	0.54, 0.24	< 0.05, < 0.05	0.54, 0.24	CER 01307/01
Vanscoy, Saskatchewan, Canada (2001) Calibre	C	1	0.90	-	6	4.6, 2.7	0.16, 0.055	4.8, 2.8	CER 01307/01
	M	1	0.90	-	6	3.7, 3.2	0.06, < 0.05	3.8, 3.2	CER 01307/01
Minto, Manitoba, Canada (2001) AC Assiniboia	C	1	0.90	-	6	3.1, 1.2	0.051, 0.051	3.2, 1.3	CER 01307/01
	M	1	0.90	-	6	2.2, 2.4	< 0.05, < 0.05	2.2, 2.4	CER 01307/01

Location (year) variety	Form	Application N	kg ae/ha	kg ae/hL	PHI (days)	Residues (mg/kg) glyphosate	AMPA	Total	Report/ reference
Fyn, Denmark (1984) Selma	C	1	1.1	0.54	0 4 7 10 15	4.5 c0.1 6.1 c0.2 7.1 c0.2 8.2 8.6 c0.3			MLL30150
		1	2.2	1.1	0 4 7 10 15	6.3 c0.1 19 c0.2 17 c0.2 18 17 c0.3			MLL30150
Fyn, Denmark (1984) Selma	C	1	1.1	0.54	0 4 7 10 15	3.0 c0.3 7.3 c0.3 13 c0.2 8.1 c0.1 14 c0.1			MLL30150
		1	2.2	1.1	0 4 7 10 15	5.8 c0.3 17 c0.3 18 c0.2 17 c0.1 21 c0.1			MLL30150
Oglland, Denmark (1984) Selma	C	1	1.1	0.54	0 4 7 10 15	4.0 c0.1 5.1 c0.2 4.9 c0.1 2.1 c0.1 3.6 c0.1			MLL30150
Oglland, Denmark (1984) Selma	C	1	2.2	1.1	0 4 7 10 15	5.4 c0.1 9.1 c0.2 5.3 c0.1 5.1 c0.1 3.6 c0.1			MLL30150
Newark, Nottinghamshire, UK (1993) Craig	C	1	1.44	0.72	7	4.9			GLY 282, GLY 297
		1	0.72	0.36	7	3.2			GLY 282, GLY 297
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	7	3.4			GLY 282, GLY 297
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	7	0.8			GLY 282, GLY 297
East Rounton, Yorkshire, UK (1993) Mirabel	C	1	1.44	0.72	7	3.4 c0.03			GLY 282, GLY 297
		1	0.72	0.36	7	2.5 c0.03			GLY 282, GLY 297
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	7	3.3 c0.03			GLY 282, GLY 297
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	7	0.4 c0.03			GLY 282, GLY 297
Brockhampton, Herefordshire, UK (1993) Image	C	1	1.44	0.72	7	4.1 c0.05			GLY 282, GLY 297
		1	0.72	0.36	7	2.8 c0.05			GLY 282, GLY 297
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	7	3.1 c0.05			GLY 282, GLY 297
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	7	0.8 c0.05			GLY 282, GLY 297

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Disewort, Leicestershire, UK (1993) Aintree	C	1	1.4	0.72	7	5.2			GLY 261, GLY 270
		1	0.72	0.36	7	2.8			GLY 261, GLY 270
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	7	3.8			GLY 261, GLY 270
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	7	1.4			GLY 261, GLY 270
East Rounton, North Yorkshire, UK (1993) Mirabel	C	1	1.4	0.72	7	0.9 c0.03			GLY 261, GLY 270
		1	0.72	0.36	7	0.6 c0.03			GLY 261, GLY 270
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	7	1.9 c0.03			GLY 261, GLY 270
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	7	0.3 c0.03			GLY 261, GLY 270
Buckingham, UK (1982) Pennal	C	1	1.4	0.72	12	1.2	0.04	1.3	MLL30087
Cottenham, UK (1982) Trafalsar	C	1	1.4	0.72	7	6.0 c0.1	0.05	6.1	MLL30087
Edinburgh, UK (1982) Maris Tabard	C	1	1.4	0.72	7	3.4	0.06	3.5	MLL30087
Skelton, UK (1982) Maris Quest	C	1	1.4	0.72	7	8.1 c0.1	0.22	8.4	MLL30087

Formulation C = 360 g ae/L SL; Formulation M = 640 g ae/L (trimesium salt) SL + 0.5% v/v surfactant

Table 61. Residues in Rye grain: Pre-harvest Application (Denmark).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Fyn, Denmark (1984) Petkus2	C	1	1.1	0.54	0 4 7 10 15	3.1 2.4 c0.1 2.2 c0.1 2.0 c0.2 2.1 c0.1			MLL30150
		1	2.2	1.08	0 4 7 10 15	5.2 5.9 c0.1 3.5 c0.1 5.3 c0.2 5.4 c0.1			MLL30150
Oglland, Denmark (1984) Petkus2	C	1	1.1	0.54	0 4 7 10 15	1.3 c0.1 1.6 1.6 c0.1 1.2 c0.2 1.6 c0.1			MLL30150
		1	2.2	1.08	0 4 7 10 15	1.7 c0.1 2.8 1.9 c0.1 2.9 c0.2 2.3 c0.1			MLL30150

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Fyn, Denmark (1984) Petkus2	C	1	1.1	0.54	0 4 7 10 15	4.6 c0.1 1.7 1.3 c0.1 1.6 c0.2 1.5			MLL30150
		1	2.2	1.08	0 4 7 10 15	4.2 c0.1 3.2 2.8 c0.1 3.1 c0.2 2.8			MLL30150

Limit of detection of glyphosate is 0.05 ppm

Table 62. Residues in Sorghum grain: Pre-harvest Application (USA).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Wilson, North Carolina, USA (1997) Pioneer 8446	SL	1	1.7	0.82	7	6.4	0.15	6.6	MSL14918
Waller, Texas USA (1997) Mycogen 1558	SL	1	1.7	0.90	7	1.3	0.05	1.4	MSL14918
Uvalde, Texas USA (1997) Pioneer 8313	SL	1	1.7	1.08	7	1.1	< 0.05	1.1	MSL14918
Pratt, Kansas USA (1997) Pioneer 8414	SL	1	1.7	0.90	7	4.6	0.13	4.8	MSL14918
Stafford, Kansas USA (1997) Pioneer 8601	SL	1	1.7	0.90	7	4.4	0.08	4.5	MSL14918
Jackson, Arkansas USA (1992) Pioneer 8333	SL	1	1.7	0.81	8	1.7	0.09	1.8	MSL13037
Chautauqua, Kansas USA (1992) Garst 5319	SL	1	1.7	0.84	6	5.3	0.09	5.4	MSL13037
Pratt, Kansas USA (1992) NK 2030	SL	1	1.7	0.93	8	12	0.09	12	MSL13037
Shelby, Missouri USA (1992) Horizon 101-G	SL	1	1.7	0.81	7	6.0	0.11	6.2	MSL13037
York, Nebraska USA (1992) Pioneer 2030	SL	1	1.7	1.6	8	1.8	< 0.05	1.8	MSL13037
Caddo, Oklahoma USA (1992) Pioneer 8500	SL	1	1.7	1.1	7	6.3	0.22	6.6	MSL13037
Tripp, South Dakota USA (1992) DeKalb	SL	1	1.7	0.86	7	13	0.08	13	MSL13037
Burleson, Texas USA (1992) 522DR	SL	1	1.7	1.3	8	1.4	0.10	1.6	MSL13037

Table 63. Residues in Wheat grain: Pre-harvest Application.

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Franc Warret, Belgium (1999) Soissons	C	1	2.2		0 7 14	4.7 2.9 3.4	< 0.05 0.05 0.07	4.7 3.0 3.5	MLL31337
	G	1	2.2		0 7 14	0.91 2.2 3.6	< 0.05 < 0.05 0.06	0.91 2.2 3.7	MLL31337
Franc Warret, Belgium (1998) Rialto	C	1	2.2		0 7 14	2.5 1.4 1.7	0.05 < 0.05 0.12	2.6 1.4 1.9	MLL30815
	H	1	2.2		0 7 14	1.6 1.4 1.1	< 0.05 < 0.05 0.12	1.6 1.4 1.3	MLL30815
Audeville, Loiret, France (1999) Courtot IQ	F	1	2.1	-	7	1.7			RJ2910B
	E	1	2.0		7	1.4			RJ2910B
Coupigny, Seine-et-Marne, France (1999) Isengrain IQ	F	1	2.1	-	7	1.1			RJ2910B
	E	1	2.0		7	1.3			RJ2910B
Duras Aquitaine, France (1999) Isengrain	C	1	2.2		0 7 14	1.9 c0.10 0.71 c0.09 0.4	< 0.05 < 0.05 < 0.05	1.9 c0.10 0.71 c0.09 0.4	MLL31337
	G	1	2.2		0 7 14	2.5 c0.10 0.90 c0.09 1.2	< 0.05 < 0.05 < 0.05	2.5 c0.10 0.90 c0.09 1.2	MLL31337
St Paul les Romans,Rhône-Alpes, France (1999) Aztec	C	1	2.2		0 7 14	2.3 0.53 0.42	< 0.05 < 0.05 < 0.05	2.3 0.53 0.42	MLL31337
	G	1	2.2		0 7 14	2.4 0.32 0.30	< 0.05 < 0.05 < 0.05	2.4 0.32 0.30	MLL31337
Fessenheim, Alsace, France (1999) Camp Remy	C	1	2.2		0 7 14	4.6 0.36 0.34	< 0.05 < 0.05 < 0.05	4.6 0.36 0.34	MLL31337
	G	1	2.2		0 7 14	2.6 0.99 0.55	< 0.05 0.05 < 0.05	2.6 1.1 0.55	MLL31337
Battigny, Lorraine, France (1999) Camp Rémy	C	1	2.2		0 7 14	6.0 3.4 3.3	< 0.05 < 0.05 < 0.05	6.0 3.4 3.3	MLL31337
	G	1	2.2		0 7 14	5.3 3.7 6.3	< 0.05 0.07 0.14	5.3 3.8 6.5	MLL31337
Ploudalmézeau, Bretagne, France (1999) Cyrano	C	1	2.2		0 7 14	1.6 3.9 0.66 c0.09	< 0.05 < 0.05 < 0.05	1.6 3.9 0.66 c0.09	MLL31337

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	G	1	2.2		0 7 14	2.0 3.5 0.54 0.09	< 0.05 < 0.05 < 0.05	2.0 3.5 0.54 0.09	MLL31337
Duras Aquitaine, France (1998) Soissons	C	1	2.2		0 7 15	4.1 0.12 0.28	< 0.05 < 0.05 < 0.05	4.1 0.12 0.28	MLL30815
	H	1	2.3		0 7 15	3.0 0.66 0.29	< 0.05 < 0.05 < 0.05	3.0 0.66 0.29	MLL30815
St Paul les Romans, Rhône-Alpes, France (1998) Trémie	C	1	2.1		0 10 18	4.6 4.9 1.2	< 0.05 < 0.05 0.05	4.6 4.9 1.3	MLL30815
	H	1	2.2		0 10 18	4.1 0.66 0.70	< 0.05 < 0.05 0.17	4.1 0.66 0.96	MLL30815
Ploudalmézeau, Bretagne, France (1998) Tremie	C	1	2.2		0 7 14	2.2 4.0 3.1	< 0.05 < 0.05 < 0.05	2.2 4.0 3.1	MLL30815
	H	1	2.2		0 7 14	1.1 3.7 2.3	0.05 < 0.05 < 0.05	1.2 3.7 2.3	MLL30815
Levroux, Centre, France (1998) Oracle	C	1	2.2		0 9 14	2.0 c0.16 0.16 0.16	< 0.05 < 0.05 0.05	2.0 c0.16 0.16 0.24	MLL30815
	H	1	2.2		0 9 14	1.7 c0.16 0.16 0.15	< 0.05 0.05 0.05	1.7 c0.16 0.24 0.23	MLL30815
Fessenheim, Alsace, France (1998) Sideral	C	1	2.2		0 7 14	6.3 2.3 3.1	0.05 < 0.05 < 0.05	6.4 2.3 3.1	MLL30815
	H	1	2.2		0 7 14	12 3.6 3.8	0.05 0.06 < 0.05	12 3.7 3.8	MLL30815
Illiat, South France (1998) Soissons [winter soft wheat]	I	1	2.2	1.1	0 7 14	1.8 0.093 c0.033 0.042	< 0.05 < 0.05 < 0.05	1.8 0.093 c0.033 0.042	GLY 528
	J	1	2.1	1.1	0 7 14	0.80 0.081 c0.033 1.2	< 0.05 < 0.05 < 0.05	0.80 0.081 c0.033 1.2	GLY 528
Lavannes, France (1998) Tremie [winter wheat]	I	1	2.2	1.1	0 7 14	0.64 0.31 1.1	< 0.05 < 0.05 < 0.05	0.64 0.31 1.1	GLY 528
	J	1	2.2	1.1	0 7 14	0.71 1.5 1.1	< 0.05 < 0.05 < 0.05	0.71 1.5 1.1	GLY 528
Entzheim, Alsace, France (1996) Sideral	I	1	2.1	1.1	7	9.5			GLY 418
	J	1	2.1	1.1	7	6.4			GLY 418
	J	1	1.6	0.81	7	4.8			GLY 418

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Hilsprich, Lorraine, France (1996) Scheiersmatt	I	1	2.0	1.1	7	2.3			GLY 418
	J	1	2.1	1.1	7	2.4			GLY 418
	J	1	1.5	0.81	7	1.5 c0.18			GLY 418
Boyer, Tounus, France (1991) Campremy	K		1.1	0.54	7	0.40	< 0.05	0.40	MLL30281
	K	1	2.2	1.1	7	0.80	< 0.05	0.80	MLL30281
	L	1	1.0	0.53	7	0.30	< 0.05	0.30	MLL30281
	L	1	2.1	1.0	7	0.60	< 0.05	0.60	MLL30281
	C	1	2.2	1.1	7	0.70	< 0.05	0.70	MLL30281
La Planche, Cely, France (1991) Pernel	K	1	1.1	0.54	7	0.30	< 0.05	0.30	MLL30281
	K	1	2.2	1.1	7	0.60	< 0.05	0.60	MLL30281
	L	1	1.0	0.53	7	0.20	< 0.05	0.20	MLL30281
	L	1	2.1	1.0	7	0.40	< 0.05	0.40	MLL30281
	C	1	2.2	1.1	7	1.1	< 0.05	1.1	MLL30281
Secqueville, Caen, France (1991) Thesee	K	1	1.1	0.54	10	0.70	< 0.05	0.70	MLL30281
	K	1	2.2	1.1	10	2.1	0.05	2.2	MLL30281
	L	1	1.0	0.53	10	0.50	< 0.05	0.50	MLL30281
	L	1	2.1	1.0	10	1.7	< 0.05	1.7	MLL30281
	C	1	2.2	1.1	10	1.4	< 0.05	1.4	MLL30281
Montigny sur Crecy, Laon, France (1991) Slepner	K	1	1.1	0.54	10	0.50	< 0.05	0.50	MLL30281
	K	1	2.2	1.1	10	0.90	< 0.05	0.90	MLL30281
	L	1	1.0	0.53	10	0.30	< 0.05	0.30	MLL30281
	L	1	2.1	1.0	10	0.60	< 0.05	0.60	MLL30281
	C	1	2.2	1.1	10	0.80	< 0.05	0.80	MLL30281
Norton, Worcestershire, UK (1999) Equinox	F	1	2.1	-	7	1.2			RJ2910B
	E	1	2.0		7	1.1			RJ2910B
Wilson, Derbyshire, UK (1999) Rialto IQ	F	1	2.1	-	7	1.1 c0.10			RJ2910B
	E	1	2.0		7	0.84 c0.10			RJ2910B
Debden, Essex, UK (1982) Norman	C	1	1.4		7	0.7	< 0.05	0.7	MLL30087
Debden, Essex, UK (1982 Norman	C	1	1.4		7	0.5	< 0.05	0.5	MLL30087
Tadcaster, Yorkshire, UK (1982) Bounty	C	1	1.4		7	0.1	< 0.05	0.1	MLL30087
Edinburgh, UK (1982) Mardlor	C	1	1.4		8	0.1	< 0.05	0.1	MLL30087
Chiseldon, Wiltshire, UK (1982) Avalon	C	1	1.4		8	0.3	< 0.05	0.3	MLL30087
Foxearth, Suffolk, UK (1982) Avalon	C	1	0.72		7	0.2	< 0.05	0.2	MLL30087

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
		1	1.4		7	0.3	< 0.05	0.3	MLL30087
		1	2.9		7	0.6	< 0.05	0.6	MLL30087
Dodington, Cambridgeshire, UK (1982) Kador	C	1	0.72		6	0.3 c0.1	< 0.05	0.3 c0.1	MLL30087
		1	1.4		6	0.4 c0.1	< 0.05	0.4 c0.1	MLL30087
		1	2.9		6	0.8 c0.1	< 0.05	0.8 c0.1	MLL30087
Cooksmill Green, Essex, UK (1982) Avalon	C	1	0.72		6	0.4 c0.05	< 0.05	0.4 c0.05	MLL30087
		1	1.4		6	1.0 c0.05	< 0.05	1.0 c0.05	MLL30087
		1	2.9		6	0.9 c0.05	< 0.05	0.9 c0.05	MLL30087

Formulation C = Roundup® 360 g ae/L SL; Formulation E = 337 g ae/L SL (trimesium salt); Formulation F = 347 g ae/L SL; Formulation G = MON 78294; Formulation H = MON 14420 680 g ae/kg SG; Formulation I and J both 360 g ae/L SL; Formulation K = MON 52776 360 g ae/L SL; Formulation L = MON 44068 420 g ae/kg SG

Table 64. Residues in Sugarcane (USA).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Oahu, Hawaii USA (1977)	SL	1	1.1		Cane	10	0.40	< 0.05	0.4	MSL0264
					Bagasse	10	0.34	< 0.05	0.34	
					Molasses	10	11	0.30	11	
					Raw sugar	10	0.96	< 0.05	0.96	
					Cane	28	0.97	< 0.05	0.97	
					Bagasse	28	0.18	< 0.05	0.18	
					Molasses	28	5.2	0.17	5.5	
					Raw sugar	28	0.36	< 0.05	0.36	
					Refined sugar	28	< 0.05	< 0.05	< 0.05	
	SL	1	2.2		Cane	10	2.2	< 0.05	2.2	MSL0264
					Bagasse	10	0.48	< 0.05	0.48	
					Molasses	10	15	0.38	16	
					Raw sugar	10	1.5	< 0.05	1.5	
					Refined sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	28	0.82	< 0.05	0.82	
					Bagasse	28	0.20	< 0.05	0.2	
					Molasses	28	7.4	0.23	7.8	
					Raw sugar	28	0.41	< 0.05	0.41	
Oahu, Hawaii USA (1977)	SL	1	1.1		Cane	10	1.0	< 0.05	1	MSL0264
					Bagasse	10	0.33	< 0.05	0.33	
					Molasses	10	14	0.35	15	
					Raw sugar	10	0.89	< 0.05	0.89	
					Cane	28	0.69	< 0.05	0.69	
					Bagasse	28	0.20	< 0.05	0.2	
					Molasses	28	5.8	0.20	6.1	
					Raw sugar	28	1.3	< 0.05	1.3	
	SL	1	2.2		Cane	10	3.8	< 0.05	3.8	MSL0264
					Bagasse	10	0.69	< 0.05	0.69	
					Molasses	10	12	0.34	13	
					Raw sugar	10	2.5	0.06	2.6	
					Refined sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	28	0.94	< 0.05	0.94	
					Bagasse	28	0.24	< 0.05	0.24	
					Molasses	28	7.6	0.28	8.0	
					Raw sugar	28	0.63	< 0.05	0.63	

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Weslaco, Texas USA (1976)	SL	1	0.56		Cane	10	0.31	< 0.05	0.31	MSL0264
					Bagasse	10	0.14	< 0.05	0.14	
					Molasses	10	2.4	0.08	2.5	
					Raw sugar	10	0.38	< 0.05	0.38	
					Refined sugar	10	0.07	< 0.05	0.07	
					Cane	28	0.24	< 0.05	0.24	
					Bagasse	28	0.06	< 0.05	0.06	
					Molasses	28	2.2	0.08	2.3	
					Raw sugar	28	0.26	< 0.05	0.26	
					Refined sugar	28	0.19	< 0.05	0.19	
	SL	1	1.1		Cane	10	0.15	< 0.05	0.15	MSL0264
					Bagasse	10	0.08	< 0.05	0.08	
					Molasses	10	2.3	0.09	2.4	
					Raw sugar	10	0.83	< 0.05	0.83	
					Refined sugar	10	0.36	< 0.05	0.36	
					Cane	28	0.21	< 0.05	0.21	
					Bagasse	28	0.08	< 0.05	0.08	
					Molasses	28	2.1	0.06	2.2	
					Raw sugar	28	0.51	< 0.05	0.51	
					Refined sugar	28	0.31	< 0.05	0.31	
St Martinsville, Louisiana USA (1976)	SL	1	0.56		Cane	10	0.29	< 0.05	0.29	MSL0264
					Bagasse	10	0.09	< 0.05	0.09	
					Molasses	10	2.5	0.08	2.6	
					Raw sugar	10	0.19	< 0.05	0.19	
					Cane	35	0.21	< 0.05	0.21	
					Bagasse	35	< 0.05	< 0.05	< 0.05	
					Molasses	35	1.6	0.06	1.7	
					Raw sugar	35	0.06	< 0.05	0.06	
					Refined sugar	35	< 0.05	< 0.05	< 0.05	
	SL	1	1.1		Cane	10	0.67	< 0.05	0.67	MSL0264
					Bagasse	10	0.17	< 0.05	0.17	
					Molasses	10	3.6	0.10	3.8	
					Raw sugar	10	0.24	< 0.05	0.24	
					Refined sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	35	0.28	< 0.05	0.28	
					Bagasse	35	0.27	< 0.05	0.27	
					Molasses	35	3.2	0.12	3.4	
					Raw sugar	35	0.26	< 0.05	0.26	
Pahokee, Florida USA (1977)	SL	1	0.56		Cane	10	0.11	< 0.05	0.11	MSL0264
					Bagasse	10	< 0.05	< 0.05	< 0.05	
					Molasses	10	0.81	0.07	0.92	
					Raw sugar	10	0.08	< 0.05	0.08	
					Refined sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	28	< 0.05	< 0.05	< 0.05	
					Bagasse	28	< 0.05	< 0.05	< 0.05	
					Molasses	28	0.32	< 0.05	0.32	
					Raw sugar	28	0.05	< 0.05	0.05	
	SL	1	1.1		Cane	10	0.17	< 0.05	0.17	MSL0264
					Bagasse	10	0.11	< 0.05	0.11	
					Molasses	10	1.4	0.14	1.6	
					Raw sugar	10	0.21	< 0.05	0.21	
					Refined sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	28	0.13	< 0.05	0.13	
					Bagasse	28	0.07	< 0.05	0.07	
					Molasses	28	0.87	< 0.05	0.87	
					Raw sugar	28	0.08	< 0.05	0.08	

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Belle Glade, Florida USA (1977)	SL	1	0.56		Cane	10	0.07	< 0.05	0.07	MSL0264
					Bagasse	10	< 0.05	< 0.05	< 0.05	
					Molasses	10	0.28	< 0.05	0.28	
					Raw sugar	10	0.11	< 0.05	0.11	
					Refined sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	28	< 0.05	< 0.05	< 0.05	
					Bagasse	28	< 0.05	< 0.05	< 0.05	
					Molasses	28	0.16	< 0.05	0.16	
					Raw sugar	28	0.06	< 0.05	0.06	
Belle Glade, Florida USA (1977)	SL	1	1.1		Cane	10	0.36	< 0.05	0.36	MSL0264
					Bagasse	10	0.12	< 0.05	0.12	
					Molasses	10	2.1	0.07	2.2	
					Raw sugar	10	0.60	< 0.05	0.6	
					Refined sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	28	0.07	< 0.05	0.07	
					Bagasse	28	< 0.05	< 0.05	< 0.05	
					Molasses	28	0.31	< 0.05	0.31	
					Raw sugar	28	< 0.05	< 0.05	< 0.05	
Arecibo, Puerto Rico (1977)	SL	1	0.56		Cane	10	< 0.05	< 0.05	< 0.05	MSL0264
					Bagasse	10	< 0.05	< 0.05	< 0.05	
					Molasses	10	0.16	< 0.05	0.16	
					Raw sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	28	< 0.05	< 0.05	< 0.05	
					Bagasse	28	< 0.05	< 0.05	< 0.05	
					Molasses	28	0.18	< 0.05	0.18	
					Raw sugar	28	< 0.05	< 0.05	< 0.05	
	SL	1	1.1		Cane	10	0.20	< 0.05	0.2	MSL0264
					Bagasse	10	0.18	< 0.05	0.18	
					Molasses	10	1.7	< 0.05	1.7	
					Raw sugar	10	0.25	< 0.05	0.25	
					Refined sugar	10	< 0.05	< 0.05	< 0.05	
					Cane	28	0.27	< 0.05	0.27	
					Bagasse	28	0.10	< 0.05	0.1	
					Molasses	28	1.6	0.07	1.7	
					Raw sugar	28	0.40	< 0.05	0.4	
					Refined sugar	28	< 0.05	< 0.05	< 0.05	

Table 65. Residues in Tree Nuts (nutmeat): Directed Ground Spray Application (USA).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Almond									
Esparto, California USA (1975)	SL	2	9.0 9.0		21	0.11	< 0.05	0.11	FR 442
	SL	3	9.0 9.0 9.0		1 14	0.12 0.05	< 0.05 < 0.05	0.12 0.05	FR 442
Fresno, California (1975)	SL	2	9.0 9.0		21	< 0.05	< 0.05	< 0.05	FR 442
	SL	3	9.0 9.0 9.0		1 14	0.11 0.83	< 0.05 < 0.05	0.11 0.83	FR 442
Fresno, California USA (1989) Mission	SL	1	8.9	3.2	3 10	0.10 0.06	< 0.05 < 0.05	0.10 0.06	MSL11011, MSL11519
Hughson, California USA (1989) Thompson	SL	1	8.9	7.4	3 10	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL11011, MSL11519

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Popular, California USA (1989) Mission	SL	1	8.9	3.7	3 10	0.58 0.50	< 0.05 < 0.05	0.58 0.50	MSL11011, MSL11519
Porterville, California USA (1989) Non-Pareil)	SL	1	8.9	3.4	3 10	< 0.05 0.15	< 0.05 < 0.05	< 0.05 0.15	MSL11011, MSL11519
Turlock, California USA (1989) Thompson	SL	1	8.9	6.8	3 10	0.06 0.05	< 0.05 < 0.05	0.06 0.05	MSL11011, MSL11519
Macadamia									
Waimanalo, Hawaii USA (1975)	SL	3	9.0 9.0 9.0		1 14	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	FR 442
Pecan									
Ft Valley, Georgia USA (1975)	SL	3	9.0 9.0 9.0		1 14	0.21 < 0.05	< 0.05 < 0.05	0.21 < 0.05	FR 442
Opelika, Alabama USA (1975)	SL	3	9.0 9.0 9.0		1	0.08	< 0.05	0.08	FR 442
Granbury, Texas USA (1975)	SL	3	9.0 9.0 9.0		23	0.06	< 0.05	0.06	FR 442
	SL	4	9.0 9.0 9.0 9.0		1 14	0.31 0.12	< 0.05 < 0.05	0.31 0.12	FR 442
Hawkinsville, Georgia USA (1989) Stuart	SL	1	8.9	4.7	3 10	0.14 < 0.05	< 0.05 < 0.05	0.14 < 0.05	MSL11011, MSL11519
College Station, Texas USA (1989) Desirable	SL	1	8.9	4.7	3 10	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL11011, MSL11519
Messilla, New Mexico USA (1989) Berton	SL	1	8.9	4.7	3 10	< 0.05 < 0.05	< 0.05 < 0.05	< 0.05 < 0.05	MSL11011, MSL11519
Walnut									
Esparto, California USA (1975)	SL	3	9.0 9.0 9.0		1 14	0.10 0.06	< 0.05 < 0.05	0.10 0.06	FR 442
Visalia, California USA (1975)	SL	3	9.0 9.0 9.0		1 14	0.07 0.07	< 0.05 < 0.05	0.07 0.07	FR 442
Fresno, California USA (1989) Franquette	SL	1	8.9	3.2	3 10	0.06 < 0.05	< 0.05 < 0.05	0.06 < 0.05	MSL11011, MSL11519
Hughson, California USA (1989) Hartley	SL	1	8.9	7.4	3 10	0.69 0.08	< 0.05 < 0.05	0.69 0.08	MSL11011, MSL11519
Popular, California USA (1989) Franquette	SL	1	8.9	3.7	3 10	0.44 0.20 c0.11	< 0.05 < 0.05	0.44 0.20 c0.11	MSL11011, MSL11519

Table 66. Residues in Conventional Cotton (cottonseed = fuzzy or non-delinted): Pre-emergence, Recirculating Sprayer and Pre-harvest Application (USA).

Location (year) variety	Type	Application			Form	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Malone, Florida USA (1974)	PRE PH	2	9.0 4.5		A	9	0.54	< 0.05	0.54	MSL 1283
Ropesville, Texas USA (1974)	PRE PH	2	9.0 4.5		B C	13	3.6	0.06	3.7	MSL 1283
Sasser, Georgia USA (1974)	PRE RCS RCS PH	4	9.0 6.7 6.7 4.5		B C D	9	2.7	0.08	2.8	MSL 1283
Mount Pleasant, Mississippi USA (1974)	PRE RCS RCS RCS PH	5	9.0 6.7 6.7 6.7 4.5		A C	13	2.9	0.06	3.0	MSL 1283
St. Joseph, Louisiana UDSA (1974)	PRE PRE RCS PH	4	9.0 9.0 11 4.5		A C	9	5.9 c0.2	0.07	6.0	MSL 1283
Five Points, California USA (1974)	PRE PH	2	9.0 4.5		B C	13	1.9	< 0.05	1.9	MSL 1283
Kernan, California USA (1975)	PH	1	5.0	2.2	A	10	0.49	0.06	0.58	MSL 1283
	PH	1	5.0	2.2	A	3	1.5 c0.06	< 0.05	1.5	MSL 1283
Weldon, North Carolina USA (1975)	PH	1	5.0	4.0	A	10	0.92	0.20	1.2	MSL 1283
	PH	1	5.0	4.0	A	3	2.0	< 0.05	2	MSL 1283
Cheneyville, Louisiana USA (1975)	PH	1	5.0	2.2	A	14	0.15	< 0.05	0.15	MSL 1283
	PH	1	5.0	2.2	A	7	2.2	< 0.05	2.2	MSL 1283
Sledge, Mississippi USA (1975)	PH	1	5.0	2.5	A	10	0.27	< 0.05	0.27	MSL 1283
	PH	1	5.0	2.5	A	5	0.63	< 0.05	0.63	MSL 1283
Ropesville, Texas USA (1975)	PH	1	5.0	2.2	A	10 3	0.47 0.26	< 0.05 < 0.05	0.47 0.26	MSL 1283
Dawson, Georgia USA (1975)	PH	1	5.0	2.2	A	8	2.9 c0.09	0.06	3.0	MSL 1283
	PH	1	5.0	2.2	A	3	4.1 c0.09	< 0.05	4.1	MSL 1283

Treatment types are: PRE = pre-emergence; RCS = Recirculating sprayer; PH = pre-harvest
*Formulations used at each site are listed A = MON 2139; B = MON 3139; C = MON 0139; D = MON 0011. All SL formulations. Not specified which formulation was used for each application.

Table 67. Residues in Glyphosate Tolerant Cotton (cottonseed: fuzzy or undelinted) (Roundup Ready Flex cotton – improved 2nd generation tolerant cotton (USA) – 3 different lines trialled (MON 88913, MON 88915, MON 88903), Roundup UltraMAX Herbicide (372 g ae/L) SL.

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Crittendon Co., Arkansas USA (2002) MON88913	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.4 0.95 0.42 0.95	80% open bolls	7	6.4	0.22	6.7	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	1.9 0.83 0.95	80% open bolls	7	13	0.40	14	MSL17635
MON88915	FWF FOB PH	3	3.3 1.7 1.7	1.9 0.83 0.95	80% open bolls	7	10	0.24	10	MSL17635
MON88903	FWF FOB PH	3	3.3 1.7 1.7	1.9 0.83 0.95	80% open bolls	7	12	0.35	13	MSL17635
Jackson Co., Arkansas USA (2002) MON88913	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.2 0.83 0.42 0.83	70-80% open bolls	6	3.6	0.11	3.8	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	1.7 0.83 0.83	70-80% open bolls	6	7.2	0.19	7.5	MSL17635
MON88915	FWF FOB PH	3	3.3 1.7 1.7	1.7 0.83 0.83	70-80% open bolls	6	6.9	0.14	7.1	MSL17635
MON88903	FWF FOB PH	3	3.3 1.7 1.7	1.7 0.83 0.83	70-80% open bolls	6	5.9	0.15	6.1	MSL17635
Pinal Co., Arizona USA (2002) MON88913	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.7 1.1 0.56 1.1	60-70% open bolls	7	12	0.26	12	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	2.2 1.1 1.1	60-70% open bolls	7	18	0.36	19	MSL17635
Tulare Co. California USA (2002) MON88913	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.7 1.1 0.56 1.1	80-100% open bolls	7	12	0.45	13	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	2.2 1.1 1.1	80-100% open bolls	7	18	0.77	19	MSL17635
MON88915	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.7 1.1 0.56 1.1	80-90% open bolls	7	18	0.70	19	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	2.2 1.1 1.1	80-90% open bolls	-1 1 7 14 21 35	12 14 17 12 12 12	0.62 0.72 0.71 0.67 0.67 0.59	13 15 18 13 13 13	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	2.2 1.1 1.1	80-100% open bolls	7	21	0.66	22	MSL17635
MON88903	FWF FOB PH	3	3.3 1.7 1.7	2.2 1.1 1.1	80-100% open bolls	7	16	0.56	17	MSL17635

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Clarke Co., Georgia USA (2002) MON88915	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.4 0.95 0.67 1.1	80% open bolls	8	5.7	0.14	5.9	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	1.9 1.3 1.1	80% open bolls	-0 1 8 15 22 35	6.5 9.9 7.1 5.2 5.4 7.5	0.16 0.35 0.20 0.15 0.18 0.25	6.7 10 7.4 5.4 5.7 7.9	MSL17635
Tift Co., Georgia USA (2002) MON88913	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.7 1.1 0.56 1.1	88-95% open bolls	6	7.9	0.29	8.3	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	2.2 1.1 1.1	88-95% open bolls	6	16	0.47	17	MSL17635
Washita Co. Oklahoma USA (2002) MON88913	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	2.5 1.1 0.67 1.1	25-30% open bolls	7	3.3	0.05	3.4	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	2.7 1.1 1.3	90% open bolls	7	18	0.34	19	MSL17635
Waller Co. Texas USA (2002) MON88913	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.2 0.83 0.42 0.83	80% open bolls	7	11	0.31	11	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	1.7 0.83 0.83	80% open bolls	7	22	0.40	23	MSL17635
Armstrong Co., Texas USA (2002) MON88913	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.4 1.1 0.56 1.1	80-85% open bolls	8	3.4	< 0.05	3.4	MSL17635
	FWF FOB PH	3	3.33 1.7 1.7	2.2 1.1 1.1	80-85% open bolls	8	9.7	0.07	9.8	MSL17635
Uvalde Co. Texas USA (2002) MON88913	LPO FWF FOB PH	4	2.50 1.7 0.84 1.7	1.7 0.83 0.56 1.1	75% open bolls	7	7.3	0.18	7.6	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	1.7 1.1 1.1	75% open bolls	7	13	0.31	13	MSL17635
MON88915	FWF FOB PH	3	3.3 1.7 1.7	1.7 1.1 1.1	75% open bolls	7	18	0.28	18	MSL17635
MON88903	FWF FOB PH	3	3.3 1.7 1.7	1.7 1.1 1.1	75% open bolls	7	14	0.28	14	MSL17635
Washington Co., Mississippi USA (2002) MON88903	6-8 Lf FWF FOB PH	4	2.5 1.7 0.84 1.7	1.4 1.3 0.56 1.1	90-95% open bolls	6	2.9	0.13	3.1	MSL17635
	FWF FOB PH	3	3.3 1.7 1.7	2.7 1.1 1.1	90-95% open bolls	6	4.9	0.15	5.1	MSL17635
Hockley Co., Texas USA (2002) MON88903	LPO FWF FOB PH	4	2.5 1.7 0.84 1.7	1.2 0.83 0.42 0.83	70% open bolls	7	13	0.15	13	MSL17635

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	FWF FOB PH	3	3.3 1.7 1.7	1.7 0.83 0.83	70% open bolls	7	28	0.28	28	MSL17635

Types of applications: LPO = Late post-emergence (6-8 leaf stage); FWF = First White Flower; FOB = First Open Boll; PH = Pre-harvest

AR1 – John Deere 9900 cotton picker; AR2- John Deere 699 cotton picker; AZ - International 728 Harvester (cotton picker); CA1 – samples collected by hand; CA2 – samples collected by hand; GA1 - John Deere 9930 cotton picker, spindle type; GA2 – samples collected by hand; MS – modified International 622 spindle picker; OK – John Deere 33 row stripper and by hand; TX1 – Farmall-McCormick 4M-120 spindle picker; TX2 - John Deere 33 cotton stripper; TX3 - John Deere 33 cotton stripper; TX4 - John Deere 9900 spindle type cotton picker

Bolls open at harvest ranged 70-80% to 97-99% at the plots with the exception of OK which only had 25-30% bolls open at harvest.

Table 68. Residues in Glyphosate Tolerant Cotton genotype1445 and 1698 (USA) (cottonseed: fuzzy or undelinted) (Formulation 410 g/L glyphosate isopropylamine salt SL= 307 g ae/L).

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Houston Co. Alabama USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.7 0.63 0.63 0.75	70% Bolls Open	7	0.46 c0.05	< 0.05	0.46 c0.05	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.7 0.42 0.63 0.63 0.75	70% Bolls Open	7	0.46 c0.05	< 0.05	0.46	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.7 0.42 0.63 0.84 0.75	70% Bolls Open	7	0.44 c0.05	< 0.05	0.44 c0.05	MSL13884
Crittenden Co. Arkansas USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	3.4 1.0 0.72 1.3	70% Bolls Open	8	0.41	0.21	0.73	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	3.4 0.67 1.3 0.72 1.3	70% Bolls Open	8	0.33	0.06	0.42	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	3.4 0.67 1.3 0.96 1.3	70% Bolls Open	8	0.43	< 0.05	0.43	MSL13884
1698	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	3.4 1.0 0.72 1.3	70% Bolls Open	8	0.67	< 0.05	0.67	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	3.4 0.67 1.3 0.72 1.3	70% Bolls Open	8	0.58	< 0.05	0.58	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	3.4 0.67 1.3 0.96 1.3	70% Bolls Open	8	0.69	< 0.05	0.69	MSL13884

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Maricopa Co. Arizona USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.9 0.63 0.72 0.84	Maturity	7	1.3	0.06	1.4	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.9 0.42 0.72 0.72 0.84	Maturity	7	0.43	< 0.05	0.43	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.9 0.42 0.72 0.96 0.84	Maturity	7	1.0	< 0.05	1.0	MSL13884
Tulare Co. California USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 0.84 0.84 1.1	Maturity	6	2.8	0.08	2.9	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.56 0.84 0.84 1.1	Maturity	6	2.0	0.07	2.1	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.56 0.84 1.1 1.1	Maturity	6	1.4	0.08	1.5	MSL13884
St Landry Co. Louisiana USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 1.3 1.3 1.7		17	0.43	< 0.05	0.43	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.84 1.3 1.3 1.7		17	0.50	0.05	0.58	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.84 1.3 1.7 1.7		17	0.40	< 0.05	0.40	MSL13884
1698	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 1.3 1.3 1.7		17	0.44	< 0.05	0.44	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.84 1.3 1.3 1.7		17	0.30	< 0.05	0.30	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.84 1.3 1.7 1.7		17	0.30	< 0.05	0.30	MSL13884
Bolivar Co. Mississippi USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 1.0 1.0 1.1	Mature	6	3.6 c0.05	0.07	3.7	MSL13884

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.67 1.0 1.0 1.1	Mature	6	3.4 c0.05	0.05	3.5 c0.05	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.67 1.0 1.3 1.1	Mature	6	0.69 c0.05	< 0.05	0.69 c0.05	MSL13884
Washington Co. Mississippi USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.7 0.63 1.0 1.1	Open Bolls	9	0.43	< 0.05	0.43	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.7 0.42 0.72 1.0 1.1	Open Bolls	9	0.41	< 0.05	0.41	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.7 0.42 1.0 1.3 1.1	Open Bolls	9	0.13	< 0.05	0.13	MSL13884
1698	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.7 0.63 1.0 1.1	Open Bolls	9	1.2	< 0.05	1.2	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.7 0.42 0.72 1.0 1.1	Open Bolls	9	0.98	< 0.05	0.98	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.7 0.42 1.0 1.3 1.1	Open Bolls	9	0.60	< 0.05	0.60	MSL13884
Fayette Co. Tennessee USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	3.4 1.0 0.72 1.3	70% Bolls Open	8	2.1	0.10	2.3	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	3.4 0.67 1.0 0.72 1.3	70% Bolls Open	8	5.0	0.13	5.2	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	3.4 0.67 1.3 0.96 1.3	70% Bolls Open	8	2.5	< 0.05	2.5	MSL13884
Uvalde Co. Texas USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.7 1.3 1.3 1.3	60% Bolls Open	6	2.0	< 0.05	2.0	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.7 0.84 1.0 1.3 1.3	60% Bolls Open	6	2.1	< 0.05	2.1	MSL13884

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE	5	3.4	2.7	60%	6	2.4	< 0.05	2.4	MSL13884
	EPO		0.84	0.84	Bolls					
	LPO		1.3	1.3	Open					
	PD		1.7	1.7						
	PH		1.7	1.3						
1698	PRE	4	3.4	2.7	60%	6	2.5	< 0.05	2.5	MSL13884
	EPO		1.3	1.3	Bolls					
	PD		1.3	1.3	Open					
	PH		1.7	1.3						
	PRE	5	3.4	2.7	60%	6	2.1	< 0.05	2.1	MSL13884
	EPO		0.84	0.84	Bolls					
	MPO		1.3	1.0	Open					
	PD		1.3	1.3						
	PH		1.7	1.3						
	PRE	5	3.4	2.7	60%	6	1.8	< 0.05	1.8	MSL13884
	EPO		0.84	0.84	Bolls					
	LPO		1.3	1.3	Open					
	PD		1.7	1.7						
	PH		1.7	1.3						
Willacy Co. Texas USA (1994) 1445	PRE	4	3.4	1.7	Maturity	8	2.5	< 0.05	2.5	MSL13884
	EPO		1.3	0.63						
	PD		1.3	0.63						
	PH		1.7	0.84						
	PRE	5	3.4	1.7	Maturity	8	2.7	< 0.05	2.7	MSL13884
	EPO		0.84	0.42						
	MPO		1.3	0.63						
	PD		1.3	0.63						
	PH		1.7	0.84						
	PRE	5	3.4	1.7	Maturity	8	3.0	< 0.05	3.0	MSL13884
	EPO		0.84	0.42						
	LPO		1.3	0.63						
	PD		1.7	0.84						
	PH		1.7	0.84						
1698	PRE	4	3.4	1.7	Maturity	8	4.0 c0.09	0.14	4.2	MSL13884
	EPO		1.3	0.63						
	PD		1.3	0.63						
	PH		1.7	0.84						
	PRE	5	3.4	1.7	Maturity	8	4.2 c0.09	0.14	4.4	MSL13884
	EPO		0.84	0.42						
	MPO		1.3	0.63						
	PD		1.3	0.63						
	PH		1.7	0.84						
	PRE	5	3.4	1.7	Maturity	8	4.0 c0.09	0.13	4.2	MSL13884
	EPO		0.84	0.42						
	LPO		1.3	0.63						
	PD		1.7	0.84						
	PH		1.7	0.84						
Hockley Co Texas USA (1994) 1445	PRE	4	3.4	2.2	Maturity	7	1.7	< 0.05	1.7	MSL13884
	EPO		1.3	0.84						
	PD		1.3	0.84						
	PH		1.7	1.1						
	PRE	5	3.4	2.2	Maturity	7	2.8	< 0.05	2.8	MSL13884
	EPO		0.84	0.56						
	MPO		1.3	0.84						
	PD		1.3	0.84						
	PH		1.7	1.1						
	PRE		3.4	2.2	Maturity	7	4.6	< 0.05	4.6	MSL13884
	EPO		0.84	0.56						
	LPO		1.3	0.84						
	PD		1.7	1.1						
	PH		1.7	1.1						

Application types: PRE = Pre-emergence; EPO = Early Post-emergence; MPO = Mid-Post-emergence; LPO = Late Post-emergence; PD = Post-Directed; PH = Pre-harvest

AL – hand harvested, processed research-type gin; AR – Mechanical John Deere 99 cotton picker, 10 saw gin; AZ – hand harvested, research type gin; CA – Hand harvested, research type gin; LA – mechanical IH 622 cotton picker, 20 saw table top gin; MS1 – Hand harvested research type gin; MS2 – hand harvested research type gin; TN - mechanical IH 416 row picker, research type gin; TX1 – Mechanical John Deere 9900 picker, Dennis 20 saw gin; TX2 – Mechanical picker, Denis 20 saw gin; TX3 – Hand harvested, Dennis 20 saw gin.
Gin BP from the Arkansas and Tennessee trial sites were collected from gin material while the other sites were simulated gin BP by collecting a mixture of leaves, burs and stems.
AR – Mechanical John Deere 99 cotton picker, 10 saw gin; LA – mechanical IH 622 cotton picker, 20 saw table top gin; MS – hand harvested research type gin; TX1 – Mechanical John Deere 9900 picker, Dennis 20 saw gin; TX2 – Mechanical picker, Denis 20 saw gin.
Gin BP from the Arkansas trial site were collected from gin material while the other sites were simulated gin BP by collecting a mixture of leaves, burs and stems.

Table 69. Residues in linseed (flax): Pre-harvest Application (United Kingdom).

Location (year) variety	Form	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Tetsworth, Oxfordshire, UK (1993) Antares	SL	1	1.4	0.70	Seed	7	2.0			GLY 267, GLY 296
		1	0.72	0.36	Seed	7	0.61			GLY 267, GLY 296
Melbourne, Derbyshire, UK (1992) Flanders	SL	1	1.4	0.70	Seed	7	4.6			GLY 134, GLY 218
		1	0.72	0.36	Seed	7	1.9			GLY 134, GLY 218
Arbroath, UK (1982) Regina	SL	1	1.4	0.72	Seeds Capsules Cake Oil Stems	5 5 5 5 50	1.3 c0.65 250 c2.8 2.1 < 0.05 0.8 c0.1	< 0.05 1.2 < 0.05 < 0.05 0.06	1.3 252 2.1 < 0.05 0.89 c0.1	ML30106
		1	2.9	1.4	Seeds Capsules Cake Oil Stems	5 5 5 5 50	2.2 c0.65 230 c2.8 2.4 < 0.05 1.9 c0.1	< 0.05 1.8 < 0.05 < 0.05 0.13	2.2 233 2.4 < 0.05 2.1	ML30106
		1	1.4	0.72	Stems	82	1.0 c0.1	< 0.05	1.0	ML30106
		1	2.8	1.4	Stems	82	1.5 c0.1	0.06	1.6	ML30106
Backboath, UK (1982) Hera	SL	1	1.4	0.72	Seeds Capsules Cake Oil Stems	5 5 5 5 40	1.1 c1.6 103 c1.1 1.6 < 0.05 0.8 c0.05	< 0.05 1.0 < 0.05 < 0.05 0.07	1.1 105 1.6 < 0.05 0.91	ML30106
		1	2.9	1.4	Seeds Capsules Cake Oil Stems	5 5 5 5 40	3.5 c1.6 85 c1.1 6.3 < 0.05 0.9 c0.05	< 0.05 3.2 < 0.05 < 0.05 0.10	3.5 90 6.3 < 0.05 1.1	ML30106
		1	1.4	0.72	Stems	72	0.8 c0.05	0.07	0.91	ML30106
		1	2.9	1.4	Stems	72	1.2 c0.05	0.16	1.4	ML30106
Lisburn, Ireland (1982) Reina	SL	1	1.4	0.58	Seeds Capsules Fibres Shives	35 35 35 35	24 22 6.6 c0.2 2.7	0.31 0.8 0.23 0.10	24 23 7.0 2.9	ML30106

Location (year) variety	Form	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
		1	2.9	1.2	Seeds	35	24	0.26	24	ML30106
					Capsules	35	22	0.4	23	
					Fibres	35	6.3 c0.2	0.09	6.4	
					Shives	35	3.6	0.06	3.7	
		1	1.4	0.58	Seeds	46	128	1.3	130	ML30106
					Capsules	46	44	0.8	45	
					Fibres	46	6.2 c0.2	0.18	6.5	
					Shives	46	2.2	0.05	2.3	
			2.9	1.2	Seeds	46	189	1.9	192	ML30106
					Capsules	46	45	0.9	46	
					Fibres	46	5.9 c0.2	0.21	6.2	
					Shive	46	3.4	0.11	3.6	

Table 70. Residues in Mustard seed (entire grain): Pre-harvest Application (United Kingdom).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Bixley, Norwich, UK (1980) Newton	SL	1	1.4	0.7	8	0.25	< 0.05	0.25	ML30104
		1	2.9	1.4	8	0.5	< 0.05	0.5	ML30104
Long Sutton, Lincolnshire, UK (1980) Tilney	SL	1	1.4	0.7	7	2.6	< 0.05	2.6	ML30104
		1	2.9	1.4	7	3.2	< 0.05	3.2	ML30104

Table 71. Residues in Rape/Canola (seed): Pre-harvest Application, single spray of glyphosate formulations.

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Franc-Waret, Belgium (1999) Olara	A	1	1.4	0.72	0 12	5.4 4.6	< 0.05 < 0.05	5.4 4.6	MLL31336
	C	1	1.4	0.72	0 12	2.8 0.40	< 0.05 < 0.05	2.8 0.40	MLL31336
Franc-Waret, Belgium (1998) Synergie	A	1	1.3	0.65	0 14	1.7 c0.18 0.23	< 0.05 < 0.05	1.7 c0.18 0.23	MLL30817
	D	1	1.4	0.70	0 14	2.7 c0.18 0.12	< 0.05 < 0.05	2.7 c0.18 0.12	MLL30817
Elm Creek, Manitoba, Canada (2001) Ebony	A	1	0.90	-	7	1.1, 1.3	< 0.05, < 0.05	1.1, 1.3	CER 1403/01
	B	1	0.90	-	7	1.1, 2.1	< 0.05, < 0.05	1.1, 2.1	CER 1403/01
Vanscoy, Saskatchewan, Canada (2001) Clearfield	A	1	0.90	-	7	0.52, 0.61	< 0.05, < 0.05	0.52, 0.61	CER 1403/01
	B	1	0.90	-	7	0.33, 0.54	< 0.05, < 0.05	0.33, 0.54	CER 1403/01
Kipp, Alberta, Canada (2001) Q2	A	1	0.90	-	6	2.2, 2.6	0.053, 0.052	2.3, 2.7	CER 1403/01

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	B	1	0.90	-	6	3.6, 3.1	0.07, < 0.05	3.7, 3.1	CER 1403/01
Minto, Manitoba, Canada (2001) 46A76	A	1	0.90	-	7	0.54, 0.33	< 0.05, < 0.05	0.54, 0.33	CER 1403/01
Lacombe, Alberta Canada (2001) Reward	A	1	0.90	-	7	1.6, 1.8	< 0.05, < 0.05	1.6, 1.8	CER 1403/01
Denmark (1981) Line	C	1	1.4	0.72	17	10	0.05	10	ML30104
Denmark (1981) Sulliver	C	1	1.4	0.72	17	12	0.10	12	ML30104
Hasley Denmark (1982) Hasley	C	1	1.4	0.72	21	8.6	< 0.05	8.6	ML30104
Horsens Denmark (1982) Brutor	C	1	1.4	0.72	21	6.7	< 0.05	6.7	ML30104
Slaselse Denmark (1982) Karat	C	1	1.4	0.72	21	4.1	< 0.05	4.1	ML30104
Finland (1981) Torch	C	1	1.4	0.72	7 14	6.3 1.5	0.08 0.06	6.4 1.6	ML30104
Finland (1981) Oro	C	1	1.4	0.72	2 20	4.3 0.8	0.07 < 0.05	4.4 0.8	ML30104
Duras, Aquitaine, France (1999) Corrida	A	1	1.4	0.81	0 10	1.4 0.23	< 0.05 < 0.05	1.4 0.23	MLL31336
	C	1	1.4	0.82	0 10	2.3 0.08	< 0.05 < 0.05	2.3 0.08	MLL31336
St Paul les Romans, Rhône-Alpes, France (1999) Bristol	A	1	1.5	0.82	0 13	2.4 1.2	< 0.05 < 0.05	2.4 1.2	MLL31336
	C	1	1.5	0.82	0 13	1.3 1.4	< 0.05 < 0.05	1.3 1.4	MLL31336
Levroux, Centre, France (1999) Pollen	A	1	1.5	0.82	0 17	2.9 0.86	< 0.05 < 0.05	2.9 0.86	MLL31336
	C	1	1.4	0.82	0 17	2.3 0.96	< 0.05 < 0.05	2.3 0.96	MLL31336
Seebach, Alsace, France (1998) Capitol	A	1	1.4	0.82	0 11	6.5 0.32	< 0.05 < 0.05	6.5 0.32	MLL31336
	C	1	1.4	0.82	0 11	1.9 0.35	< 0.05 < 0.05	1.9 0.35	MLL31336
Fessenheim, Alsace, France (1999) Coctail	A	1	1.4	0.82	0 10	6.6 0.87	< 0.05 < 0.05	6.6 0.87	MLL31336
	C	1	1.5	0.82	0 10	5.8 0.54	< 0.05 < 0.05	5.8 0.54	MLL31336
Duras, Aquitaine, France (1998) Mavaja	A	1	1.5	0.71	0 12	3.4 0.40	< 0.05 < 0.05	3.4 0.40	MLL30817
	D	1	1.5	0.70	0 12	3.1 0.93	< 0.05 < 0.05	3.1 0.93	MLL30817

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
St Paul les Romans, Rhône-Alpes, France (1998) Cocktail	A	1	1.5	0.71	0 10	21 1.8	0.07 < 0.05	21 1.8	MLL30817
	D	1	1.5	0.74	0 10	19 5.6	0.07 0.07	19 5.7	MLL30817
Levroux, Centre, France (1998) Contact	A	1	1.5	0.74	0 10	0.80 0.32	< 0.05 < 0.05	0.80 0.32	MLL30817
	D	1	1.5	0.74	0 10	1.4 0.50	< 0.05 < 0.05	1.4 0.50	MLL30817
Vaudemont, Alsace, France (1998) Colombus	A	1	1.4	0.72	0 14	0.98 0.06	< 0.05 < 0.05	0.98 0.06	MLL30817
	D	1	1.4	0.71	0 14	2.1 0.21	< 0.05 < 0.05	2.1 0.21	MLL30817
Fessenheim, Alsace, France (1998) Lisabeth	A	1	1.4	0.73	0 10	2.0 1.9	< 0.05 < 0.05	2.0 1.9	MLL30817
	D	1	1.5	0.74	0 10	4.6 1.5	< 0.05 < 0.05	4.6 1.5	MLL30817
Sweden (1981) Skaberjo	C	1	0.72	0.36	16	1.1 c0.2	0.09 c0.06	1.2	ML30104
		1	1.1	0.54	16	1.8 c0.2	0.15 c0.06	2.0	ML30104
		1	1.4	0.72	16	2.8 c0.2	0.13 c0.06	3.0	ML30104
Sweden (1981) Svalof	C	1	1.4	0.72	10	0.4	< 0.05	0.40	ML30104
Sweden (1980)	C	1	1.4	0.72	18	2.0 c0.1	< 0.05	2.0	ML30104
		1	2.2	1.01	18	1.4 c0.1	< 0.05	1.4	ML30104
Wilson, Derbyshire UK (1992) Lictor	A	1	1.4	0.72	0 14	4.5 c0.2 0.9	< 0.05 < 0.05	4.5 c0.2 0.9	MLL30321
	A	1	2.9	1.4	0 14	4.9 c0.2 1.8	< 0.05 < 0.05	4.9 c0.2 1.8	MLL30321
	E	1	1.4	0.72	0 14	4.8 c0.2 0.9	< 0.05 < 0.05	4.8 c0.2 0.9	MLL30321
	E	1	2.9	1.4	0 14	12 c0.2 2.5	< 0.05 < 0.05	12 c0.2 2.5	MLL30321
	F	1	1.5	0.74	0 14	7.3 c0.2 0.9	< 0.05 < 0.05	7.3 c0.2 0.9	MLL30321
	F	1	2.9	1.5	0 14	13 c0.2 2.6	0.1 < 0.05	13 2.6	MLL30321
Wintringham, Yorkshire UK (1992) Samuri	A	1	1.4	0.72	0 14	3.6 c0.1 0.4	< 0.05 0.2	3.6 0.70	MLL30321
	A	1	2.9	1.4	0 14	23 c0.1 1.1	< 0.05 < 0.05	23 c0.1 1.1	MLL30321
	E	1	1.4	0.72	0 14	5.0 0.4	0.1 < 0.05	5.2 0.4	MLL30321
	E	1	2.9	1.4	0 14	28 c0.1 1.3	< 0.05 < 0.05	28 c0.1 1.3	MLL30321
	F	1	1.5	0.74	0 14	8.0 c0.1 0.7	0.1 < 0.05	8.2 0.7	MLL30321
	F	1	2.9	1.5	0 14	45 c0.1 1.0	< 0.05 < 0.05	45 c0.1 1.0	MLL30321
Terling, Essex UK (1992) Falcon	A	1	1.4	0.72	0 14	4.2 0.7	< 0.05 < 0.05	4.2 0.7	MLL30321
	A	1	2.9	1.4	0 14	5.8 0.9	< 0.05 < 0.05	5.8 0.9	MLL30321

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	E	1	1.4	0.72	0 14	4.7 0.5	< 0.05 < 0.05	4.7 0.5	MLL30321
	E	1	2.9	1.4	0 14	8.8 0.9	< 0.05 < 0.05	8.8 0.9	MLL30321
	F	1	1.5	0.74	0 14	3.1 0.6	< 0.05 < 0.05	3.1 0.6	MLL30321
	F	1	2.9	1.5	0 14	18 0.7	0.1 < 0.05	18 0.7	MLL30321
Burnham on Crouch, Essex UK (1992) Lictor	A	1	1.4	0.72	0 14	6.9 0.4	< 0.05 < 0.05	6.9 0.4	MLL30321
	A	1	2.9	1.4	0 14	7.3 0.3	< 0.05 < 0.05	7.3 0.3	MLL30321
	E	1	1.4	0.72	0 14	3.1 0.3	< 0.05 < 0.05	3.1 0.3	MLL30321
	E	1	2.9	1.4	0 14	5.8 1.2	< 0.05 < 0.05	5.8 1.2	MLL30321
	F	1	1.5	0.74	0 14	6.6 0.4	< 0.05 < 0.05	6.6 0.4	MLL30321
	F	1	2.9	1.5	0 14	10 1.0	< 0.05 < 0.05	10 1.0	MLL30321
Bottisham, Cambridgeshire UK (1982) Brutor	C	1	1.4	0.72	14	0.16	< 0.05	0.16	ML30104
		1	2.9	1.4	14	0.48	< 0.05	0.48	ML30104
Easton Cambridgeshire UK (1982) Jet Neuf	C	1	1.4	0.72	14	1.5	< 0.05	1.5	ML30104
		1	2.9	1.4	14	3.2	< 0.05	3.2	ML30104
Easton Cambridgeshire UK (1982) Jet Neuf	C	1	1.4	0.72	14	2.7	< 0.05	2.7	ML30104
		1	2.9	1.4	14	4.0	< 0.05	4.0	ML30104
Cattenham, Cambridgeshire UK (1980) Jet Neuf.	C	1	0.72	0.36	7	0.30	< 0.05	0.30	ML30104
		1	1.4	0.72	7	0.60	< 0.05	0.60	ML30104
		1	2.9	1.4	7	1.8	< 0.05	1.8	ML30104
Sheardown, Grantham, Lincolnshire, UK (1980) Brutor	C	1	1.4	0.72	11	0.35	< 0.05	0.35	ML30104
		1	2.9	1.4	11	0.95	< 0.05	0.95	ML30104
UK – Cliffield 30058-1980	C	1	1.4	0.72	11	0.80	< 0.05	0.80	ML30104

Formulations A = 360 g ae/L SL; B = 440 g ae/L as trimesium salt+surfactant Rely 0.5% v/v; C = MON 78294 (450 g/L SL); D = MON 14420 (680 g/kg SG); Formulation E = MON 52276 (360 g/L = SL); F = MON 44068 (420 g/kg = SG)

Table 72. Residues of glyphosate in Sunflower seed (Hungary).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Enying, Fejér Co., Hungary (2000) Alexandra	SL	1	0.70	0.48	7 14 21	0.20 0.13 0.18			00 MON AA 0504
	SL	1	1.7	1.2	7 14 21	1.3 0.99 3.7			00 MON AA 0504
Kápolnásnyék, Fejér Co., Hungary (2000) Arena	SL	1	0.68	0.47	7 14 21	2.9 8.4 8.6			00 MON AA 0504
	SL	1	1.8	1.2	7 14 21	13 16 5.6			00 MON AA 0504
Bőcs, Borsod-Abaúj-Zemplén Co., Hungary (2000) EX-399	SL	1	0.71	0.48	7 14 21	0.21 < 0.05 < 0.05			00 MON AA 0504
	SL	1	1.8	1.2	7 14 21	0.35 0.65 0.16			00 MON AA 0504
Felsőzsolca, Borsod-Abaúj-Zemplén Co., Hungary (2000) Util	SL	1	0.75	0.48	7 14 21	0.46 0.65 0.74			00 MON AA 0504
	SL	1	1.8	1.1	7 14 21	4.5 5.4 4.9			00 MON AA 0504
Nyíregyháza, Szabolcs-Szatmár-Bereg Co., Hungary (2000) Semu	SL	1	0.70	0.24	7 14 21	0.55 0.35 0.27			00 MON AA 0504
	SL	1	1.8	0.6	7 14 21	0.75 1.8 0.40			00 MON AA 0504
Kápolnásnyék, Fejér Co., Hungary (1999) Arena	SL	1	0.72	0.49	7 14 21	0.91 0.56 0.20	0.13 < 0.05 < 0.05	1.1 0.56 0.20	99 GLY 01
	SL	1	1.6	1.2	7 14 21	1.3 1.5 0.39	< 0.05 < 0.05 < 0.05	1.3 1.5 0.39	99 GLY 01
Nyíregyháza, Szabolcs-Szatmár-Bereg Co., Hungary (1999) Semu	SL	1	0.76	0.46	7 14 21	< 0.05 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05	99 GLY 01
	SL	1	1.9	1.2	7 14 21	0.10 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05	0.10 < 0.05 < 0.05	99 GLY 01
Nyíregyháza, Szabolcs-Szatmár-Bereg Co., Hungary (1999) Util	SL	1	0.81	0.47	7 14 21	< 0.05 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05	99 GLY 01
	SL	1	1.9	1.2	7 14 21	0.09 < 0.05 < 0.05	< 0.05 < 0.05 < 0.05	0.09 < 0.05 < 0.05	99 GLY 01

Table 73. Residues in Coffee: Directed Ground Spray Application (Brazil, Colombia, Costa Rica, USA).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Sao Paulo, Brazil (1973)	SL	1	4.5		Green beans	14	< 0.05	< 0.05	< 0.05	FR 434
					Green beans	28	< 0.05	< 0.05	< 0.05	
					Green beans	56	< 0.05	< 0.05	< 0.05	
		2	4.5 4.5		Green beans	84	< 0.05	< 0.05	< 0.05	FR 434
Cali, Columbia (1972)	SL	1	2.2		Green beans	8	0.71	< 0.05	0.71	FR 434
					Green beans	21	0.57	< 0.05	0.57	
					Green beans	49	0.27	< 0.05	0.27	
					Roasted	49	0.07	< 0.05	0.07	
					beans	49	0.23	< 0.05	0.23	
					Instant coffee					
		2	2.2 2.2		Green beans	1	0.11	< 0.05	0.11	FR 434
		1	4.5		Green beans	8	0.41	< 0.05	0.41	FR 434
					Green beans	21	0.24	< 0.05	0.24	
					Green beans	49	0.30	< 0.05	0.30	
					Roasted	49	0.11	< 0.05	0.11	
					beans	49	0.34	< 0.05	0.34	
					Instant coffee					
		2	4.5 4.5		Green beans	1	0.62	< 0.05	0.62	FR 434
Kona Branch Station, Hawaii USA (1972/3)	SL	1	2.2		Green beans	14	< 0.05	< 0.05	< 0.05	FR 434
					Green beans	27	< 0.05	< 0.05	< 0.05	
					Green beans	53	0.38	< 0.05	0.38	
		2	2.2 2.2		Green beans	1	0.08	< 0.05	0.08	FR 434
					Green beans	27	0.31	< 0.05	0.31	
					Green beans	56	0.11	< 0.05	0.11	
		1	4.5		Green beans	14	< 0.05	< 0.05	< 0.05	FR 434
					Green beans	27	0.07	< 0.05	0.07	
					Green beans	53	0.16	< 0.05	0.16	
		2	4.5 4.5		Green beans	1	0.35	< 0.05	0.35	FR 434
					Green beans	28	0.58	< 0.05	0.58	
					Roasted	28	0.06	< 0.05	0.06	
					beans	28	0.20	< 0.05	0.20	
					Instant coffee	57	0.27	< 0.05	0.27	
					Green beans					
San Jose, Costa Rica (1972)	SL	1	4.5		Green beans	14	< 0.05	< 0.05	< 0.05	FR 434
					Green beans	28	< 0.05	< 0.05	< 0.05	
					Green beans	56	< 0.05	< 0.05	< 0.05	
		2	4.5 4.5		Green beans	1	< 0.05	< 0.05	< 0.05	FR 434
					Green beans	28	< 0.05	< 0.05	< 0.05	
					Green beans	56	< 0.05	< 0.05	< 0.05	

Roasted beans were prepared in the laboratory. Instant coffee was prepared from roasted beans by percolator-extraction and the solution dried to simulate commercial practices (limited details provided)

Table 74. Residues in Tea: Directed Ground Spray Application.

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Kyoto, Japan (1990) Kyouken No. 129	SL	3	4.5 4.5 4.5	0.90 0.90 0.90	Tea, ground	3	0.11	< 0.02	0.11	Takano and Fuji 1991
					Tea, hot water steeping)		0.13	< 0.02	0.13	Takano and Fuji 1991

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Kagoshima, Japan (1990) Okumidori	SL	3	4.5 4.5 4.5	0.90 0.90 0.90	Tea, ground	7	0.04	< 0.02	0.04	Takano and Fuji 1991
					Tea, hot water steeping		0.02	< 0.02	0.02	Takano and Fuji 1991
Wategoda Estate, Talawakale, Sri Lanka (1980)	SL	1	2.2		Tea (black)	1 7 14	1.7 c0.18 0.42 0.26	< 0.08 < 0.08 < 0.08	1.7 c0.18 0.42 0.26	MSL01582
		2	2.2 2.2		Tea (black)	1 7 14	2.9 1.2 0.36	< 0.08 < 0.08 < 0.08	2.9 1.2 0.36	MSL01582
		3	2.2 2.2 2.2		Tea (black)	1 7 14	1.9 0.40 c0.17 0.33 c0.17	< 0.08 < 0.08 < 0.08	1.9 0.40 c0.17 0.33 c0.17	MSL01582
Wategoda Estate, Talawakale, Sri Lanka (1980)	SL	1	2.2		Tea (black)	1 7 14	0.94 0.12 0.21	< 0.08 < 0.08 < 0.08	0.94 0.12 0.21	MSL01582
		2	2.2 2.2		Tea (black)	1 7 14	1.9 1.3 0.36	< 0.08 < 0.08 < 0.08	1.9 1.3 0.36	MSL01582
		3	2.2 2.2 2.2		Tea (black)	1 7 14	2.4 0.44 0.26	0.08 < 0.08 < 0.08	2.5 0.44 0.26	MSL01582
St. Coombs, Tri, Talawakale, Sri Lanka (1980)	SL	1	2.2		Tea (black)	1 7 14	0.73 0.12 0.11	< 0.08 < 0.08 < 0.08	0.73 0.12 0.11	MSL01582
		2	2.2 2.2		Tea (black)	1 7 14	2.9 0.41 0.17	< 0.08 < 0.08 < 0.08	2.9 0.41 0.17	MSL01582
		3	2.2 2.2 2.2		Tea (black)	1 7 14	0.84 0.42 0.24	< 0.08 < 0.08 < 0.08	0.84 0.42 0.24	MSL01582
St. Coombs, Tri, Talawakale, Sri Lanka (1980)	SL	1	2.2		Tea (black)	1 7 14	1.8 0.27 0.13	< 0.08 < 0.08 < 0.08	1.8 0.27 0.13	MSL01582
		2	2.2 2.2		Tea (black)	1 7 14	9.6 0.81 0.26	< 0.08 < 0.08 < 0.08	9.6 0.81 0.26	MSL01582
		3	2.2 2.2 2.2		Tea (black)	1 7 14	2.2 0.66 0.20	< 0.08 < 0.08 < 0.08	2.2 0.66 0.20	MSL01582
Tocklai Tea Estate, Tocklai Division, Jorhat, Assam, India (1977)	SL	3		2.2 2.2 2.2	Tea (black)	1A 1B 1C 14	< 0.08 0.15 0.35 < 0.08	< 0.08 < 0.08 < 0.08 < 0.08	< 0.08 0.15 0.35 < 0.08	MSL0980
		3		6.5 6.5 6.5	Tea (black)	1A 1B 1C 14	0.40 0.18 0.75 0.11	< 0.08 < 0.08 < 0.08 0.08	0.40 0.18 0.75 0.23	MSL0980

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Tocklai Tea Estate, Cinnamara Division (1977)	SL	3		2.2 2.2 2.2	Tea (black)	1A 1B 1C 14	0.09 < 0.08 0.25 < 0.08	0.11 < 0.08 < 0.08 < 0.08	0.26 < 0.08 0.25 < 0.08	MSL0980
Jorhat, Assam, India		3		6.5 6.5 6.5	Tea (black)	1A 1B 1C 14	0.43 0.10 1.2 0.11	< 0.08 < 0.08 0.08 < 0.08	0.43 0.10 1.3 0.11	MSL0980
Lin-Kou, Taiwan (1978)	SL	3		2.2 2.2 2.2	Tea (black)	1A 1B 1C 15	< 0.08 0.11 0.20 0.10	< 0.08 < 0.08 < 0.08 < 0.08	< 0.08 0.11 0.20 0.10	MSL0980
		3		6.5 6.5 6.5	Tea (black)	1A 1B 1C 15	0.21 0.56 1.1 0.24	< 0.08 < 0.08 < 0.08 < 0.08	0.21 0.56 1.1 0.24	MSL0980
Holyrood Estate, Talawakale, Sri Lanka (1978)	SL	3		2.2 2.2 2.2	Tea (black)	1A 1B 1C 8 15	2.1 7.4 2.6 0.80 0.43	< 0.08 < 0.08 < 0.08 < 0.08 < 0.08	2.1 7.4 2.6 0.80 0.43	MSL0980
		3		6.5 6.5 6.5	Tea (black)	1A 1B 1C 8 15	2.4 2.8 14 1.1 0.53	0.09 < 0.08 < 0.08 < 0.08 < 0.08	2.5 2.8 14 1.1 0.53	MSL0980
St Coombs, Tri, Talawakale, Sri Lanka (1977)	SL	3		2.2 2.2 2.2	Tea (black)	1A 1B 1C 8 15	0.24 12 4.5 0.64 0.32	< 0.08 < 0.08 0.08 < 0.08 < 0.08	0.24 12 4.6 0.64 0.32	MSL0980
		3		6.5 6.5 6.5	Tea (black)	1A 1B 1C 8 15	1.2 17 5.7 0.82 0.23	0.08 0.22 0.11 < 0.08 < 0.08	1.3 17 5.9 0.82 0.23	MSL0980

1A = 1 day after 1st spray, 1B = 1 day after 2nd spray and 1C = 1 day after 3rd spray.
Processed tea (Sri Lanka trials) withered 4-6 hours (reduces moisture from ca. 75% to ca. 35%), rolling (partial grinding), sifting to remove midribs and other large leaf sections, roll breaking to grind to into smaller pieces, fermentation, firing to reduce the moisture content from ca 25% to 3% in a dryer. All Sri Lankan trials are for processed tea.

Table 75. Residues in Conventional Alfalfa (forage and hay): Pre-harvest Application.

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Brantford, Ontario Canada (1992)	SL	1	0.91	0.82	Hay	3 (3)	30	0.28	30	MSL12617
		1	1.8	1.5	Hay	3 (3)	57	0.40	58	MSL12617
Cambridge, Ontario Canada (1992)	SL	1	0.91	0.81	Hay	4 (2)	45 c0.33	0.31	45	MSL12617
		1	1.7	1.6	Hay	4 (2)	78	0.62	79	MSL12617
Strathroy, Ontario Canada (1992)	SL	1	0.91	0.81	Hay	4 (2)	41	0.39	42	MSL12617
		1	1.7	1.6	Hay	4 (2)	77	0.70	78	MSL12617

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
California USA (1992) GT13R Plus	SL	1	0.84	0.60	Forage Hay	1 4	60 165 c0.06	0.47 1.2	61 167	MSL12953
		1	1.7	1.2	Forage Hay	1 4	85 256 c0.06	0.51 2.3	86 260	MSL12953
Colorado USA (1992) Pioneer 521	SL	1	0.84	0.68	Forage Hay	1 5	33 127	0.15 0.83	33 128	MSL12953
		1	1.7	1.4	Forage Hay	1 5	107 341	0.42 2.0	108 344	MSL12953
Idaho USA (1992) WL 312	SL	1	0.85	0.82	Forage Hay	1 3	42 164	0.20 0.70	42 165	MSL12953
		1	1.7	1.6	Forage Hay	1 3	122 280	0.51 1.6	123 282	MSL12953
Illinois USA (1992) Pioneer 5010	SL	1	0.85	0.45	Forage Hay	1 4	66 c0.07 110 c0.29	0.40 0.79	67 111	MSL12953
		1	1.7	0.90	Forage Hay	1 4	114 c0.07 208 c0.29	0.55 1.1	115 210	MSL12953
Iowa USA (1992) Pioneer 8010	SL	1	0.86	0.45	Forage Hay	1 3	38 76	0.16 0.46	38 77	MSL12953
		1	1.7	0.90	Forage Hay	1 3	76 189	0.27 0.94	76 190	MSL12953
Iowa USA (1992) Pioneer 5010	SL	1	0.85	0.45	Forage Hay	1 4	54 120 c0.07	0.37 0.76	55 121	MSL12953
		1	1.7	0.90	Forage Hay	1 4	153 195 c0.07	0.63 1.0	154 197	MSL12953
Michigan USA (1992) Rin 5432	SL	1	0.84	0.52	Forage Hay	1 4	54 188 c0.08	0.29 1.2	54 190	MSL12953
		1	1.7	1.0	Forage Hay	1 4	70 335 c0.08	0.44 2.0	71 338	MSL12953
Minnesota USA (1992) Pioneer 5432	SL	1	0.84	0.52	Forage Hay	1 3	35 40	0.19 0.26	35 40	MSL12953
		1	1.7	1.0	Forage Hay	1 3	58 83	0.21 0.47	58 84	MSL12953
Minnesota USA (1992) Pioneer 5432	SL	1	0.84	0.84	Forage Hay	1 4	23 51	0.16 0.38	23 52	MSL12953
		1	1.7	1.7	Forage Hay	1 4	99 131	0.47 0.94	100 132	MSL12953
Montana USA (1992)	SL	1	0.84	0.67	Forage Hay	1 4	24 44	0.09 0.17	24 44	MSL12953
		1	1.7	1.3	Forage Hay	1 4	54 97	0.20 0.43	54 98	MSL12953
Nebraska USA (1992) Wrangle	SL	1	0.76	0.81	Forage Hay	1 4	36 52	0.14 0.64	36 53	MSL12953
		1	1.5	1.6	Forage Hay	1 4	54 187	0.22 0.97	54 188	MSL12953
New York USA (1992) Onieda	SL	1	0.84	0.45	Forage Hay	1 4	30 102	0.13 0.53	30 103	MSL12953
		1	1.7	0.90	Forage Hay	1 4	66 204	0.25 1.1	66 206	MSL12953
North Dakota USA (1992) Vernal	SL	1	0.84	0.45	Forage Hay	1 4	21 18	0.08 0.10	21 18	MSL12953

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
		1	1.7	0.90	Forage Hay	1 4	55 0.45	0.22 0.22	55 0.79	MSL12953
Oklahoma USA (1992) Oklahoma Common	SL	1	0.84	0.63	Forage Hay	1 3	48 91	0.23 0.45	48 92	MSL12953
		1	1.7	1.3	Forage Hay	1 3	98 214	0.43 0.83	99 215	MSL12953
Pennsylvania USA (1992) Arrow	SL	1	0.84	0.50	Forage Hay	1 4	36 83	0.14 0.47	36 84	MSL12953
		1	1.7	1.0	Forage Hay	1 4	74 196	0.29 0.96	74 197	MSL12953
South Dakota USA (1992) Northrup King	SL	1	0.84	0.52	Forage Hay	1 5	31 62	0.13 0.33	31 63	MSL12953
		1	1.7	1.0	Forage Hay	1 5	61 148	0.24 0.73	61 149	MSL12953
South Dakota USA (1992) 4-Star	SL	1	0.83	0.76	Forage Hay	1 4	23 73	0.18 c0.11 0.51	23 74	MSL12953
		1	1.7	1.5	Forage Hay	1 4	77 117	0.44 c0.11 1.2	78 119	MSL12953
Washington USA (1992) WL 316	SL	1	0.85	0.46	Forage Hay	1 3	27 c0.16 103 c0.08	0.17 c0.14 0.47	27 104	MSL12953
		1	1.7	0.92	Forage Hay	1 3	57 c0.16 219 c0.08	0.27 c0.14 1.1	57 221	MSL12953
Wisconsin USA (1992) Vernal	SL	1	0.84	0.53	Forage Hay	1 4	24 21	0.12 0.16	24 21	MSL12953
		1	1.7	1.1	Forage Hay	1 4	64 97	0.29 0.64	64 98	MSL12953
Wisconsin USA (1992) Vernal	SL	1	0.84	0.47	Forage Hay	1 6	42 123	0.25 0.50	42 124	MSL12953
		1	1.7	0.92	Forage Hay	1 6	94 257	0.45 1.2	95 259	MSL12953

Hay from Cambridge and Strathroy collected prior to drying to required moisture due to impending rain

480SL = 480 g/L as isopropylamine salt = 360 g ae/L

Table 76. Residues in Grass: Pre-harvest Application (USA).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)*			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Wilson Co. North Carolina, USA (1997) Bermuda, grass, 1st cutting	SL	1	1.3	0.63	forage forage	0 3	296 c0.2 121	1.1 1.9	298 123	MSL14992
	SL	1	2.5	1.3	forage forage forage	0 3 7	773 227 277	2.7 1.9 2.9	777 230 282	MSL14992
	SL	1	1.3	0.63	hay	3 (7)	128 c0.06	1.3	130	MSL14992
	SL	1	2.5	1.3	hay hay	3 (7) 7 (11)	259 c0.06 94 c0.06	1.9 1.8	262 97	MSL14992
Lake Co., Florida, USA (1997) Bermuda, 1st cutting	SL	1	1.3	0.63	forage forage	0 3	349 c0.3 89 c0.4	1.4 1.6	351 92	MSL14992

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)*			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	SL	1	2.5	1.3	forage	0	664 c0.3	2.2	668	MSL14992
					forage	3	419 c0.4	3.6	424	
					forage	7	337	3.6	343	
	SL	1	1.3	0.63	hay	3 (7)	69 c0.09	1.4	71	MSL14992
	SL	1	2.5	1.7	hay	3 (4)	7.3 c0.09	1.7	9.9	MSL14992
					hay	7 (8)	116 c0.16	2.6	120	
St. Landry, Louisiana, USA (1997) Bermuda, 1st cutting	SL	1	1.3	0.84	forage	0	283	1.3	285	MSL14992
					forage	3	144	4.3	151	
	SL	1	2.5	1.7	forage	0	527	2.2	530	MSL14992
					forage	3	293	6.2	302	
					forage	7	159	6.0	168	
	SL	1	1.3	0.84	hay	3 (7)	110 c0.06	2.7	114	MSL14992
1	SL	1	2.5	1.7	hay	3 (7)	233 c0.06	4.5	240	MSL14992
					hay	7 (10)	181	4.1	187	
Waller Co., Texas, USA (1997) Bermuda, 1st cutting	SL	1	1.3	0.63	forage	0	348	2.0	351	MSL14992
					forage	3	36 c0.2	1.4	38	
	SL	1	2.5	1.3	forage	0	869	3.6	875	MSL14992
					forage	3	91 c0.2	2.4	95	
					forage	7	71	2.2	75	
	SL	1	1.3	0.63	hay	3 (6)	106 c0.05	3.0	111	MSL14992
	SL	1	2.5	1.3	hay	3 (6)	203 c0.05	4.5	210	MSL14992
					hay	7 (10)	161	4.7	168	
Wayne Co., New York, USA (1997) Kentucky Blue, 2nd cutting	SL	1	1.3	0.63	forage	0	373	1.3	375	MSL14992
					forage	3	97	1.8	100	
	SL	1	2.5	1.3	forage	0	657	2.0	660	MSL14992
					forage	3	136	1.7	139	
					forage	7	131	1.7	133	
	SL	1	1.3	0.63	hay	3 (6)	54 c0.07	0.80	55	MSL14992
	SL	1	2.5	1.3	hay	3 (6)	75 c0.07	1.0	77	MSL14992
					hay	7 (9)	59 c0.12	1.2	61	
Guthrie Co., Iowa, USA (1997) Blue grass, 1st cutting	SL	1	1.3	0.63	forage	0	195 c0.2	0.57	196	MSL14992
					forage	3	308 c0.2	2.4	312	
	SL	1	2.5	1.3	forage	0	881 c0.2	< 0.06	881	MSL14992
					forage	3	756 c0.2	3.5	762	
					forage	6	200	2.2	203	
	SL	1	1.3	0.63	hay	3 (6)	124 c0.10	1.3	126	MSL14992
	SL	1	2.5	1.3	hay	3 (6)	215 c0.10	1.8	218	MSL14992
					hay	7 (10)	290 c0.09	4.1	296	
Grant Co., Washington, USA (1997) Kentucky Blue, 2nd cutting	SL	1	1.3	0.84	forage	0	257	0.77	258	MSL14992
					forage	3	25	0.34	26	
	SL	1	2.5	1.7	forage	0	689	1.6	691	MSL14992
					forage	3	58	0.43	59	
					forage	7	40	0.40	41	
	SL	1	1.3	0.84	hay	3 (4)	32 c0.10	0.32	32	MSL14992
	SL	1	2.5	1.7	hay	3 (4)	66 c0.10	0.58	67	MSL14992
					hay	7 (8)	32 c0.07	0.41	33	
Walworth Co., Wisconsin, USA (1997) Kentucky Blue, 1st cutting	SL	1	1.3	0.72	forage	0	163	0.92	164	MSL14992
					forage	2	131	2.1	134	
	SL	1	2.5	1.4	forage	0	456	2.5	460	MSL14992
					forage	2	303	4.9	311	
					forage	7	46	1.6	49	
	SL	1	1.3	0.72	hay	3 (5)	13 c0.09	0.44	14	MSL14992

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)*			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	SL	1	2.5	1.4	hay	3 (5)	38 c0.09	0.75	39	MSL14992
					hay	7 (10)	21 c0.09	0.74	22	
Tulare Co. California, USA (1997) Fescue, 6th cutting	SL	1	1.3	0.72	forage	0	605	2.1	608	MSL14992
					forage	3	145	2.6	149	
	SL	1	2.5	1.4	forage	0	1093	3.7	1099	MSL14992
					forage	3	320	3.3	325	
					forage	7	107	1.6	110	
	SL	1	1.3	0.72	hay	3 (7)	94 c0.05	1.0	96	MSL14992
	SL	1	2.5	1.4	hay	3 (7)	244 c0.05	2.3	248	MSL14992
					hay	7 (9)	207 c0.11	2.4	211	
York Co., Nebraska, USA (1997), Brome grass	SL	1	1.3	0.63	forage	0	238 c0.2	2.0	241	MSL14992
					forage	3	213 c0.3	1.6	215	
	SL	1	2.5	1.3	forage	0	431 c0.2	2.9	435	MSL14992
					forage	3	466 c0.3	3.1	471	
					forage	7	385	2.6	389	
	SL	1	1.3	0.63	hay	3 (5)	94	0.64	95	MSL14992
	SL	1	2.5	1.3	hay	3 (5)	212	1.1	214	MSL14992
					hay	7 (8)	62	0.75	63	
Cache Co., Utah, USA (1997) Brome grass/Fescue/smooth Broome/Alta Fescue, 2nd cutting	SL	1	1.3	1.0	forage	0	439 c0.2	1.5	442	MSL14992
					forage	3	257 c0.2	1.8	259	
	SL	1	2.5	2.0	forage	0	884 c0.2	4.4	891	MSL14992
					forage	3	507 c0.2	3.1	512	
					forage	7	428	3.8	433	
	SL	1	1.3	1.0	hay	3 (7)	47 c0.07	0.49	48	MSL14992
	SL	1	2.5	2.0	hay	3 (7)	122 c0.07	1.3	124	MSL14992
					hay	7 (9)	35 c0.07	1.1	37	
Eddy Co., North Dakota, USA (1997) Brome grass, 1st cutting	SL	1	1.3	0.84	forage	0	366	2.7	370	MSL14992
					forage	3	218	1.5	220	
	SL	1	2.5	1.7	forage	0	616	5.0	623	MSL14992
					forage	3	515	3.2	520	
					forage	7	201	1.4	203	
	SL	1	1.3	0.84	hay	3 (7)	63 c0.06	0.57	64	MSL14992
	SL	1	2.5	1.7	hay	3 (7)	100 c0.06	0.79	101	MSL14992
					hay	7 (10)	66	0.94	67	
Armstrong Co., Texas, USA (1997) Fescue (Tall), 3rd cutting	SL	1	1.3	0.72	forage	0	291	1.0	293	MSL14992
					forage	3	150 c0.1	1.2	152	
	SL	1	2.5	1.4	forage	0	713	2.9	718	MSL14992
					forage	3	332 c0.2	2.2	335	
					forage	7	289	2.6	293	
	SL	1	1.3	0.72	hay	3 (7)	58 c0.09	1.0	59	MSL14992
	SL	1	2.5	1.4	hay	3 (7)	153 c0.09	1.5	155	MSL14992
					hay	7 (10)	187	2.1	190	

Plots were cut and sampled for forage on the same day. Hay was cut and then field dried prior to sampling. The pre-harvest interval between application and cutting is given, followed by the interval from application to sampling (in parentheses) for hay.

*forage expressed on a dry weight basis following correction for moisture content; residues in hay samples were not corrected for moisture content

Table 77. Residues in Dry Beans (haulm/straw): Pre-harvest Application.

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
5380 Franc-Waret, Belgium (1995) Mars	K	1	1.4	0.72	0 7	40 c0.34 28 c0.28	0.18 0.20	40 28	MLL30463
Wilson, Derbyshire, UK (1995) Mars	K	1	1.4	0.72	0 7	91 c0.74 63 c14	0.39 0.60 c0.08	92 64	MLL30463
Wheaton Aston, Staffordshire, UK (1995) Sirrocco	K	1	1.4	0.72	0 7	51 c0.71 36 c6.0	0.22 0.31 c0.05	51 36	MLL30463
Womesley, Doncaster, UK (1995) Victor	K	1	1.4	0.72	0 7	62 c0.50 51 c0.23	0.27 0.48	62 52	MLL30463
Isley Walton, Derbyshire, UK (1992) Banner	C	1	1.4	0.70	7	16			GLY 140
		1	0.72	0.36	7	9.3			GLY 140
Thorne, South Yorkshire, UK (1992) Troy	C	1	1.4	0.70	7	17			GLY 140
		1	0.72	0.36	7	7.0			GLY 140
Terling, North Chelmsford, Essex, UK (1992) Punch	C	1	1.4	0.70	7	4.4 c0.1			GLY 140
		1	0.72	0.36	7	3.4 c0.1			GLY 140
Kings Newton, Derbyshire, UK (1993) Boxer	C	1	1.4	0.70	4 hrs 1 3 7	16 c0.61 15 c0.07 3.6 3.4 c0.09			GLY 264, GLY 305
		1	0.72	0.36	4 hrs 1 3 7	14 c0.61 14 c0.07 3.3 3.0 c0.09			GLY 264, GLY 305
Sancton, Humberside, UK (1993) Boxer	C	1	1.4	0.70	4 hrs 1 3 7	20 c0.15 4.1* c0.16 7.8 7.8 c0.13			GLY 264, GLY 305
		1	0.72	0.36	4 hrs 1 3 7	14 c0.15 17* c0.16 2.0 3.3 c0.13			GLY 264, GLY 305
Neston, UK (1986) Banner	A	1	2.9	3.6	7	170 c0.4			MLL30180
	A	1	2.9	1.2	7	160 c0.4			MLL30180
	B	1	2.9	1.2	7	100 c0.4			MLL30180
	C	1	2.9	1.2	7	130 c0.4			MLL30180
	D	1	2.9	1.2	7	140 c0.4			MLL30180
St. Ives, Cambridgeshire, UK (1982) Herro	C	1	1.4	0.72	7	50 c0.1	0.47	51	MLL30109
		1	2.9	1.4	7	70 c0.1	0.51	71	MLL30109
Thornhough, UK (1982) Minden	C	1	1.4	0.65	10	46	0.39	u	MLL30109
		1	2.9	1.3	10	63	0.68	64	MLL30109
Hemingford, UK (1982) Throws As	C	1	1.4	0.65	9	93	0.99	95	MLL30109

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
		1	2.9	1.3	9	160	1.21	162	MLL30109

Residue values are corrected for recovery of 72% for glyphosate and 81% for AMPA.

Table 78. Residues in Dry Peas (haulm/straw): Pre-harvest Application.

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Franc-Waret, Belgium (1995) Baccara	K	1	1.4	0.72	0 7	111 c0.09 125	0.51 1.6	112 127	MLL30464
Venurne, Belgium (1982) Finale	C	1	1.1	0.36	17 17	78 c0.4 65 c0.4	0.47 0.40	79 66	MLL30131
Clive, Alberta Canada (1988) Princess	C	1	0.67	0.61	12	13	0.16	13	MSL9398
		1	0.90	0.82	12	19	0.17	19	MSL9398
Clive, Alberta Canada (1988) Tara	C	1	0.67	0.61	12	20	0.18	20	MSL9398
		1	0.90	0.82	12	17	0.16	17	MSL9398
Clive, Alberta Canada (1988) Trapper	C	1	0.67	0.61	16	16	0.16	16	MSL9398
		1	0.90	0.82	16	12	0.11	12	MSL9398
Lacombe, Alberta Canada (1988) Alaska	C	1	0.67	0.61	14	21	0.16	21	MSL9398
		1	0.90	0.82	14	28	0.26	28	MSL9398
Kingsbury, Staffordshire, UK (1995) Princess	K	1	1.4	0.72	0 7	148 c0.14 154 c0.09	0.56 0.92	149 155	MLL30464
Banbury, Oxfordshire, UK (1995) Princess	K	1	1.4	0.72	0 7	130 c0.06 79 c0.08	0.50 0.48	131 80	MLL30464
Scunthorpe, Humberside, UK (1995) Montana	K	1	1.4	0.72	0 7	170 c0.50 179 c0.40	0.78 1.5	171 181	MLL30464
Wilson, Derbyshire, UK (1992) Guido	C	1	1.4	0.72	7	27 c0.07			GLY 141, GLY 222
		1	0.72	0.36	7	6.2 c0.07			GLY 141, GLY 222
Goole, Humberside, UK (1992) Solara	C	1	1.4	0.72	7	118 c25			GLY 141, GLY 222
		1	0.72	0.36	7	0.7 c25			GLY 141, GLY 222
Market Weighton, Yorkshire, UK (1992) Baroness	C	1	1.4	0.72	7	27 c0.08			GLY 141, GLY 222
		1	0.72	0.36	7	18 c0.08			GLY 141, GLY 222

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Wilson, Derbyshire, UK (1992) Guido	C	1	1.4	0.72	4 hrs 1 3 7	33 c0.14 38 c0.11 13 31 c0.08			GLY 143, GLY 221
		1	0.72	0.36	4 hrs 1 3 7	14 c0.14 13 c0.11 5.2 8.2 c0.08			GLY 143, GLY 221
UK Felsted, Essex UK (1986) Progreta	A		2.9	1.2	9	240			MLL30131
	C		2.9	1.2	9	270			MLL30131
	D		2.9	1.2	9	320			MLL30131
UK Hemmingford, Cambridge UK (1986) Bunting	A		2.9	3.6	8	150			MLL30131
	A		2.9	1.2	8	160			MLL30131
	B		2.9	1.2	8	180			MLL30131
	C		2.9	1.2	8	200			MLL30131
	D		2.9	1.2	8	190			MLL30131

All SL formulations

Table 79. Residues in Lentils (straw): Pre-harvest Application (Canada).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Legal, Alberta Canada (1988) Laird	C	1	0.67	0.61	13	8.2	0.17	8.5	MSL9398
		1	0.90	0.82	13	11	0.16	11	MSL9398
Gray, Saskatchewan Canada (1988) Laird	C	1	0.67	0.67	12	< 0.05	< 0.05	< 0.05	MSL9398
		1	0.90	0.90	12	< 0.05	< 0.05	< 0.05	MSL9398
		1	1.8	1.8	12	< 0.05	< 0.05	< 0.05	MSL9398

Table 80. Residues in Conventional Soya bean (hay): Pre-harvest Application (USA) with glyphosate 360 SL formulation.

Location (year) variety	Type	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Banks, Mississippi USA (1979)	RCS RCS PH	3	2.1 2.1 0.84	1.7 1.2 0.45	15	3.4	0.18	3.7	MSL3259
	RCS RCS PH	3	2.1 2.1 1.7	1.7 1.2 0.90	15	7.9	0.38	8.5	MSL3259
	RCS RCS PH	3	2.1 2.1 3.4	1.7 1.2 1.8	15	10	0.32	10	MSL3259
	RCS RCS PH	3	2.1 2.1 5.0	1.7 1.2 2.70	15	10	0.44	11	MSL3259

Location (year) variety	Type	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Banks, Mississippi USA (1979)	RCS RCS PH	3	2.1 2.1 0.84	1.7 1.2 0.22	9	7.1	0.32	7.6	MSL3259
	RCS RCS PH	3	2.1 2.1 1.7	1.7 1.2 0.45	9	15	0.52	16	MSL3259
	RCS RCS PH	3	2.1 2.1 3.4	1.7 1.2 0.90	9	21	0.44	22	MSL3259
	RCS RCS PH	3	2.1 2.1 5.0	1.7 1.2 1.4	9	29	0.42	30	MSL3259
Bruins, Arkansas USA (1979)	RCS RCS PH	3	2.5 2.5 0.84	NS NS 0.45	7 16	2.1 c0.40 1.8 c0.37	0.11 c0.07 0.14 c0.07	2.3 2.0	MSL3259
	RCS RCS PH	3	2.5 2.5 1.7	NS NS 0.45	7 16	5.9 c0.40 5.0 c0.37	0.18 c0.07 0.20 c0.07	6.2 5.3	MSL3259
	RCS RCS PH	3	2.5 2.5 3.4	NS NS 0.45	7 16	13 c0.40 12 c0.37	0.29 c0.07 0.26 c0.07	13 12	MSL3259
	RCS RCS PH	3	2.5 2.5 5.0	NS NS 0.45	7 16	22 c0.40 20 c0.37	0.32 c0.07 0.33 c0.07	22 21	MSL3259
Bruins, Arkansas USA (1979)	RCS RCS PH	3	2.5 2.5 0.84	NS NS 0.45	10	7.2 c0.42	0.17 c0.07	7.5	MSL3259
	RCS RCS PH	3	2.5 2.5 1.7	NS NS 0.45	10	14 c0.39	0.31 c0.07	14	MSL3259
	RCS RCS PH	3	2.5 2.5 3.4	NS NS 0.45	10	34 c0.39	0.54 c0.07	35	MSL3259
	RCS RCS PH	3	2.5 2.5 5.0	NS NS 0.45	10	31 c0.39	0.49 c0.07	32	MSL3259
Adel, Iowa USA (1979)	RCS RCS RCS PH	4	5.0 5.0 5.0 0.84	2.7 2.7 2.7 0.45	11	9.9	0.10	10	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 1.7	2.7 2.7 2.7 0.90	11	49	0.38	50	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 3.4	2.7 2.7 2.7 1.8	11	87	0.72	88	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 5.0	2.7 2.7 2.7 2.7	11	199	1.7	202	MSL3259
Adel, Iowa USA (1979)	RCS RCS RCS PH	4	5.0 5.0 5.0 0.84	2.7 2.7 2.7 0.45	8	13	0.12	13	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 1.7	2.7 2.7 2.7 0.90	8	42	0.31	42	MSL3259

Location (year) variety	Type	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	RCS RCS RCS PH	4	5.0 5.0 5.0 3.4	2.7 2.7 2.7 1.8	8	89	0.78	90	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 5.0	2.7 2.7 2.7 2.7	8	195	1.6	197	MSL3259
Princeton, Kentucky USA (1979)	RCS RCS RCS PHI	4	5.0 5.0 5.0 0.84	NS NS NS 0.36	11 25	4.1 3.3	0.13 0.23	4.3 3.7	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 1.7	NS NS NS 0.72	11 25	6.5 4.7	0.34 0.29	7.0 5.1	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 3.4	NS NS NS 1.4	11 25	17 8.5	0.66 0.30	18 9.0	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 5.0	NS NS NS 2.2	11 25	30 16	0.76 0.72	31 17	MSL3259
Princeton, Kentucky USA (1979)	RCS RCS RCS PH	4	5.0 5.0 5.0 0.84	NS NS NS 0.36	13	2.5	0.16	2.7	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 1.7	NS NS NS 0.72	13	3.6	0.23	4.0	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 3.4	NS NS NS 1.44	13	7.0	0.32	7.5	MSL3259
	RCS RCS RCS PH	4	5.0 5.0 5.0 5.0	NS NS NS 2.2	13	14	0.30	14	MSL3259

Type of applications: RCS = recirculating sprayer; PH = pre-harvest

Table 81. Residues in Glyphosate Tolerant Soyabean forage and hay (USA) following application of a SL formulation of glyphosate (as the isopropylamine salt) containing 360 g ae/L.

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Clarence, Missouri USA (1992) 40-3	PRE LPO	2	6.4 0.84	6.7 0.89	Forage (1) Hay (2)	55 51	0.12 2.4	0.16 0.67	0.36 3.4	MSL13462
	PRE EPO	2	6.4 0.63	6.7 0.42	Forage (2) Hay (2)	15 87	1.5 0.09	0.23 < 0.05	1.9 0.09	MSL13462
	PRE LPO	2	6.4 1.7	6.7 1.8	Forage (1) Hay (2)	55 51	2.2 7.2	0.27 1.4	2.6 9.3	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.7 1.3 0.89	Forage (2) Hay (3)	15 51	0.12 3.8	0.16 0.76	0.36 5.0	MSL13462

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO LPO	3	6.4 0.84 0.84	6.7 1.3 0.89	Forage (2) Hay (3)	15 51	2.4 2.8	0.30 0.50	2.9 3.6	MSL13462
Conklin, Michigan, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.1 0.52	Forage (1) Hay (2)	49 33	0.11 8.2	0.074 0.71	0.22 9.3	MSL13462
	PRE EPO	2	6.4 0.63	4.1 0.38	Forage (2) Hay (2)	9 93	6.8 0.46	0.37 0.08	7.4 0.58	MSL13462
	PRE LPO	2	6.4 1.7	4.1 1.0	Forage (1) Hay (2)	49 33	0.069 14	0.067 1.3	0.17 16	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.1 0.50 0.52	Forage (2) Hay (3)	9 33	0.91 6.9	0.48 0.64	1.6 7.9	MSL13462
	PRE EPO LPO PH	4	6.4 0.84 0.84	4.1 0.50 0.52	Forage (2) Hay (3)	9 33	7.9 7.1	0.43 0.65	8.6 8.1	MSL13462
Danville, Iowa, USA (1992) 40-3	PRE LPO	2	6.4 1.7	3.4	Forage (1) Hay (2)	56 42	< 0.05 6.9	< 0.05 0.94	< 0.05 8.3	MSL13462
	PRE EPO	2	6.4 1.3	3.4	Forage (2) Hay (2)	14 80	5.2 0.67	0.34 0.17	5.7 0.93	MSL13462
	PRE LPO	2	6.4 3.4	3.4	Forage (1) Hay (2)	56 42	< 0.05 12	< 0.05 1.7	< 0.05 15	MSL13462
	PRE EPO LPO	3	6.4 1.7 1.7	3.4	Forage (2) Hay (3)	14 42	5.5 4.2	0.31 0.68	6.0 5.2	MSL13462
	PRE EPO LPO	3	6.4 1.7 1.7	3.4	Forage (2) Hay (3)	14 42	9.1 10	0.49 1.7	9.8 13	MSL13462
Elko, South Carolina USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.8 0.52	Forage (2) Hay (2)	5 38	7.3 3.6	0.38 0.72	7.9 4.7	MSL13462
	PRE EPO	2	6.4 0.63	3.8 0.40	Forage (2) Hay (2)	6 39	3.9 1.8	0.21 0.43	4.2 2.5	MSL13462
	PRE LPO	2	6.4 1.7	3.8 1.0	Forage (2) Hay (2)	5 38	18 8.0	0.69 1.4	19 10	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.8 0.54 0.52	Forage (3) Hay (3)	5 38	8.9 6.5	0.71 1.3	10 8.5	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.8 0.54 0.52	Forage (3) Hay (3)	5 38	8.2 6.6	0.88 1.3	9.5 8.6	MSL13462
Emporia, Virginia, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.9 0.64	Forage (2) Hay (2)	2 71	6.2 0.31	0.18 0.05	6.5 0.39	MSL13462

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO	2	6.4 0.63	4.9 0.48	Forage (2) Hay (2)	16 85	4.8 0.47	0.24 0.11	5.2 0.64	MSL13462
	PRE LPO	2	6.4 1.7	4.9 1.3	Forage (2) Hay (2)	2 71	8.9 0.94	0.36 0.10	9.4 1.1	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.9 0.64 0.64	Forage (3) Hay (3)	2 71	8.2 0.88	0.61 0.13	9.1 1.1	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.9 0.64 0.64	Forage (3) Hay (3)	2 71	7.6 1.0	0.75 0.16	8.7 1.2	MSL13462
Goldsboro, North Carolina, USA (1992) 40-3	PRE LPO	2	6.4 0.84	6.9 0.89	Forage (2) Hay (2)	2 40	8.6 3.4	0.40 0.69	9.2 4.5	MSL13462
	PRE EPO	2	6.4 0.63	6.9 0.67	Forage (2) Hay (2)	14 52	3.5 2.2	0.32 0.49	4.0 2.9	MSL13462
	PRE LPO	2	6.4 1.7	6.9 1.79	Forage (2) Hay (2)	2 40	29 10	1.1 1.7	31 13	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.9 0.89 0.89	Forage (3) Hay (3)	2 40	20 8.4	1.1 1.3	22 10	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.9 0.89 0.89	Forage (3) Hay (3)	2 40	20 6.6	0.95 1.0	21 8.1	MSL13462
Greenville, Mississippi, USA (1992) 40-3	PRE LPO	2	6.4 0.84	6.8 0.72	Forage (2) Hay (2)	6 47	20 2.6	0.81 0.70	21 3.7	MSL13462
	PRE EPO	2	6.4 0.63	6.8 0.53	Forage (2) Hay (2)	8 49	11 5.3	0.68 1.2	12 7.1	MSL13462
	PRE LPO	2	6.4 1.7	6.8 1.4	Forage (2) Hay (2)	6 47	18 1.3	1.5 0.39	20 1.9	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.8 0.70 0.72	Forage (3) Hay (3)	6 47	14 5.1	1.1 1.4	16 7.2	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.8 0.70 0.72	Forage (3) Hay (3)	6 47	18 5.9	1.3 1.4	20 8.0	MSL13462
Hickory Withe, Tennessee, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.4 0.45	Forage (2) Hay (2)	1 43	18 1.7	0.35 0.39	19 2.3	MSL13462
	PRE EPO	2	6.4 0.63	3.4 0.34	Forage (2) Hay (2)	14 56	3.2 1.3	0.34 0.26	3.7 1.7	MSL13462
	PRE LPO	2	6.4 1.7	3.4 0.89	Forage (2) Hay (2)	1 43	39 8.7	0.70 1.9	40 12	MSL13462

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Forage (3) Hay (3)	1 43	25 2.5	0.78 0.44	26 3.2	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Forage (3) Hay (3)	1 43	31 6.0	1.1 1.3	33 8.0	MSL13462
La Center, Kentucky, USA (1992) 40-3	PRE LPO	2	6.4 0.84	5.9 0.83	Forage (2) Hay (2)	7 71	4.3 0.59	0.34 0.15	4.8 0.82	MSL13462
	PRE EPO	2	6.4 0.63	5.9 0.59	Forage (2) Hay (2)	15 79	0.87 0.20	0.12 < 0.05	1.1 0.2	MSL13462
	PRE LPO	2	6.4 1.7	5.9 1.7	Forage (2) Hay (2)	7 71	7.2 1.2	0.52 0.24	8.0 1.6	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.79 0.83	Forage (3) Hay (3)	7 71	4.5 0.95	0.39 0.20	5.1 1.3	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.79 0.83	Forage (3) Hay (3)	7 71	7.7 0.52	0.61 0.13	8.6 0.72	MSL13462
Martinsville, Indiana, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.5 0.45	Forage (2) Hay (2)	6 62	10 1.8	0.61 0.42	11 2.4	MSL13462
	PRE EPO	2	6.4 0.63	3.5 0.37	Forage (2) Hay (2)	12 68	3.3 0.47	0.25 0.16	3.7 0.71	MSL13462
	PRE LPO	2	6.4 1.7	3.5 0.90	Forage (2) Hay (2)	6 62	28 4.0	1.3 0.74	30 5.1	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.5 0.50 0.45	Forage (3) Hay (3)	6 62	12 3.4	0.73 0.59	13 4.3	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.5 0.50 0.45	Forage (3) Hay (3)	6 62	14 2.1	0.84 0.47	15 2.8	MSL13462
New Holland, Ohio, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.2 0.57	Forage (1) Hay (2)	56 69	0.05 < 0.05	< 0.05 < 0.05	0.05 < 0.05	MSL13462
	PRE EPO	2	6.4 0.63	4.2 0.39	Forage (2) Hay (2)	22 92	1.3 1.2	0.14 0.14	1.5 1.4	MSL13462
	PRE LPO	2	6.4 1.7	4.2 1.1	Forage (1) Hay (2)	56 69	< 0.05 0.06	< 0.05 < 0.05	< 0.05 0.06	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.2 0.53 0.57	Forage (2) Hay (3)	22 69	1.3 1.4	0.10 0.15	1.5 1.6	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.2 0.53 0.57	Forage (2) Hay (3)	22 69	1.3 1.3	0.12 0.15	1.5 1.5	MSL13462

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Proctor, Arkansas, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.4 0.45	Forage (2) Hay (2)	6 35	2.6 1.4	0.17 0.37	2.9 2.0	MSL13462
	PRE EPO	2	6.4 0.63	3.4 0.34	Forage (2) Hay (2)	13 42	4.2 1.6	0.29 0.30	4.6 2.1	MSL13462
	PRE LPO	2	6.4 1.7	3.4 0.89	Forage (2) Hay (2)	6 35	11 6.6	0.80 1.1	12 8.3	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Forage (3) Hay (3)	6 35	12 5.9	0.73 0.87	13 7.2	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Forage (3) Hay (3)	6 35	12 5.7	0.83 0.90	13 7.1	MSL13462
Rosa, Louisiana, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.4 0.55	Forage (2) Hay (2)	10 39	1.7 0.94	0.19 0.26	2.0 1.3	MSL13462
	PRE EPO	2	6.4 0.63	4.4 0.42	Forage (2) Hay (2)	11 40	2.4 1.3	0.24 0.30	2.8 1.8	MSL13462
	PRE LPO	2	6.4 1.7	4.4 1.1	Forage (2) Hay (2)	10 39	4.5 2.8	0.41 0.54	5.1 3.6	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.4 0.56 0.55	Forage (3) Hay (3)	10 39	6.1 3.0	0.53 0.57	6.9 3.9	MSL13462
	PRE EPO LPO	2	6.4 0.84 0.84	4.4 0.56 0.55	Forage (3) Hay (3)	10 39	5.3 2.7	0.46 0.51	6.0 3.5	MSL13462
Sandusky, Illinois, USA (1992) 40-3	PRE LPO	2	6.4 0.84	5.9 0.83	Forage (2) Hay (2)	7 71	3.8 0.87	0.37 0.21	4.4 1.2	MSL13462
	PRE EPO	2	6.4 0.63	5.9 0.59	Forage (2) Hay (2)	15 79	0.56 0.15	0.10 < 0.05	0.71 0.15	MSL13462
	PRE LPO	2	6.4 1.7	5.9 1.7	Forage (2) Hay (2)	7 71	12 5.4	0.98 0.82	13 6.6	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.79 0.83	Forage (3) Hay (3)	7 71	1.7 0.50	0.21 0.14	2.0 0.71	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.79 0.83	Forage (3) Hay (3)	7 71	7.0 2.2	0.70 0.34	8.1 2.7	MSL13462
Sedan, Kansas, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.6 0.89	Forage (1) Hay (2)	50 51	0.13 2.9	< 0.05 1.1	0.13 4.6	MSL13462
	PRE EPO	2	6.4 0.63	4.6 0.67	Forage (2) Hay (2)	9 61	0.89 0.29	0.23 0.14	1.2 0.50	MSL13462

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE LPO	2	6.4 1.7	4.6 1.8	Forage (1) Hay (2)	50 51	0.11 8.7	< 0.05 3.1	0.11 13	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.6 0.89 0.89	Forage (2) Hay (3)	9 51	1.1 2.9	0.25 1.2	1.5 4.7	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.6 0.89 0.89	Forage (2) Hay (3)	9 51	0.98 3.7	0.24 1.6	1.3 6.1	MSL13462
Sheridan, Indiana, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.6 1.4	Forage (2) Hay (2)	6 63	5.7 0.34	0.69 0.05	6.8 0.42	MSL13462
	PRE EPO	2	6.4 0.63	3.6 0.34	Forage (2) Hay (2)	19 76	1.0 0.06	0.095 < 0.05	1.1 0.06	MSL13462
	PRE LPO	2	6.4 1.7	3.6 0.99	Forage (2) Hay (2)	6 63	9.8 1.6	0.49 0.18	11 1.9	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.6 0.45 0.50	Forage (3) Hay (3)	6 63	6.2 1.6	0.32 0.19	6.7 1.9	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.6 0.45 0.50	Forage (3) Hay (3)	6 63	7.5 1.4	0.37 0.17	8.1 1.7	MSL13462
Shoffner, Arkansas, USA (1992) 40-3	PRE LPO	2	6.4 0.84	3.4 0.45	Forage (2) Hay (2)	12 32	4.0 3.5	0.48 0.68	4.7 4.5	MSL13462
	PRE EPO	2	6.4 0.63	3.4 0.34	Forage (2) Hay (2)	14 34	1.9 2.3	0.21 0.48	2.2 3.0	MSL13462
	PRE LPO	2	6.4 1.7	3.4 0.90	Forage (2) Hay (2)	12 32	<u>12</u> 11	0.89 1.8	<u>13</u> 14	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Forage (3) Hay (3)	12 32	8.9 6.9	0.62 1.0	9.8 8.4	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	3.4 0.45 0.45	Forage (3) Hay (3)	12 32	9.2 8.2	0.70 1.3	10 10	MSL13462
Webster City, Iowa (1992) 40-3	PRE LPO	2	6.4 0.84	4.3	Forage Hay (2)	58 60	< 0.05 1.4	< 0.05 0.21	< 0.05 1.7	MSL13462
	PRE EPO	2	6.4 0.63	4.3	Forage (2) Hay (2)	17 80	1.5 0.9	0.15 0.09	1.7 1.0	MSL13462
	PRE LPO	2	6.4 1.7	4.3	Forage Hay (2)	58 60	0.07 3.1	< 0.05 0.41	0.07 3.7	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.3	Forage Hay (3)	17 60	1.7 2.2	0.18 0.29	2.0 2.6	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.3	Forage Hay (3)	17 60	1.5 1.6	0.16 0.24	1.7 2.0	MSL13462

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Steele, Missouri, USA (1992) 40-3	PRE LPO	2	6.4 0.84	5.9 0.79	Hay (2)	39	2.5	0.76	3.7	MSL13462
	PRE EPO	2	6.4 0.63	5.9 0.58	Hay (2)	81	0.30	0.20	0.60	MSL13462
	PRE LPO	2	6.4 1.7	5.9 1.6	Hay (2)	72	7.3	2.1	10	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.83 0.78	Hay (3)	72	1.7	0.55	2.5	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	5.9 0.83 0.78	Hay (3)	72	4.4	1.2	6.2	MSL13462
Winterville, Georgia, USA (1992) 40-3	PRE LPO	2	6.4 0.84	4.0 0.50	Forage (2) Hay (2)	14 46	3.3 1.7	0.34 0.55	3.8 2.5	MSL13462
	PRE EPO	2	6.4 0.63	4.0 0.39	Forage (2) Hay (2)	22 54	1.6 0.87	0.19 0.26	1.9 1.3	MSL13462
	PRE LPO	2	6.4 1.7	4.0 0.99	Forage (2) Hay (2)	14 46	4.1 2.8	0.48 0.76	4.8 4.0	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.0 0.53 0.50	Forage (3) Hay (3)	14 46	3.7 1.8	0.40 0.76	4.3 3.0	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	4.0 0.53 0.50	Forage (3) Hay (3)	14 46	4.2 2.1	0.45 0.63	4.9 3.1	MSL13462
York, Nebraska, USA (1992) 40-3	PRE LPO	2	6.4 0.84	6.8 0.90	Forage (1) Hay (2)	56 60	< 0.05 0.27	< 0.05 0.12	< 0.05 0.45	MSL13462
	PRE EPO	2	6.4 0.63	6.8 0.68	Forage (2) Hay (2)	16 77	1.3 < 0.05	0.08 < 0.05	1.4 < 0.05	MSL13462
	PRE LPO	2	6.4 1.7	6.8 1.8	Forage Hay (2)	56 60	< 0.05 1.0	< 0.05 0.19	< 0.05 1.3	MSL13462
	PRE EPO LPO	3	6.4 0.84 0.84	6.8 0.90 0.90	Forage (2) Hay (3)	16 60	1.1 0.41	< 0.05 0.15	1.1 0.64	MSL13462
	PRE EPO LPO	3	6. 0.84 0.84	6.8 0.90 0.90	Forage (2) Hay (3)	16 60	1.1 0.52	0.05 0.16	1.2 0.76	MSL13462
Carlyle, Illinois USA (1993) 40-3	PRE LPO	2	6.4 0.84	6.1 0.55	Forage (2) Hay (2)	9 44	5.8 3.9	0.48 1.2	6.5 5.7	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	6.13 0.56 0.55	Forage (3) Hay (3)	9 44	6.8 2.1	0.50 0.76	7.6 3.3	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	6.13 0.56 0.55	Forage (3) Hay (3)	9 44	5.5 2.0	0.46 0.63	6.2 3.0	MSL13464
Carman, Illinois USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.39 0.45	Forage (2) Hay (2)	8 62	2.5 0.61	0.19 0.23	2.8 0.96	MSL13464

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO LPO	3	6.4 0.84 0.84	3.39 0.45 0.45	Forage (3) Hay (3) Seed (3)	8 62	2.4 0.68	0.18 0.29	2.7 1.1	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.39 0.45 0.45	Forage (3) Hay (3)	8 62	2.2 0.31	0.17 0.11	2.5 0.48	MSL13464
Conklin, Michigan USA (1993) 40-3	PRE LPO	2	6.4 0.84	4.23 0.53	Forage (2) Hay (2)	6 54	7.7 0.83	0.37 0.18	8.3 1.1	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	4.23 0.53 0.53	Forage (3) Hay (3)	6 54	8.2 1.6	0.44 0.34	8.9 2.1	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	4.23 0.53 0.53	Forage (3) Hay (3)	6 54	8.2 2.1	0.45 0.46	8.9 2.8	MSL13464
Danville, Iowa USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.39 0.45	Forage (2) Hay (2)	8 62	1.6 0.15	0.12 0.07	1.8 0.26	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.39 0.45 0.45	Forage (3) Hay (3)	8 62	1.4 0.19	0.14 0.07	1.6 0.30	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.39 0.45 0.45	Forage (3) Hay (3)	8 62	1.6 0.17	0.14 0.08	1.8 0.29	MSL13464
Faiborn, Ohio USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.60 0.43	Forage (2) Hay (2)	13 55	4.5 4.1	0.44 1.1	5.2 5.8	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.60 0.41 0.43	Forage (3) Hay (3)	13 55	5.7 2.3	0.47 0.76	6.4 3.5	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.60 0.41 0.43	Forage (3) Hay (3)	13 55	4.6 2.5	0.40 0.80	5.2 3.7	MSL13464
Grangeburg, Alabama USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.32 0.45	Forage (2) Hay (2)	21 80	0.11 0.15	< 0.05 < 0.05	0.11 0.15	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.32 0.45 0.44	Forage (3) Hay (3)	0 59	40 0.98	0.35 0.32	41 1.5	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.32 0.45 0.44	Forage (3) Hay (3)	0 59	81 0.98	0.59 0.34	82 1.5	MSL13464
Hills, Minnesota USA (1993) 40-3	PRE LPO	2	6.4 0.84	6.72 0.87	Forage (2) Hay (2)	17 65	1.9 0.65	0.21 0.20	2.2 0.95	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	6.72 0.83 0.87	Forage (3) Hay (3)	17 65	2.7 0.75	0.28 0.21	3.1 1.1	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	6.72 0.83 0.87	Forage (3) Hay (3)	17 65	2.6 0.33	0.25 0.09	3.0 0.47	MSL13464

Location (year) variety	Type	Application			Sample	PHI days	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Lamberton, Minnesota USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.41 0.45	Forage (2) Hay (2)	11 41	1.9 1.7	0.16 0.35	2.1 2.2	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.41 0.45 0.45	Forage (3) Hay (3)	11 41	3.3 3.8	0.36 0.82	3.8 5.0	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.41 0.45 0.45	Forage (3) Hay (3)	11 41	2.9 2.9	0.31 0.61	3.4 3.8	MSL13464
Martinsville, Indiana USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.47 0.83	Forage (2) Hay (2)	29 78	0.12 < 0.05	< 0.05 < 0.05	0.12 < 0.05	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.47 0.83 0.76	Forage (3) Hay (3)	10 59	3.6 0.84	0.33 0.40	4.1 1.4	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.47 0.83 0.76	Forage (3) Hay (3)	10 59	4.1 0.84	0.38 0.39	4.7 1.4	MSL13464
New Holland, Ohio USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.66 0.43	Forage (2) Hay (2)	9 45	6.1 1.1	0.57 0.43	7.0 1.8	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.66 0.47 0.43	Forage (3) Hay (3)	9 45	18 4.1	1.2 1.2	20 5.9	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.67 0.47 0.43	Forage (3) Hay (3)	9 45	4.6 0.87	0.40 0.29	5.2 1.3	MSL13464
Renner, South Dakota USA (1993) 40-3	PRE LPO	2	6.4 0.84	6.58 0.82	Forage (2) Hay (2)	17 66	2.7 1.0	0.29 0.27	3.1 1.4	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	6.58 0.84 0.82	Forage (3) Hay (3)	17 66	4.0 1.6	0.44 0.37	4.7 2.2	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	6.58 0.84 0.82	Forage (3) Hay (3)	17 66	5.0 2.0	0.66 0.49	6.0 2.7	MSL13464
Richland, Iowa USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.78 0.49	Forage (2) Hay (2)	15 52	1.5 0.44	0.13 0.14	1.7 0.65	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.78 0.48 0.49	Forage (3) Hay (3)	15 52	1.7 0.51	0.15 0.16	1.9 0.75	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.78 0.48 0.49	Forage (3) Hay (3)	15 52	2.0 0.51	0.16 0.15	2.2 0.74	MSL13464
Salisbury, Maryland USA (1993) 40-3	PRE LPO	2	6.4 0.84	4.73 0.57	Forage (2) Hay (2)	22 57	0.87 0.30	0.10 0.07	1.0 0.41	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	4.73 0.59 0.57	Forage (3) Hay (3)	22 57	2.2 0.72	0.21 0.15	2.5 0.95	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	4.73 0.59 0.57	Forage (3) Hay (3)	22 57	1.7 0.62	0.16 0.14	1.9 0.83	MSL13464

Location (year) variety	Type	Application N	kg ae/ha	kg ae/hL	Sample	PHI days	Residues (mg/kg) glyphosate	AMPA	Total	Report/ reference
Sheridan, Indiana USA (1993) 40-3	PRE LPO	2	6.4 0.84	3.45 0.75	Forage (2) Hay (2)	20 56	6.5 2.7	0.74 0.93	7.6 4.1	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.45 0.89 0.75	Forage (3) Hay (3)	20 56	3.2 0.95	0.36 0.33	3.7 1.5	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	3.45 0.89 0.75	Forage (3) Hay (3)	20 56	2.1 0.66	0.25 0.28	2.5 1.1	MSL13464
Steele, Missouri USA (1993) 40-3	PRE LPO	2	6.4 0.84	5.50 0.58	Forage (2) Hay (2)	20 66	0.31 0.12	0.084 < 0.05	0.44 0.12	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	5.45 0.59 0.76	Forage (3) Hay (3)	6 52	2.4 0.83	0.22 0.30	2.7 1.3	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	5.50 0.59 0.75	Forage (3) Hay (3)	6 52	1.6 0.54	0.17 0.19	1.9 0.83	MSL13464
Webster City, Iowa USA (1993) 40-3	PRE LPO	2	6.4 0.84	4.52 0.52	Forage (2) Hay (2)	14 56	1.8 0.44	0.12 0.09	2.0 0.58	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	4.52 0.57 0.52	Forage (3) Hay (3)	14 56	3.4 0.75	0.18 0.15	3.7 0.98	MSL13464
	PRE EPO LPO	3	6.4 0.84 0.84	4.52 0.57 0.52	Forage (3) Hay (3)	14 56	4.1 1.1	0.21 0.25	4.4 1.5	MSL13464

Application type: PRE = pre-emergence; EPO = early post-emergence; LPO = late post-emergence; PH = pre-harvest
Figures in brackets for forage and hay are the number of applications prior to sampling. In some cases not all the applications for a given treatment were made prior to the forage or hay sampling.

Table 82. Residues in Glyphosate tolerant sugar beet (tops) (USA) following application of an SL formulation of glyphosate (SL as the isopropylamine salt = 360 g ae/L).

Location (year) variety	type	Application N	kg ae/ha	kg ae/hL	PHI (days)	Residues (mg/kg) glyphosate	AMPA	Total	Report/ reference
Clay county, Minnesota, USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.4 0.86 0.85 0.85	4.2 0.84 0.84 0.84	59	0.49	0.10	0.64	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.85 0.86 1.7	3.4 0.84 0.84 1.68	28	3.6	0.17	3.9	MSL14542
Polk, Minnesota USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.1 0.81 0.87 0.83	2.4 0.48 0.48 0.48	58	0.13	0.09	0.27	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.82 0.83 1.7	1.920.48 0.48 0.96	31	5.6	0.19	5.9	MSL14542
Renville, Minnesota USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.3 0.84 0.83 0.84	3.4 0.48 0.48 0.48	56	0.66	< 0.05	0.66	MSL14542

Location (year) variety	type	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	PRE 2-4 12-14 PH	4	3.2 0.84 0.82 1.7	2.7 0.48 0.56 0.96	28	4.2	0.09	4.3	MSL14542
Saginaw, Michigan, USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.1 0.84 0.84 0.83	2.1 0.42 0.42 0.42	70 95	0.05 < 0.05	< 0.05 < 0.05	0.05 < 0.05	MSL14542
	PRE 2-4 12-14 PH	4	3.3 0.85 0.83 1.7	1.7 0.42 0.42 0.84	31 56	4.3 3.2	0.05 < 0.05	4.4 3.2	MSL14542
Richland, North Dakota USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.1 0.83 0.84 0.84	2.8 0.56 0.56 0.56	52 59 66 73 80	1.8 1.7 1.4 0.82 1.4	0.05 < 0.05 < 0.05 < 0.05 < 0.05	1.9 1.7 1.4 0.82 1.4	MSL14542
	PRE 2-4 12-14 PH	4	3.3 0.84 0.84 1.7	2.2 0.56 0.56 1.12	22 29 36 43 50	5.2 4.6 4.0 3.4 4.4	0.09 < 0.05 0.07 0.05 0.07	5.3 4.6 4.1 3.5 4.5	MSL14542
Scottsbluff, Nebraska USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.1 0.82 0.81 0.83	2.1 0.42 0.42 0.42	59 98	0.05 < 0.05	< 0.05 < 0.05	0.05 < 0.05	MSL14542
	PRE 2-4 12-14 PH	4	3.2 0.82 0.83 1.7	1.7 0.42 0.42 0.84	29 68	1.8 1.4	< 0.05 < 0.05	1.8 1.4	MSL14542
Hockley, Texas USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.3 0.83 0.85 0.84	2.8 0.56 0.56 0.56	59 92	0.34 0.23	< 0.05 < 0.05	0.34 0.23	MSL14542
	PRE 2-4 12-14 PH	4	3.5 0.84 0.85 1.7	2.2 0.56 0.56 1.12	29 62	3.9 3.2	0.09 0.12	4.0 3.4	MSL14542
Weld, Colorado, USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.3 0.85 0.87 0.84	2.4 0.48 0.56 0.56	63	0.13	< 0.05	0.13	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.84 0.85 1.7	1.92 0.48 0.56 1.12	31	2.2	0.10	2.4	MSL14542
Stanislaus, California USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.2 0.86 0.86 0.86	2.1 0.37 0.37 0.37	61 99	0.39 0.11	< 0.05 < 0.05	0.39 0.11	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.87 0.83 1.8	1.5 0.37 0.42 0.75	31 69	6.8 2.4	0.80 0.11	8.0 2.6	MSL14542
Stanislaus, California USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.4 0.87 0.83 0.82	1.9 0.37 0.42 0.42	62 99	0.23 0.12	< 0.05 < 0.05	0.23 0.12	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.83 0.83 1.7	1.7 0.42 0.42 0.84	32 69	8.4 3.4	0.56 0.24	9.3 3.8	MSL14542

Location (year) variety	type	Application N	Application kg ae/ha	Application kg ae/hL	PHI (days)	Residues (mg/kg) glyphosate	Residues (mg/kg) AMPA	Residues (mg/kg) Total	Report/ reference
Power, Idaho USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.3 0.90 0.86 0.86	2.8 0.56 0.56 0.56	60	0.11	< 0.05	0.11	MSL14542
	PRE 2-4 12-14 PH	4	3.4 0.90 0.84 1.6	2.2 0.56 0.56 0.56	29	2.0	0.06	2.1	MSL14542
Twin Falls, Idaho USA (1996) Event 77	PRE 2-4 6-8 PH	4	4.2 0.84 0.85 0.85	2.8 0.56 0.56 0.56	58	0.16	< 0.05	0.16	MSL14542
	PRE 2-4 12-14 PH	4	3.3 0.86 0.88 1.7	2.2 0.56 0.56 1.12	30	3.9	0.11	4.1	MSL14542

The first application is a pre-emergent application. Subsequent applications are in-crop post-emergent applications, 2-4 leaf stage, 4-8 leaf stage, 12-14 leaf stage and pre-harvest rescue.

Table 83. Residues in Barley (straw): Pre-harvest Application.

Location (year) variety	Form	Application N	Application kg ae/ha	Application kg ae/hL	PHI (days)	Residues (mg/kg) glyphosate	Residues (mg/kg) AMPA	Residues (mg/kg) Total	Report/ reference
Franc Warret, Belgium (1999) Marilor	C	1	2.2		0 7 14	80 c0.16 25 c0.22 22 c0.06	0.66 0.40 0.42	81 26 23	MLL31337
	G	1	2.2		0 7 14	90 c0.16 29 c0.22 18 c0.06	0.82 0.44 0.34	91 30 19	MLL31337
Franc Warret, Belgium (1998) Marilor	C	1	2.2		0 7 14	117 86 c0.08 25 c0.08	0.83 1.9 c0.05 0.92 c0.05	118 89 26	MLL30815
	H	1	2.2		0 7 14	145 75 c0.08 30 c0.08	0.79 2.2 c0.05 1.1 c0.05	146 78 32	MLL30815
Ansoville, Loiret, France (1999) Esterel	E	1	2.1	0.67	7	39		39	RJ2907B
	F	1	2.12	0.69	7	18		18	RJ2907B
Coupigny, Seine-et-Marne, France (1999) Esterel	E	1	2.0	0.68	7	6.4 c0.06		6.4 c0.06	RJ2907B
	F	1	2.1	0.69	7	6.9 c0.06		6.9 c0.06	RJ2907B
Duras Aquitaine, France (1999) Intro	C	1	2.2		0 7 14	184 c0.10 40 c0.11 22 c0.10	1.8 0.98 0.62	187 41 23	MLL31337
	G	1	2.2		0 7 14	161 c0.10 59 c0.11 26 c0.10	1.2 0.99 0.71	163 61 27	MLL31337
St Paul les Romans, Rhône-Aples, France (1999) Platine	C	1	2.2		0 7 14	112 c0.11 61 26 c0.37	1.7 1.2 0.97	115 63 27	MLL31337
	G	1	2.2		0 7 14	120 c0.11 71 28 c0.37	1.5 1.6 1.1	122 73 30	MLL31337

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Ploudalmézeau, Bretagne, France (1999) Scarlett	C	1	2.2		0 7 14	84 62 c0.05 9.1 c0.14	2.0 2.1 0.95	87 65 11	MLL31337
	G	1	2.2		0 7 14	145 110 c0.05 15 c0.14	1.4 3.0 1.7	147 115 18	MLL31337
Levroux, Centre, France (1999) Scarlett	C	1	2.2		0 7 14	189 c0.05 41 24	1.4 0.69 0.78	191 42 25	MLL31337
	G	1	2.2		0 7 14	180 c0.05 80 31	2.1 1.2 0.90	183 82 32	MLL31337
Favières, Lorraine, France (1999) Emeraude	C	1	2.2		0 7 14	110 31 29	0.83 0.49 0.84	111 32 30	MLL31337
	G	1	2.2		0 7 14	110 43 38	0.87 0.57 0.66	111 44 39	MLL31337
Duras Aquitaine, France (1998) Express	C	1	2.1		0 7 15	63 28 12 c0.14	0.24 0.6 0.65 c0.05	63 29 13	MLL30815
	H	1	2.0		0 7 15	70 40 31 c0.14	0.34 0.6 1.1 c0.05	71 41 33	MLL30815
St Paul les Romans, Rhône-Alpes, France (1998) Deborah	C	1	2.4		0 7 15	116 c0.08 102 61 c0.2	0.75 c0.05 2.0 1.9 c0.05	117 105 64	MLL30815
	H	1	2.2		0 7 15	98 c0.08 102 69 c0.2	0.63 c0.05 2.2 2.4 c0.05	99 105 73	MLL30815
Ploudalmézeau, Bretagne, France (1998) Intro	C	1	2.1		0 7 14	174 124 84	1.0 2.4 2.4	176 128 88	MLL30815
	H	1	2.1		0 7 14	164 147 56	1.0 2.4 2.4	166 151 50	MLL30815
Levroux, Centre, France (1998) Nevada	C	1	2.2		0 9 14	250 c0.34 11 12 c0.1	0.97 c0.05 0.26 0.4 c0.05	251 11 13	MLL30815
	H	1	2.2		0 9 14	206 c0.34 11 12 c0.1	0.78 c0.05 0.38 0.3 c0.05	207 12 12	MLL30815
Favières, Lorraine, France (1998) Scarlet	C	1	2.1		0 7 14	225 c0.07 4.4 6.0	0.74 c0.05 < 0.05 0.06	226 4.4 6.1	MLL30815
	H	1	2.3		0 7 14	208 c0.07 < 0.05 3.2	0.79 c0.05 < 0.05 < 0.05	209 < 0.05 3.2	MLL30815
Villeneuve, South France (1998) Sunrise [winter barley]	I	1	2.1	1.1	0 7 14	74 19 c0.16 33 c0.096	3.0 0.79 0.67	79 20 34	GLY 528
	J	1	2.1	1.1	0 7 14	156 21 c0.16 32 c0.096	0.76 0.90 0.66	157 22 33	GLY 528

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Bron, France (1998) Cameo [spring barley]	I	1	2.3	1.1	0 7 14	218 c0.18 96 c0.059 59 c0.11	1.4 2.6 2.3	220 100 63	GLY 528
	J	1	2.3	1.1	0 7 14	162 c0.18 72 c0.059 58 c0.11	1.9 2.4 3.1	165 76 63	GLY 528
Berstheim, Alsace, France (1998) Nevacla	I	1	2.1	1.1	7	93 c0.37		93 c0.37	GLY 418
	J	1	2.1	1.1	7	126 c0.37		126 c0.37	GLY 418
	J	1	1.7	0.81	7	115 c0.37		115 c0.37	GLY 418
Vayres sur Essonne, La Ferte-Alais, France (1991) Volga	K	1	1.1	0.54	8	9.0	0.07	9.1	MLL30281
	K	1	2.2	1.1	8	15	0.10	15	MLL30281
	L	1	1.0	0.53	8	0.30	< 0.05	0.3	MLL30281
	L	1	2.1	1.0	8	7.5	0.06	7.6	MLL30281
	C	1	2.2	1.1	8	9.0	0.06	9.1	MLL30281
Champmotteux, Maisse, France (1991) Natacha	K	1	1.1	0.54	7	7.9 c0.07	0.10	8.1	MLL30281
	K	1	2.2	1.1	7	17 c0.07	< 0.05	17	MLL30281
	L	1	1.0	0.53	7	4.2 c0.07	< 0.05	4.2	MLL30281
	L	1	2.1	1.0	7	16 c0.07	0.20	16	MLL30281
	C	1	2.2	1.1	7	12 c0.07	0.10	12	MLL30281
Sept Sauly, Reims, France (1991) Volga	K	1	1.1	0.54	7	61 c0.1	0.50	62	MLL30281
	K	1	2.2	1.1	7	140 c0.1	1.3	142	MLL30281
	L	1	1.0	0.53	7	49 c0.1	0.40	50	MLL30281
	L	1	2.1	1.0	7	72 c0.1	0.50	73	MLL30281
	C	1	2.2	1.1	7	140 c0.1	1.0	142	MLL30281
Verneuil sur Serre, Laon, France (1991) Natacha	K	1	1.1	0.54	7	70	0.70	71	MLL30281
	K	1	2.2	1.1	7	160	1.6	162	MLL30281
	L	1	1.0	0.53	7	30	0.30	30	MLL30281
	L	1	2.1	1.0	7	140	1.8	143	MLL30281
	C	1	2.2	1.1		120	1.2	122	MLL30281
Denton, Lincolnshire, UK (1999) Gleam	E	1	2.0		7	43		43	RJ2907B
	F	1	2.1		7	56		56	RJ2907B
Elford, Staffordshire, UK (1999) Regina	E	1	2.0	0.68	7	22		22	RJ2907B
	F	1	2.1	0.69	7	22		22	RJ2907B
Normanton, UK (1982) Igri	C	1	1.4	0.56	9	47	0.82	48	MLL30087
Lechdale, UK (1982) Igri	C	1	1.4	0.70	12	14	0.35	15	MLL30087
East Lothians, UK (1982) Igri	C	1	1.4	0.70	6	41	0.73	42	MLL30087

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Bossal, UK (1982) Igri	C	1	1.4	0.54	8	62	1.4	64	MLL30087
Cottenham, UK (1982) Triumph	C	1	1.4	0.70	7	13 c0.1	0.52	14	MLL30087

Formulation C = Roundup® 360 g ae/L SL; Formulation E = 337 g ae/L SL (trimesium salt); Formulation F = 347 g ae/L SL; Formulation G = MON 78294 450 g ae/L SL; Formulation H = MON 14420 680 g ae/kg SG; Formulation I and J both 360 g ae/L SL formulations; Formulation K = MON52776 360 g ae/L SL; Formulation L = MON44068 420 g ae/kg SG

Table 84. Residues in Conventional Maize stover and aspirate grain fractions: Pre-harvest Application (USA).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Greene Co., Iowa, USA (1997) DR592SR	SL	1	2.5	1.3	Stover AGF	7	4.8 1.6	< 0.05 < 0.05	4.8 1.6	MSL14917
Guthrie Co., Iowa, USA (1997) 2547	SL	1	2.5	1.4	Stover	7	6.7	0.09	6.8	MSL14917
Jefferson Co., Iowa, USA (1997) 34RO6	SL	1	2.6	1.6	Stover	7	3.4	0.05	3.5	MSL14917
Clinton Co., Illinois, USA (1997) Pioneer 3394	SL	1	2.5	1.5	Stover	7	44	0.40	45	MSL14917
Jersey Co., Illinois, USA (1997) Pioneer 3394	SL	1	2.5	1.3	Stover	7	35	0.48	36	MSL14917
Burt Co., Nebraska, USA (1997) P34RO6 B+	SL	1	2.5	1.3	Stover	7	2.6	< 0.05	2.6	MSL14917
York Co., Nebraska, USA (1997) 3394	SL	1	2.5	1.2	Stover AGF	6	2.1 0.71	< 0.05 < 0.05	2.1 0.71	MSL14917
Wayne Co., New York, USA (1997) Agway 266	SL	1	2.6	1.2	Stover	7	53	0.38	54	MSL14917
Wilson Co., North Carolina USA (1997) Pioneer 3163	SL	1	2.7	1.2	Stover	7	43	1.1	45	MSL14917
Monmouth, Illinois USA (1993) Asgrow 707/623	SL	1	2.5	1.6	stover	6	23	0.66	24	MSL13654
Fishers, Indiana USA (1993) Select 3720	SL	1	2.5	1.9	stover	7	8.4	0.26	8.8	MSL13654
Danville, Iowa USA (1993) Querna 7670	SL	1	2.5	1.2	stover	7	28	0.41	29	MSL13654

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Lexington, Kentucky, USA (1993) Pioneer 3320	SL	1	2.5	1.7	stover	7	43	0.52	44	MSL13654
Conklan, Michigan USA (1993) Pioneer 3563	SL	1	2.6	1.5	stover	6	3.7	0.09	3.8	MSL13654
Lamberton, Minnesota USA (1993) Pioneer 3563	SL	1	2.5	1.2	stover	6	82	0.46	83	MSL13654
Leonard, Missouri USA (1993) C-G-4490	SL	1	2.5	1.4	stover	6	8.8	0.13	9.0	MSL13654
York, Nebraska USA (1993) Pioneer 3162	SL	1	2.5	2.4	stover	6	92	0.81	93	MSL13654
New Holland, Ohio USA (1993) Madison Seed GL 235	SL	1	2.5	1.4	stover	6	11	0.14	11	MSL13654
Valley Springs, South Dakota USA (1993) Pioneer 3563	SL	1	2.5	2.3	stover	7	55	0.33	56	MSL13654
Uvalde, Texas USA (1993) Pioneer 3245	SL	1	2.5	1.2	stover	6	54	0.61	55	MSL13654
Delavan, Wisconsin USA (1993) RK 702	SL	1	2.5	1.3	stover	7	18	0.12	18	MSL13654

AGF = aspirated grain fraction

Table 85. Residues in Glyphosate Tolerant Maize forage and stover.

Location (year) variety	Type	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Chula, Tift County, Georgia USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.86 0.85 0.84	2.1 0.42 0.48 0.67	forage stover	34 68	0.94 1.6	0.03 < 0.06	0.99 1.6	MSL15334
	PRE EPO LPO DN	4	3.4 0.86 0.86 1.7	2.1 0.42 0.48 1.34	forage stover	34 68	1.3 2.6	0.04 < 0.06	1.4 2.6	MSL15334
	PRE EPO LPO	3	4.3 0.87 1.7	2.1 0.42 0.96	forage stover	40 74	2.6 5.7	0.06 < 0.06	2.7 5.7	MSL15334
Richland, Jefferson County Iowa USA (1999) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.84	2.1 0.42 0.42 0.42	forage stover	56 77	0.66 0.87	0.06 < 0.06	0.75 0.87	MSL15334

Location (year) variety	Type	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE	4	3.5	2.1	forage	56	0.47	0.05	0.55	MSL15334
	EPO		0.85	0.42	stover	77	0.81	< 0.06	0.81	
	LPO		0.85	0.42						
	DN		1.7	0.84						
	PRE	3	4.2	2.1	forage	64	0.32	0.03	0.37	MSL15334
	EPO		0.86	0.42	stover	85	0.43	< 0.06	0.43	
	LPO		1.7	0.84						
Webster City, Hamilton County, Iowa USA (1998) GA21	PRE	4	4.2	2.8	forage	42	0.93	< 0.03	0.93	MSL15334
	EPO		0.84	0.56	stover	98	1.4	< 0.06	1.4	
	LPO		0.84	0.56						
	DN		0.84	0.48						
	PRE	4	3.3	2.8	forage	42	1.2	0.05	1.3	MSL15334
	EPO		0.84	0.56	stover	98	1.4	< 0.06	1.4	
	LPO		0.84	0.56						
	DN		1.7	0.96						
	PRE	3	4.3	2.8	forage	51	1.8	0.04	1.9	MSL15334
	EPO		0.85	0.56	stover	107	2.3	< 0.06	2.3	
	LPO		1.7	1.12						
Bagley, Guthrie County Iowa USA (1998) GA21	PRE	4	4.3	2.1	forage	65	0.55	0.03	0.60	MSL15334
	EPO		0.88	0.42	stover	96	0.89	< 0.06	0.89	
	LPO		0.84	0.42						
	DN		0.80	0.48						
	PRE	4	3.5	2.1	forage	65	0.49	0.03	0.54	MSL15334
	EPO		0.87	0.42	stover	96	0.98	< 0.06	0.98	
	LPO		0.84	0.42						
	DN		1.6	0.96						
	PRE	3	4.2	2.1	forage	74	0.85	< 0.03	0.85	MSL15334
	EPO		0.88	0.42	stover	105	2.0	< 0.06	2.0	
	LPO		1.7	0.84						
Berkley, Boone County Iowa USA (1998) GA21	PRE	4	4.3	2.1	forage	64	0.26	< 0.03	0.26	MSL15334
	EPO		0.88	0.42	stover	93	0.48	< 0.06	0.48	
	LPO		0.85	0.42						
	DN		0.80	0.48						
	PRE	4	3.4	2.1	forage	64	1.5	0.03	1.5	MSL15334
	EPO		0.87	0.42	stover	93	1.8	0.05	1.9	
	LPO		0.84	0.42						
	DN		1.6	0.96						
	PRE	3	4.2	2.1	forage	74	0.91	< 0.03	0.91	MSL15334
	EPO		0.88	0.42	stover	103	0.49	< 0.06	0.49	
	LPO		1.7	0.84						
Dow, Jersey County, Illinois USA (1998) GA21	PRE	4	4.2	2.4	forage	40	0.72	0.05	0.80	MSL15334
	EPO		0.84	0.48	stover	77	1.2	< 0.06	1.2	
	LPO		0.84	0.48						
	DN		0.85	0.48						
	PRE	4	3.4	2.4	forage	40	1.3	0.08	1.4	MSL15334
	EPO		0.85	0.48	stover	77	2.2	< 0.06	2.2	
	LPO		0.86	0.48						
	DN		1.6	0.96						
	PRE	3	4.2	2.4	forage	47	1.8	0.04	1.9	MSL15334
	EPO		0.85	0.48	stover	84	2.6	< 0.06	2.6	
	LPO		1.7	0.96						
Carlyle, Clinton County Illinois USA (1998) GA21	PRE	4	4.2	2.8	forage	43	0.56	0.04	0.62	MSL15334
	EPO		0.84	0.56	stover	84	0.79	< 0.06	0.79	
	LPO		0.84	0.48						
	DN		0.82	0.56						
	PRE	4	3.4	2.8	forage	43	0.82	0.05	0.90	MSL15334
	EPO		0.84	0.56	stover	84	1.5	< 0.06	1.5	
	LPO		0.85	0.48						
	DN		1.6	1.12						
	PRE	3	4.2	2.8	forage	52	1.1	0.04	1.2	MSL15334
	EPO		0.86	0.56	stover	93	1.8	< 0.06	1.8	
	LPO		1.7	0.96						

Location (year) variety	Type	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Wyoming,, Stark County Illinois USA (198) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.84	2.4 0.56 0.67 0.67	forage stover	50 101	0.38 0.85	0.04 < 0.06	0.44 0.85	MSL15334
	PRE EPO LPO DN	4	3.4 0.84 0.84 1.7	2.4 0.56 0.67 1.34	forage stover	50 101	0.42 0.84	0.05 < 0.06	0.50 0.84	MSL15334
	PRE EPO LPO	3	4.2 0.86 1.7	2.4 0.56 1.34	forage stover	57 108	0.79 1.1	0.03 < 0.06	0.84 1.1	MSL15334
Noblesville, Hamilton County Indiana, USA (1998) GA21	PRE EPO LPO DN	4	4.2 0.84 0.85 0.82	2.1 0.42 0.42 0.48	forage stover	59 91	0.51 0.28	< 0.03 < 0.06	0.51 0.28	MSL15334
	PRE EPO LPO DN	4	3.4 0.85 0.85 1.7	2.1 0.42 0.42 0.96	forage stover	59 91	1.3 0.38	0.04 < 0.06	1.4 0.38	MSL15334
	PRE EPO LPO DN	3	4.2 0.85 1.7	2.1 0.42 0.96	forage stover	70 102	0.82 1.3	< 0.03 < 0.06	0.82 1.3	MSL15334
Williamston, Ingham County Michigan USA (1998) GA21	PRE EPO LPO DN	4	4.1 0.84 0.84 0.84	2.8 0.56 0.56 0.56	forage stover	50 88	0.54 0.83	< 0.03 < 0.06	0.54 0.83	MSL15334
	PRE EPO LPO DN	4	3.3 0.84 0.84 1.7	2.8 0.56 0.56 1.1	forage stover	50 88	0.30 0.57	< 0.03 < 0.06	0.30 0.57	MSL15334
	PRE EPO LPO	3	4.2 0.84 1.7	2.8 0.56 1.1	forage stover	60 98	0.19 0.36	< 0.03 < 0.06	0.19 0.36	MSL15334
Conklin, Ottawa County Michigan USA (1998) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.84	2.4 0.48 0.48 0.48	forage stover	49 94	0.81 0.92	0.06 < 0.06	0.90 0.92	MSL15334
	PRE EPO LPO DN	4	3.4 0.84 0.85 1.7	2.4 0.48 0.48 0.96	forage stover	49 94	1.0 1.2	0.09 < 0.06	1.1 1.2	MSL15334
	PRE EPO LPO	3	4.2 0.84 1.7	2.4 0.48 0.96	forage stover	59 104	1.3 2.0	0.06 < 0.06	1.4 2.0	MSL15334
Campbell, Wilkin County Minnesota USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.85 0.85 0.84	2.1 0.84 0.84 0.84	forage stover	54 75	0.26 0.58	< 0.03 < 0.06	0.26 0.58	MSL15334
	PRE EPO LPO DN	4	3.4 0.85 0.85 1.7	2.1 0.84 0.84 1.68	forage stover	54 75	0.27 0.63	< 0.03 < 0.06	0.27 0.63	MSL15334
	PRE EPO LPO	3	4.2 0.85 1.7	2.1 0.84 1.68	forage stover	65 86	0.50 1.0	< 0.03 < 0.06	0.5 1.0	MSL15334
Hollandale, Freeborn County Minnesota USA (1998) GA21	PRE EPO LPO DN	4	4.0 0.84 0.84 0.84	2.8 0.56 0.56 0.56	forage stover	52 91	0.68 1.5	0.04 < 0.06	0.74 1.5	MSL15334

Location (year) variety	Type	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE	4	3.2	2.8	forage	45	0.21	< 0.03	0.21	MSL15334
	EPO		0.86	0.56	stover	85	0.25	< 0.06	0.25	
	LPO		0.87	0.56						
	DN		1.7	1.1						
	PRE	3	4.1	2.8	forage	63	1.2	0.04	1.3	MSL15334
	EPO		0.86	0.56	stover	102	2.9	< 0.06	2.9	
	LPO		1.7	1.1						
Rose Hill, Sampson County North Carolina USA (1998) GA21	PRE	4	4.1	2.8	forage	39	1.5	0.05	1.6	MSL15334
	EPO		0.84	0.56	stover	67	3.9	< 0.06	3.9	
	LPO		0.84	0.56						
	DN		0.84	0.56						
	PRE	4	3.3	2.8	forage	39	1.9	0.06	2.0	MSL15334
	EPO		0.84	0.56	stover	67	4.0	< 0.06	4.0	
	LPO		0.84	0.56						
	DN		1.7	1.12						
	PRE	3	4.1	2.8	forage	43	2.2	0.11	2.4	MSL15334
	EPO		0.84	0.56	stover	71	5.2	< 0.06	5.2	
	LPO		1.7	1.12						
York, York County Nebraska (1998) GA21	PRE	4	4.2	2.8	forage	54	0.52	< 0.03	0.52	MSL15334
	EPO		0.84	0.56	stover	75	0.80	< 0.06	0.80	
	LPO		0.84	0.56						
	DN		0.85	0.56						
	PRE	4	3.3	2.8	forage	54	0.53	0.03	0.58	MSL15334
	EPO		0.84	0.56	stover	75	0.79	< 0.06	0.79	
	LPO		0.84	0.56						
	DN		1.67	1.1						
	PRE	3	4.2	2.8	forage	60	0.87	0.03	0.92	MSL15334
	EPO		0.84	0.56	stover	81	1.3	< 0.06	1.3	
	LPO		1.7	1.1						
Osceola, Polk County Nebraska (1998) GA21	PRE	4	4.2	2.1	forage	44	0.50	0.03	0.55	MSL15334
	EPO		0.84	0.56	stover	70	0.82	< 0.06	0.82	
	LPO		0.84	0.56						
	DN		0.84	0.84						
	PRE	4	3.3	2.1	forage	44	0.50	< 0.03	0.50	MSL15334
	EPO		0.84	0.56	stover	70	0.76	< 0.06	0.76	
	LPO		0.84	0.56						
	DN		1.7	1.7						
	PRE	3	4.2	2.1	forage	52	0.92	0.04	0.98	MSL15334
	EPO		0.84	0.56	stover	78	2.0	< 0.06	2.0	
	LPO		1.7	1.1						
New Holland, Fayette County Ohio USA (1998) GA21	PRE	4	4.1	2.4	forage	54	2.8	0.05	2.9	MSL15334
	EPO		0.84	0.42	stover	84	4.3	< 0.06	4.3	
	LPO		0.85	0.48						
	DN		0.84	0.67						
	PRE	4	3.3	2.4	forage	54	2.4	0.06	2.5	MSL15334
	EPO		0.85	0.42	stover	84	5.1	< 0.06	5.1	
	LPO		0.85	0.48						
	DN		1.7	1.34						
	PRE	3	4.2	2.4	forage	58	4.6	0.08	4.7	MSL15334
	EPO		0.84	0.42	stover	88	14	0.09	14	
	LPO		1.7	0.96						
Germansville, Leigh Co. Pennsylvania USA (1998) GA21	PRE	4	4.3	2.1	forage	66	4.2	0.09	4.3	MSL15334
	EPO		0.85	0.42	stover	102	1.1	< 0.06	1.1	
	LPO		0.86	0.42						
	DN		0.86	1.7						
	PRE	4	3.4	2.1	forage	66	5.2	0.11	5.4	MSL15334
	EPO		0.85	0.42	stover	102	1.5	< 0.06	1.5	
	LPO		0.85	0.42						
	DN		1.7	1.7						
	PRE	3	4.3	2.1	forage	74	5.5	0.08	5.6	MSL15334
	EPO		0.86	0.42	stover	110	2.3	< 0.06	2.3	
	LPO		1.7	0.84						

Location (year) variety	Type	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Britton, Marshall County South Dakota USA (1998) GA21	PRE EPO LPO DN	4	4.2 0.84 0.84 0.84	4.2 0.84 0.84 0.56	forage stover	56 101	0.06 0.64	0.04 < 0.06	0.12 0.64	MSL15334
	PRE EPO LPO DN	4	3.3 0.84 0.84 1.7	4.2 0.84 0.84 1.1	forage stover	56 101	0.15 2.3	0.03 < 0.06	0.20 2.3	MSL15334
	PRE EPO LPO	3	4.2 0.84 1.7	4.2 0.84 1.7	forage stover	61 106	0.30 1.2	0.03 < 0.06	0.35 1.2	MSL15334
Buffalo Springs, Clay County Texas USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.86 0.85 0.85	2.8 0.48 0.56 0.67	forage stover	25 46	2.4 5.4	0.15 c0.08 0.07	2.6 5.5	MSL15334
	PRE EPO LPO DN	4	3.4 0.86 0.84 1.7	2.8 0.48 0.56 1.34	forage stover	25 46	2.8 4.6	0.36 c0.08 < 0.06	3.3 4.6	MSL15334
	PRE EPO LPO	3	4.3 0.86 1.7	2.8 0.48 1.12	forage stover	33 54	2.54 5.9	0.13 c0.08 < 0.06	2.7 5.9	MSL15334
Verona, Dane County Wisconsin USA (1998) GA21	PRE EPO LPO DN	4	4.2 0.85 0.87 0.86	3.4 0.56 0.48 0.48	forage stover	56 99	0.49 0.75	0.03 < 0.06	0.54 0.75	MSL15334
	PRE EPO LPO DN	4	3.2 0.82 0.82 1.7	3.4 0.56 0.48 0.96	forage stover	56 99	0.66 0.90	0.04 < 0.06	0.72 0.90	MSL15334
	PRE EPO LPO	3	4.2 0.84 1.7	3.4 0.56 0.96	forage stover	68 111	0.73 0.95	0.03 < 0.06	0.78 0.95	MSL15334
Delavan, Walworth County Wisconsin USA (1998) GA21	PRE EPO LPO DN	4	4.3 0.82 0.84 0.85	2.4 0.48 0.48 0.67	forage stover	54 102	0.65 c0.05 1.0	< 0.03 < 0.06	0.65 1.0	MSL15334
	PRE EPO LPO DN	4	3.4 0.85 0.82 1.7	2.4 0.48 0.48 1.3	forage stover	54 102	0.67 c0.05 1.0	0.04 < 0.06	0.73 1.0	MSL15334
	PRE EPO LPO	3	4.1 0.84 1.6	2.4 0.48 0.96	forage stover	62 110	1.1 c0.05 1.5	0.04 < 0.06	1.2 1.5	MSL15334

Treatment types include: PRE = pre-emergence; EPO = early post-emergence; LPO = late post-emergence; DN = drop nozzle.

Table 86. Residues in Oat plants and straw: Pre-harvest Application.

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Elm Creek Manitoba, Canada (2001) Triple Crown	C	1	0.90	-	Straw	7	1.7, 1.5	0.058, < 0.05	1.8, 1.5	CER 01307/01
	M	1	0.90	-	Straw	7	3.5, 1.5	0.08, < 0.05	3.6, 1.5	CER 01307/01
Vanscoy, Saskatchewan, Canada (2001) Calibre	C	1	0.90	-	Straw	6	33, 19	0.51, 0.24	34, 19	CER 01307/01

Location (year) variety	Form	Application N	kg ae/ha	kg ae/hL	Sample	PHI (days)	Residues (mg/kg) glyphosate	AMPA	Total	Report/ reference
	M	1	0.90	-	Straw	6	21, 16	0.22, 0.47	21, 17	CER 01307/01
Minto, Manitoba, Canada (2001) AC Assiniboia	C	1	0.90	-	Straw	6	16, 19	0.16, 0.38	16, 20	CER 01307/01
	M	1	0.90	-	Straw	6	14, 27	0.098, 0.36	14, 28	CER 01307/01
Newark, Nottinghamshire, UK (1993) Craig	C	1	1.4	0.72	Straw	7	16 c0.06			GLY 282, GLY 297
		1	0.72	0.36	Straw	7	4.8 c0.06			GLY 282, GLY 297
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	Straw	7	6.2 c0.06			GLY 282, GLY 297
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	Straw	7	3.7 c0.06			GLY 282, GLY 297
East Rounton, Yorkshire, UK (1993) Mirabel	C	1	1.4	0.72	Straw	7	12 c0.07			GLY 282, GLY 297
		1	0.72	0.36	Straw	7	7.6 c0.07			GLY 282, GLY 297
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	Straw	7	10 c0.07			GLY 282, GLY 297
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	Straw	7	2.9 c0.07			GLY 282, GLY 297
Brockhampton, Herefordshire, UK (1993) Image	C	1	1.4	0.72	Straw	7	64			GLY 282, GLY 297
		1	0.72	0.36	Straw	7	36			GLY 282, GLY 297
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	Straw	7	2.6/63/50*) 58			GLY 282, GLY 297
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	Straw	7	12			GLY 282, GLY 297
Disewort, Leicestershire, UK (1993) Aintree	C	1	1.4	0.72	Whole plant Whole plant Whole plant Straw	4 (hrs) 1 3 7	39 32 34 c0.05 33 c0.1			GLY 261, GLY 270
		1	0.72	0.36	Whole plant Whole plant Whole plant Straw	4 (hrs) 1 3 7	22 24 22 c0.05 8.7 c0.1			GLY 261, GLY 270
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	Whole plant Whole plant Whole plant Straw	4 (hrs) 1 3 7	21 18 17 c0.05 15 c0.1			GLY 261, GLY 270

Location (year) variety	Form	Application N	kg ae/ha	kg ae/hL	Sample	PHI (days)	Residues (mg/kg) glyphosate	AMPA	Total	Report/ reference
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	Whole plant Whole plant Whole plant Straw	4 (hrs) 1 3 7	8.8 12 9.6 c0.05 5.7 c0.1			GLY 261, GLY 270
East Rounton, North Yorkshire, UK (1993) Mirabel	C	1	1.4	0.72	Whole plant Whole plant Whole plant Straw	4 (hrs) 1 3 7	24 19 c0.1 6.7 c0.12 21 c0.6			GLY 261, GLY 270
		1	0.72	0.36	Whole plant Whole plant Whole plant Straw	4 (hrs) 1 3 7	11 12 c0.1 6.3 c0.12 11 c0.6			GLY 261, GLY 270
		1	0.72+0.825 Frigate	0.36+0.41 Frigate	Whole plant Whole plant Whole plant Straw	4 (hrs) 1 3 7	7.5 11 c0.1 3.6 c0.12 6.6 c0.6			GLY 261, GLY 270
		1	0.36+0.825 Frigate	0.18+0.41 Frigate	Whole plant Whole plant Whole plant Straw	4 (hrs) 1 3 7	8.6 5.6 c0.1 2.3 c0.12 4.5 c0.6			GLY 261, GLY 270
Buckingham, UK (1982) Pennal	C	1	1.4	0.72	Straw	12	8.2 c0.1	0.20	8.5	MLL30087
Cottenham, UK (1982) Trafalsar	C	1	1.4	0.72	Straw	7	25 c0.1	0.54	26	MLL30087
Edinburgh, UK (1982) Maris Tabard	C	1	1.4	0.72	Straw	7	35 c0.9	0.99	37	MLL30087
Skelton, UK (1982) Maris Quest	C	1	1.4	0.72	Straw	7	49	0.48	50	MLL30087

Formulation C = 360 g/L SL; Formulation M = 640 g/L trimesium salt SL + 0.5% v/v surfactant; Frigate = tallow amine ethoxylate

Table 87. Residues in Rye straw: Pre-harvest Application (Denmark).

Location (year) variety	Form	Application N	kg ae/ha	kg ae/hL	Sample	PHI (days)	Residues (mg/kg) glyphosate	AMPA	Total	Report/ reference
Fyn, Denmark (1984) Petkus2	C	1	1.1	0.54	Straw	0	134 c1.3			MLL30150
		1	2.2	1.1	Straw	0	263 c1.3			MLL30150
Oglland, Denmark (1984) Petkus2	C	1	1.1	0.54	Straw	0	198 c1.5			MLL30150
		1	2.2	1.1	Straw	0	279 c1.5			MLL30150

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Fyn, Denmark (1984) Petkus2	C	1	1.1	0.54	Straw	0	193 c0.6			MLL30150
		1	2.2	1.1	Straw	0	362 c0.6			MLL30150

Table 88. Residues in Sorghum stover and hay: Pre-harvest Application (USA).

Location (year) variety	Form	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Wilson, North Carolina, USA (1997) Pioneer 8446	SL	1	1.7	0.82	Stover	7 (0)	16	0.27	16	MSL14918
Waller, Texas USA (1997) Mycogen 1558	SL	1	1.7	0.90	Stover	9 (2)	21	0.44	22	MSL14918
Uvalde, Texas USA (1997) Pioneer 8313	SL	1	1.7	1.08	Stover	14 (7)	17	0.17	17	MSL14918
Pratt, Kansas USA (1997) Pioneer 8414	SL	1	1.7	0.90	Stover	17 (10)	19	0.45	20	MSL14918
Stafford, Kansas USA (1997) Pioneer 8601	SL	1	1.7	0.90	Stover	16 (9)	17	0.37	18	MSL14918
Jackson, Arkansas USA (1992) Pioneer 8333	SL	1	1.7	0.81	stover hay	8 12 (4)	16 18	0.29 0.36	16 19	MSL13037
Chautauqua, Kansas USA (1992) Garst 5319	SL	1	1.7	0.84	stover hay	6 11 (5)	33 15	0.33 0.22	33 15	MSL13037
Pratt, Kansas USA (1992) NK 2030	SL	1	1.7	0.93	stover hay	8 11 (3)	29 37	0.27 0.31	29 37	MSL13037
Shelby, Missouri USA (1992) Horizon 101-G	SL	1	1.7	0.81	stover hay	7 15 (8)	28 15	0.22 0.15	28 15	MSL13037
York, Nebraska USA (1992) Pioneer 2030	SL	1	1.7	1.6	stover hay	8 12 (4)	7.0 4.3	0.09 0.08	7.1 4.4	MSL13037
Caddo, Oklahoma USA (1992) Pioneer 8500	SL	1	1.7	1.1	stover hay	7 11 (4)	30 36	0.41 0.45	30 37	MSL13037
Tripp, South Dakota USA (1992) DeKalb	SL	1	1.7	0.86	stover hay	7 10 (3)	2.9 6.4	< 0.05 < 0.05	2.9 6.4	MSL13037
Burleson, Texas USA (1992) 522DR	SL	1	1.7	1.3	stover hay	8 11 (3)	8.2 3.1	0.16 < 0.05	8.4 3.1	MSL13037

Table 89. Residues in Wheat straw: Pre-harvest Application.

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Franc Warret, Belgium (1999) Soissons	C	1	2.2		0 7 14	135 c0.08 88 c0.24 79 c0.12	1.5 1.4 1.2	137 90 81	MLL31337
	G	1	2.2		0 7 14	147 c0.08 103 c0.24 60 c0.12	1.4 1.4 1.2	149 105 62	MLL31337
Franc Warret, Belgium (1998) Rialto	C	1	2.2		0 7 14	156 198 c0.28 103 c0.28	0.67 2.4 c0.05 2.2 c0.05	157 202 106	MLL30815
	H	1	2.2		0 7 14	111 c0.05 151 c0.28 152 c028	0.84 2.4 c0.05 3.2 c0.05	112 155 157	MLL30815
Audeville, Loiret, France (1999) Courtot IQ	F	1	2.1	-	7	68		68	RJ2910B
	E	1	2.0		7	67		67	RJ2910B
Coupigny, Seine-et-Marne, France (1999) Isengrain IQ	F	1	2.1	-	7	109 c0.14		109	RJ2910B
	E	1	2.0		7	60 c0.14		60 c0.14	RJ2910B
Duras Aquitaine, France (1999) Isengrain	C	1	2.2		0 7 14	53 c1.1 25 c0.06 21	0.55 0.77 0.99	54 26 23	MLL31337
	G	1	2.2		0 7 14	61 c1.1 32 c0.06 28	0.52 0.72 1.1	62 33 30	MLL31337
St Paul les Romans, Rhône-Alpes, France (1999) Aztec	C	1	2.2		0 7 14	67 c0.06 19 19 c0.06	0.91 0.61 0.58	68 20 20	MLL31337
	G	1	2.2		0 7 14	100 c0.06 25 19 c0.06	0.86 0.95 0.57	101 26 20	MLL31337
Fessenheim, Alsace, France (1999) Camp Remy	C	1	2.2		0 7 14	44 13 7.8	0.55 0.38 0.20	45 14 8.1	MLL31337
	G	1	2.2		0 7 14	57 23 13	0.60 0.56 0.31	58 24 13	MLL31337
Battigny, Lorraine, France (1999) Camp Remy	C	1	2.2		0 7 14	84 0.08 25 21	0.97 0.41 0.39	85 26 22	MLL31337
	G	1	2.2		0 7 14	84 c0.08 25 21	0.48 0.27 0.40	85 25 22	MLL31337
Ploudalmézeau, Bretagne, France (1999) Cyrano	C	1	2.2		0 7 14	106 91 16	0.99 1.9 1.3	108 94 18	MLL31337
	G	1	2.2		0 7 14	113 107 14	1.2 2.8 1.0	115 111 16	MLL31337

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Duras Aquitaine, France (1998) Soissons	C	1	2.2		0 7 15	39 c0.14 5.1 c0.05 15	0.26 c0.05 < 0.05 c0.05 3.7	39 5.1 21	MLL30815
	H	1	2.3		0 7 15	53 c0.14 13 c0.05 16	0.41 c0.05 0.18 c0.05 0.44	54 13 17	MLL30815
St Paul les Romans, Rhône-Alpes, France (1998) Tremie	C	1	2.1		0 10 18	67 16 16	0.61 0.49 0.67	68 17 17	MLL30815
	H	1	2.2		0 10 18	86 24 9.7	0.75 0.58 0.26	87 25 10	MLL30815
Ploudalmézeau, Bretagne, France (1998) Tremie	C	1	2.2		0 7 14	95 c0.7 79 c0.7 90	0.75 c0.05 0.12 c0.05 0.24 c0.05	96 79 90	MLL30815
	H	1	2.2		0 7 14	88 c0.70 80 c0.70 66	0.78 c0.05 0.08 c0.05 0.89 c0.05	89 80 67	MLL30815
Levroux, Centre, France (1998) Oracle	C	1	2.2		0 9 14	140 c0.76 7.5 c0.08 9.8 c0.06	0.54 c0.05 1.4 c0.05 3.2	141 9.6 15	MLL30815
	H	1	2.2		0 9 14	139 c0.76 5.6 c0.08 20 c0.06	0.55 c0.05 1.5 c0.05 1.8	140 7.9 23	MLL30815
Fessenheim, Alsace, France (1998) Sideral	C	1	2.2		0 7 14	95 64 59	0.41 0.61 0.71	96 65 60	MLL30815
	H	1	2.2		0 7 14	91 77 59	0.4 0.55 0.68	92 78 60	MLL30815
Illiat, South France (1998) Soissons [winter soft wheat]	I	1	2.2	1.1	0 7 14	69 c0.18 7.1 3.5	0.63 0.53 0.89	70 7.9 4.9	GLY 528
	J	1	2.1	1.1	0 7 14	87 c0.18 6.4 4.1	0.91 0.64 0.70	88 7.4 5.2	GLY 528
Lavannes, France (1998) Tremie [winter wheat]	I	1	2.2	1.1	0 7 14	132 44 c0.081 36 c0.093	1.1 1.0 0.82	134 46 37	GLY 528
	J	1	2.2	1.1	0 7 14	95 39 c0.081 58 c0.093	1.7 1.2 1.4	98 41 60	GLY 528
Entzheim, Alsace, France (1996) Sideral	I	1	2.1	1.1	7	96 c0.051		96	GLY 418
	J	1	2.1	1.1	7	78 c0.051		78	GLY 418
	J	1	1.6	0.81	7	60 c0.051		60	GLY 418
Hilsprich, Lorraine, France (1996) Scheiersmatt	I	1	2.0	1.1	7	41 c0.055		41	GLY 418
	J	1	2.1	1.1	7	46 c0.055		46	GLY 418
	J	1	1.5	0.81	7	37 c0.055		37 c0.055	GLY 418
Boyer, Tounus, France (1991) Campremy	K	1	1.1	0.54	7	36	0.30	36	MLL30281

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	K	1	2.2	1.1	7	70	0.70	71	MLL30281
	L	1	1.0	0.53	7	28	0.30	28	MLL30281
	L	1	2.1	1.0	7	57	0.70	58	MLL30281
	C	1	2.2	1.1	7	63	0.50	64	MLL30281
La Planche, Cely, France (1991) Pernel	K	1	1.1	0.54	7	50	0.70	51	MLL30281
	K	1	2.2	1.1	7	87	1.6	89	MLL30281
	L	1	1.0	0.53	7	74	1.7	77	MLL30281
	L	1	2.1	1.0	7	79	1.6	81	MLL30281
	C	1	2.2	1.1	7	120	2.2	123	MLL30281
Secqueville, Caen, France (1991) Thesee	K	1	1.1	0.54	10	42 c0.2	0.80	43	MLL30281
	K	1	2.2	1.1	10	85 c0.2	1.8	88	MLL30281
	L	1	1.0	0.53	10	31 c0.2	0.80	32	MLL30281
	L	1	2.1	1.0	10	98 c0.2	2.2	101	MLL30281
	C	1	2.2	1.1	10	71 c0.2	1.6	73	MLL30281
Montigny sur Crecy, Laon, France (1991) Slepner	K	1	1.1	0.54	10	56 c0.4	0.60	57	MLL30281
	K	1	2.2	1.1	10	130 c0.4	1.4	132	MLL30281
	L	1	1.0	0.53	10	33 c0.4	0.40	34	MLL30281
	L	1	2.1	1.0	10	87 c0.4	1.1	89	MLL30281
	C	1	2.2	1.1	10	70 c0.4	0.70	71	MLL30281
Norton, Worcestershire, UK (1999) Equinox	F	1	2.1	-	7	23 c0.26		23	RJ2910B
	E	1	2.0		7	17 c0.26		17	RJ2910B
Wilson, Derbyshire, UK (1999) Rialto IQ	F	1	2.1	-	7	27 c0.36		27	RJ2910B
	E	1	2.0		7	25 c0.36		25	RJ2910B
Debden, Essex, UK (1982) Norman	C	1	1.4		7	47	0.44	48	MLL30087
Debden, Essex, UK (1982 Norman	C	1	1.4		7	47 c0.1	0.62	48	MLL30087
Tadcaster, Yorkshire, UK (1982) Bounty	C	1	1.4		7	6.3 c0.3	0.13	6.5	MLL30087
Edinburgh, UK (1982) Mardlor	C	1	1.4		8	7.3 c0.1	0.31	7.8	MLL30087
Chiseldon, Wiltshire, UK (1982) Avalon	C	1	1.4		8	18	0.28	18	MLL30087

H = MON 14420 680 g ae/kg SG Formulation C = Roundup® 360 g ae/L SL; Formulation F = 347 g ae/L SL; E = 337 g ae/L SL (trimesium salt); Formulation G = MON 78294 SL; Formulation I and J both 360 g ae/L SL
Formulation K = MON 52776 360 g ae/L SL; Formulation L = MON 44068 420 g ae/kg SG

Table 90. Residues in almond hulls: Directed Ground Spray Application (USA).

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	

Location (year) variety	Form	Application			PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Fresno, California USA (1989) Mission	SL	1	8.9	3.2	3 10	18 7.2	0.06 0.06	18 7.3	MSL11022, MSL11519
Hughson, California USA (1989) Thompson	SL	1	8.9	7.4	3 10	0.70 0.78	0.06 0.06	0.79 0.87	MSL11022, MSL11519
Popular, California USA (1989) Mission	SL	1	8.9	3.7	3 10	13 c0.12 15	< 0.05 0.08	13 15	MSL11022, MSL11519
Porterville, California USA (1989) Non-Pareil)	SL	1	8.9	3.4	3 10	0.62 2.9	< 0.05 0.10	0.62 3.1	MSL11022, MSL11519
Turlock, California USA (1989) Thompson	SL	1	8.9	6.8	3 10	2.6 1.5	< 0.05 < 0.05	2.6 1.5	MSL11022, MSL11519
Esparto, California USA (1975)	SL	2	2×9.0		21	0.28 c0.05	0.12	0.46	FR 442
	SL	3	3×9.0		1 14	6.8 0.13	0.22 < 0.05	7.1 0.13	FR 442
Fresno, California (1975)	SL	2	2×9.0		21	0.41	< 0.05	0.41	FR 442
	SL	3	3×9.0		1 14	3.6 14	0.07 0.59	3.7 15	FR 442

Table 91. Residues in Conventional Cotton hay: Pre-emergence, Recirculating Sprayer and Pre-harvest Application (USA).

Location (year) variety	Application					PHI (days)	Residues (mg/kg)			Report/ reference
	Type	Form	N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
Malone, Florida USA (1974)	PRE PH	A	2	9.0 4.5		9	15	0.11	15	MSL1283
Ropesville, Texas USA (1974)	PRE PH	B C	2	9.0 4.5		13	29	0.17	29	MSL1283
Sasser, Georgia USA (1974)	PRE RCS RCS PH	B C D	4	9.0 6.7 6.7 4.5		9	7.4	0.08	7.5	MSL1283
Mount Pleasant, Mississippi USA (1974)	PRE RCS RCS RCS PH	A C	5	9.0 6.7 6.7 6.7 4.5		13	18	0.13	18	MSL1283
St. Joseph, Louisiana UDSA (1974)	PRE PRE RCS PH	A C	4	9.0 9.0 11 4.5		9	33	0.24	33	MSL1283
Five Points, California USA (1974)	PRE PH	B C	2	9.0 4.5		13	17	0.18	17	MSL1283
Kernan, California USA (1975)	PH	A	1	5.0	2.2	10	84 c0.08	0.45	85 99	MSL1283

Location (year) variety	Application					PHI (days)	Residues (mg/kg)			Report/ reference
	Type	Form	N	kg ae/ha	kg ae/hL		glyphosate	AMPA	Total	
	PH	A	1	5.0	2.2	3	98 c0.08	0.46	11 119	MSL1283
Weldon, North Carolina USA (1975)	PH	A	1	5.0	4.0	10	11 c0.10	0.09	11	MSL1283
	PH	A	1	5.0	4.0	3	118 c0.10	0.83	119	MSL1283
Cheneyville, Louisiana USA (1975)	PH	A	1	5.0	2.2	14	11 c0.14	0.10	11	MSL1283
	PH	A	1	5.0	2.2	7	24 c0.14	0.20	24	MSL1283
Sledge, Mississippi USA (1975)	PH	A	1	5.0	2.5	10	6.30 c0.10	0.09	6.4	MSL1283
	PH	A	1	5.0	2.5	5	20 c0.10	0.18	20	MSL1283
Ropesville, Texas USA (1975)	PH	A	1	5.0	2.2	10 3	19 c0.16 60 c0.16	0.20 0.21	19 60	MSL1283
Dawson, Georgia USA (1975)	PH	A	1	5.0	2.2	8	3.8 c0.13	0.21	4.1	MSL1283
	PH	A	1	5.0	2.2	3	27 c0.13	0.44	28	MSL1283

Treatment types are: PRE = pre-emergence; RCS = recirculating sprayer; PH = pre-harvest

*Formulations used at each site are listed. Not specified which formulation was used for each application.

Table 92. Residues in Glyphosate Tolerant Cotton (Roundup Ready Flex cotton gin by-products — 2 different lines of 2nd generation tolerant cotton (USA) trialled (MON 88913, MON 88903), Roundup UltraMAX Herbicide (372 g ae/L).

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Tift Co., Georgia USA (2002) MON88913	FWF FOB PH	3	3.3 1.7 1.7	2.2 1.1 1.1	88-95% open bolls	6	67	0.72	68	MSL17635
Washita Co. Oklahoma USA (2002) MON88913	FWF FOB PH	3	3.3 1.7 1.7	2.7 1.1 1.3	90% open bolls	7	91	0.59	92	MSL17635
Waller Co. Texas USA (2002) MON88913	FWF FOB PH	3	3.3 1.7 1.7	1.7 0.83 0.83	80% open bolls	7	126	1.51	128	MSL17635
Armstrong Co., Texas USA (2002) MON88913	FWF FOB PH	3	3.33 1.7 1.7	2.2 1.1 1.1	80-85% open bolls	8	37	0.29	37	MSL17635
Washington Co., Mississippi USA (2002) MON88903	FWF FOB PH	3	3.3 1.7 1.7	2.7 1.1 1.1	90-95% open bolls	6	19	0.24	19	MSL17635
Hockley Co., Texas USA (2002) MON88903	FWF FOB PH	3	3.3 1.7 1.7	1.7 0.83 0.83	70% open bolls	7	70	0.54	71	MSL17635

Types of applications: LPO = Late post-emergence (6-8 leaf stage); FWF = First White Flower; FOB = First Open Boll; PH = Pre-harvest GA – 88913 spindle picker; OK – 88913 stripper; TX Waller Co. – 88913 spindle picker; TX Armstrong Co. 88913 Stripper; MS – 88913 Spindle picker; TX Hockley – 88913 Stripper

Table 93. Residues in gin by-products from Glyphosate Tolerant Cotton genotypes 1445 and 1698 (USA) .

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Houston Co. Alabama USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.7 0.63 0.63 0.75	70% Bolls Open	7	9.8	0.09	9.9	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.7 0.42 0.63 0.63 0.75	70% Bolls Open	7	8.3	0.08	8.4	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.7 0.42 0.63 0.84 0.75	70% Bolls Open	7	16	0.18	16	MSL13884
Crittenden Co. Arkansas USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	3.4 1.0 0.72 1.3	70% Bolls Open	8	4.2	0.05	4.3	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	3.4 0.67 1.3 0.72 1.3	70% Bolls Open	8	7.2	0.07	7.3	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	3.4 0.67 1.3 0.96 1.3	70% Bolls Open	8	8.6	0.08	8.7	MSL13884
1698	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	3.4 1.0 0.72 1.3	70% Bolls Open	8	4.0	0.08	4.1	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	3.4 0.67 1.3 0.72 1.3	70% Bolls Open	8	7.8	0.09	7.9	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	3.4 0.67 1.3 0.96 1.3	70% Bolls Open	8	6.2	0.10	6.3	MSL13884
Maricopa Co. Arizona USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.9 0.63 0.72 0.84	Maturity	7	41 c0.12	0.27	41	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.9 0.42 0.72 0.72 0.84	Maturity	7	23 c0.12	0.20	23	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.9 0.42 0.72 0.96 0.84	Maturity	7	32 c0.12	0.19	32	MSL13884
Tulare Co. California USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 0.84 0.84 1.1	Maturity	6	36	0.39	37	MSL13884

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.56 0.84 0.84 1.1	Maturity	6	26	0.25	26	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.56 0.84 1.1 1.1	Maturity	6	20	0.18	20	MSL13884
St Landry Co. Louisiana USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 1.3 1.3 1.7		17	1.1	< 0.05	1.1	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.84 1.3 1.3 1.7		17	0.79	< 0.05	0.79	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.84 1.3 1.7 1.7		17	0.86	< 0.05	0.86	MSL13884
1698	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 1.3 1.3 1.7	7 Day PHI	17	2.2	< 0.05	2.2	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.84 1.3 1.3 1.7	7 Day PHI	17	2.0	< 0.05	2.0	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.84 1.3 1.7 1.7	7 Day PHI	17	0.99	< 0.05	0.99	MSL13884
Bolivar Co. Mississippi USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 1.0 1.0 1.1	Mature	6	30 c0.05	0.26	30	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.67 1.0 1.0 1.1	Mature	6	31 c0.05	0.23	31	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.67 1.0 1.3 1.1	Mature	6	27 c0.05	0.13	27	MSL13884
Washington Co. Mississippi USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.7 0.63 1.0 1.1	Open Bolls	9	5.8	0.05	5.9	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.7 0.42 0.72 1.0 1.1	Open Bolls	9	3.7	< 0.05	3.7	MSL13884

Location (year) variety	Type	Application			GSLT	PHI (days)	Residues (mg/kg)			Report/ reference
		N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.7 0.42 1.0 1.3 1.1	Open Bolls	9	4.0	< 0.05	4.0	MSL13884
1698	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.7 0.63 1.0 1.1	Open Bolls	9	5.0	0.05	5.1	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.7 0.42 0.72 1.0 1.1	Open Bolls	9	4.3	< 0.05	4.3	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.7 0.42 1.0 1.3 1.1	Open Bolls	9	5.1	0.05	5.2	MSL13884
Fayette Co. Tennessee USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	3.4 1.0 0.72 1.3	70% Bolls Open	8	34 c0.97	0.45	35	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	3.4 0.67 1.0 0.72 1.3	70% Bolls Open	8	26 c0.97	0.26	26	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	3.4 0.67 1.3 0.96 1.3	70% Bolls Open	8	29 c0.97	0.27	29	MSL13884
Uvalde Co. Texas USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.7 1.3 1.3 1.3	60% Bolls Open	6	32	0.30	32	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.7 0.84 1.0 1.3 1.3	60% Bolls Open	6	84	0.84 0.54	85	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.7 0.84 1.3 1.7 1.3	60% Bolls Open	6	32	0.33	33	MSL13884
1698	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.7 1.3 1.3 1.3	60% Bolls Open	6	26	0.31	26	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.7 0.84 1.0 1.3 1.3	60% Bolls Open	6	65	0.54	66	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.7 0.84 1.3 1.7 1.3	60% Bolls Open	6	74	0.67	75	MSL13884

Location (year) variety	Type	Application N	Application kg ae/ha	Application kg ae/hL	GSLT	PHI (days)	Residues (mg/kg) glyphosate	Residues (mg/kg) AMPA	Residues (mg/kg) Total	Report/ reference
Willacy Co. Texas USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.7 0.63 0.63 0.84	Maturity	8	18	0.21	18	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.7 0.42 0.63 0.63 0.84	Maturity	8	21	0.31	21	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.7 0.42 0.63 0.84 0.84	Maturity	8	19	0.25	19	MSL13884
1698	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	1.7 0.63 0.63 0.84	Maturity	8	15	0.18	15	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	1.7 0.42 0.63 0.63 0.84	Maturity	8	16	0.15	16	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	1.7 0.42 0.63 0.84 0.84	Maturity	8	18	0.16	18	MSL13884
Hockley Co Texas USA (1994) 1445	PRE EPO PD PH	4	3.4 1.3 1.3 1.7	2.2 0.84 0.84 1.1	Maturity	7	29 c0.05	0.12	29	MSL13884
	PRE EPO MPO PD PH	5	3.4 0.84 1.3 1.3 1.7	2.2 0.56 0.84 0.84 1.1	Maturity	7	42 c0.05	0.25	42	MSL13884
	PRE EPO LPO PD PH	5	3.4 0.84 1.3 1.7 1.7	2.2 0.56 0.84 1.1 1.1	Maturity	7	31 c0.05	0.15	31	MSL13884

Application types: PRE = Pre-emergence; EPO = Early Post-emergence; MPO = Mid-Post-emergence; LPO = Late Post-emergence; PD = Post-Directed; PH = Pre-harvest

AL – hand harvested, processed research-type gin; AR – Mechanical John Deere 9900 cotton picker, 10 saw gin; AZ – hand harvested, research type gin; CA – Hand harvested, research type gin; LA – mechanical IH 622 cotton picker, 20 saw table top gin; MS1 – Hand harvested research type gin; MS2 – hand harvested research type gin; TN - mechanical IH 416 row picker, research type gin; TX1 – Mechanical John Deere 9900 picker, Dennis 20 saw gin; TX2 – Mechanical picker, Denis 20 saw gin; TX3 – Hand harvested, Dennis 20 saw gin.

Gin by-products from the Arkansas and Tennessee trial sites were collected from gin material while the other sites were simulated gin by-products by collecting a mixture of leaves, burs and stems.

Table 94. Residues in Rape/Canola straw: Pre-harvest Application.

Location (year) variety	Form	Application N	Application kg ae/ha	Application kg ae/hL	PHI (days)	Residues (mg/kg) glyphosate	Residues (mg/kg) AMPA	Residues (mg/kg) Total	Report/ reference
Sweden (1981) Svalof	SL	1	1.4	0.72	10	30.0	0.4	31	ML30104
Sweden (1980)	SL	1	1.4	0.72	18	30 c0.1	0.3	30	ML30104
		1	2.2	1.0	18	16 c0.1	0.1	16	ML30104

FATE OF RESIDUE IN STORAGE AND PROCESSING

Olives

The residue data for processing of olives into raw and refined olive oil were included in the same reports with data on the Raw Agricultural Commodities.

Olives were crushed/ground and pressed in through nylon cloth to separate the vegetable water and oil from pulp. The oil and water mixture was warmed to 30 °C until a deposit and the crude oil recovered. Refined oil was prepared by addition of NaOH, heating the mixture to 60–70 °C and the refined oil decanted off (Hontis 1996, MLL30469).

Olives were cleaned by sieving to remove small impurities while larger ones were removed manually. The olives were washed, excess water removed and the olives meshed in a laboratory scale olive grindstone mill. NaCl was added to facilitate separation of oil and water and the mixture centrifuged to separate solids from the unstable emulsion (Hontis 1993 MLL30319).

Olives were washed, blended for 2 minutes to a paste and the paste stirred for 20 minutes in a water bath at 50 °C, water added and the mixture heated to 80 °C and stirred for 10 minutes prior to centrifugation to separate oil and water from solids Hontis 1992, MLL30297).

Residues of AMPA were < 0.05 mg/kg in all samples. The mean processing factor for olive oil was < 0.2 for both glyphosate and total residue.

Table 95. Processing olives.

Location (year) variety	Application rate (kg ae/ha)	Portion analyzed	PHI (days)	Residues glyphosate (mg/kg)	Processing Factor for Oil
Villa del Rio 14640 [MLL30469]	2.2	Fruit (ground) raw oil refin. oil	0 7 7 7	5.9 0.5 < 0.05 < 0.05	 < 0.1 < 0.1
Ubeda 23400 [MLL30469]	2.2	Fruit (ground) raw oil refin. oil	0 7 7 7	6.0 0.9 < 0.05 < 0.05	 < 0.06 < 0.06
	2.2	Fruit (ground) raw oil refin. oil	0 14 14 14	6.7 0.9 < 0.05 < 0.05	 < 0.06 < 0.06
Francavilla, Puglia Italy [MLL30319]	1.4	Fruit (ground) Fruit (ground) Raw oil Raw oil	6 13 6 13	0.35 0.30 < 0.05 < 0.05	 < 0.14 < 0.17
Pedrera Spain [MLL30297]	0.36	Olives Olives Olive oil Olive oil	1 7 1 7	0.7 0.9 < 0.05 < 0.05	 < 0.07 < 0.06
Puebla de Cazalla Spain [MLL30297]	0.36	Olives Olives Olive oil Olive oil	1 7 1 7	0.9 1.0 < 0.05 < 0.05	 < 0.06 < 0.05

Location (year) variety	Application rate (kg ae/ha)	Portion analyzed	PHI (days)	Residues glyphosate (mg/kg)	Processing Factor for Oil
Torreblascopedro Spain [MLL30297]	0.36	Olives Olives Olive oil Olive oil	0 32 0 32	1.2 0.6 < 0.05 < 0.05	 < 0.04 < 0.08
Sierrayegua Spain [MLL30297]	0.36	Olives Olives Olive oil Olive oil	0 24 0 24	0.2 0.2 < 0.05 < 0.05	 < 0.25 < 0.25
Linares Spain [MLL30297]	0.36	Olives Olives Olive oil Olive oil	0 30 0 30	0.1 1.2 < 0.05 < 0.05	 < 0.5 < 0.04
Cordoba Spain [MLL30297]	0.36	Olives Olives Olive oil Olive oil	0 41 0 41	0.06 0.3 < 0.05 < 0.05	 < 0.8 < 0.17

All values are uncorrected for analytical recovery. Limit of detection of glyphosate is 0.05 ppm
ground = ground fallen olives

Glyphosate tolerant sugar beet

Steinmetz and Bleeke (1999 MSL 16087) studied the effect of processing on residues in glyphosate tolerant sugar beet. Bulk sugar beet root samples were harvested at two field sites in two states (Washington and North Dakota), representing major sugar beet-producing regions of the United States and sent to the processor for processing. Treatment was four applications: 3.4 kg ae/ha at pre-emergence; 0.84 kg ae/ha at the 2–4 leaf and 12–14 leaf stages and 1.7 kg ae/ha, 30 + 2 days after the 12–14 leaf stage application. Sugar beet roots (102–172 kg) were tub washed, cut into thick pieces (5 cm) and sliced into cossettes 0.01–0.03 cm × 3-8 cm. Sugar was extracted from the cossettes in a series of steam heated cells with a mixture of fresh and pulp press water. Extracted pulp was pressed to recover pulp press water. A sample of wet pulp was retained for analysis with the remainder dried to a moisture content less than 10% and milled. Raw juice was purified in a steam jacketed kettle by addition of lime and carbon dioxide; precipitated impurities were coagulated by a settling agent and clarified. Clear juice was obtained by decanting and screening to remove any larger particles; the sludge was vacuum filtered. The combined clarified liquids were further clarified with a second carbonation with CO_2 gas and filtration. The resulting concentrated juice was heated to 75–85 °C and vacuum filtered over diatomaceous earth. The concentrated juice was warmed to 50 °C and fed into a laboratory vacuum pan and granulator for crystallisation of sugar. Refined sugar was obtained by centrifuge filtration of the massecuite previously heated to 70–75 °C, washed with warm purified water (86–96 °C) and dried under a stream of hot air. Molasses was collected from the centrifuge as the initial spin-off syrup. The residue levels of glyphosate in the raw agricultural commodity (whole root) and the processed samples, and the concentration factors, are summarized below. AMPA levels ranged from ca. < 0.05 to 0.21 mg/kg. Concentration factors for AMPA were not calculated.

Table 96. Residues in glyphosate tolerant sugar beet and processed commodities (USA) Steinmetz and Bleeke (1999 MSL 16087).

Location (year) variety	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
	Form	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Sargent Co., North Dakota USA (1998) Empire RR	PRE	3.4	3.6	Root	48	6.0	0.21 c0.06	6.3	MSL16087
	EPO	0.86	0.80	Wet pulp		0.51	< 0.05	0.51	
	EPO	0.86	0.80	Dry pulp		4.3	0.17	4.6	
	LPO	1.7	1.8	Molasses		< 0.05	< 0.05	< 0.05	
				Sugar, refined		< 0.05	< 0.05	< 0.05	
Grant Co., Washington USA (1998) Pillar RR	PRE	3.4	2.4	Root	60	3.8	0.13	4.0	MSL16087
	EPO	0.86	0.62	Wet pulp		0.23	< 0.05	0.23	
	EPO	0.86	0.62	Dry pulp		1.9	0.09	2.0	
	LPO	1.7	1.2	Molasses		< 0.05	< 0.05	< 0.05	
				Sugar, refined		< 0.05	< 0.05	< 0.05	

Values are the mean of two or three determinations, and are uncorrected for recovery.
PRE = pre-emergent; EPO = early post emergent, the 1st at 2-4 leaf stage and the 2nd at 12-14 leaf stage; LPO = late post emergent and is 30 days after the 12-14 leaf stage application.

Table 97. Processing Factors in Glyphosate Tolerant Sugar Beet Processed Commodities.

	Glyphosate PF			Total residue PF		
Matrix	North Dakota	Washington	Mean	North Dakota	Washington	Mean
Wet Pulp	0.09	0.06	0.08	0.08	0.06	0.07
Dry Pulp	0.71	0.51	0.61	0.73	0.50	0.62
Molasses	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sugar, Refined	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Soya Beans – Conventional

The grain samples from the Banks, Mississippi trials collected 15 days after treatment were used for the processing experiment (Kunstman 1983 MSL3259) grain was mechanically shelled using a McGill sheller and the hulls and meal separately ground with dry ice in a Waring blender. The meal was further fractionated before extraction of oil with hexane. Residual solvent from the extracted meal was allowed to dissipate by evaporation. Crude oil was obtained by evaporation of hexane from the miscella (hexane oil mixture). Refined oil was prepared by alkali saponification with NaOH and separated from the soapstock by centrifugation.

Table 98. Residues in conventional soya beans and processed commodities (USA) Kunstman 1983 MSL3259.

Rate (kg ae/ha)	Residue (mg/kg)									
	Grain		Fat free meal		Hulls		Crude oil		Soapstock	
	Gly	AMPA	Gly	AMPA	Gly	AMPA	Gly	AMPA	Gly	AMPA
0.84*	9.2	1.5	7.6	1.3	42	3.3 c0.12	0.06	< 0.05	< 0.05	< 0.05
3.4	11	1.8	10	1.5	60	5.3 c0.12	0.10	< 0.05	< 0.05	< 0.05

Recirculating + pre-harvest application

Table 99. Processing factors for conventional soya beans and processed commodities (USA) Kunstman 1983 MSL3259.

Rate (kg ae/ha)	Processing factors							
	Fat free meal		Hulls		Crude oil		Soapstock	
	Glyphosate	Total	Glyphosate	Total	Glyphosate	Total	Glyphosate	Total
0.84	1.0	0.83	4.5	4.1	< 0.01	< 0.01	< 0.02	< 0.01
3.4	1.0	0.89	5.2	5.0	< 0.01	< 0.01	< 0.02	< 0.01
Mean	1.0	0.86	4.9	4.6	< 0.01	< 0.01	< 0.02	< 0.01

Soya Beans – Glyphosate Tolerant

Soybean seed was composited from fourteen field residue trials treated in 1992 with glyphosate and processed to afford the following food and feed fractions: coarse, medium and fine dust; hulls; dehulled seed; meal; crude and refined oil; and soap stock (Goure and Steinmetz 1994 MSL13463). All samples were maintained frozen during storage and shipment.

Recoveries from laboratory-fortified control samples spiked with glyphosate and AMPA are summarized in the following table.

Table 100. Recovery of Glyphosate and AMPA from Fortified Soyabean Processed Samples (Goure and Steinmetz 1994 MSL13463).

Crop Matrix	Fortification Level (mg/kg)	Glyphosate mean %recovery (range)	AMPA mean % recovery(range)
Seed VD 0541	0.05-20	91 (81-102)	88 (74-102)
coarse dust	0.05-8.0	94 (89-99)	85 (81-88)
medium dust	0.05-5.0	101 (92-110)	98 (90-106)
fine dust	0.03-3.0	93 (91-94)	84 (80-88)
hulls	0.05-10	96 (782-111)	95 (87-104)
meal	0.05-15	89 (75-99)	83 (70-98)
crude oil OC 0541	0.05-5.0	81 (72-91)	78 (69-89)
refined oil OR 0541	0.05-5.0	83 (74-88)	83 (74-88)
soap stock	0.05-5.0	84 (75-95)	70 (67-76)

The seed from field trials was dried to a moisture content of 7–10% and aspirated to remove light impurities and screened to separate whole seed from small and large plant material which were further screened and classified into coarse, medium and fine dust fractions. Hulls were removed from seed using a mill which cracked the seed into 2–6 pieces air aspiration yielding hulls and kernels. Kernels were heated to 66–74 °C, flaked in a flaking roll (0.2–3 mm gap) and crude oil extracted from the flaked kernels using warm hexane 49-60 °C. Residual hexane was removed from the extracted flakes using warm air to yield soybean meal. The hexane extracts (miscella) was concentrated at 75–90 °C to remove hexane and yield crude oil. Further extraction of the crude oil with water at 68–72 °C afforded degummed oil which was neutralised with NaOH to give refined oil and saopstock which were separated.

The field collected seed, prior to processing (unmilled seed), contained an average combined glyphosate and AMPA residue level of 5.9 mg/kg. Milled soybean seed (dust and hulls removed) contained an average combined glyphosate and AMPA residue level of 5.8 mg/kg. Combined average glyphosate and AMPA residues in coarse, medium and fine dust were 7.9, 6.4 and 3.8 mg/kg, respectively. Soybean hulls contained the highest combined glyphosate and AMPA residues of 15.8 mg/kg. The concentration factors for combined glyphosate and AMPA residues in coarse and medium dust and hulls were 1.3, 1.1, and 2.7, respectively.

The combined average glyphosate and AMPA residue level in meal was 5.4 mg/kg. This residue level is similar to that in unmilled and dehulled seed, and demonstrates that residues do not concentrate in soybean meal. In contrast, combined glyphosate and AMPA residues in crude and refined oil and soap stock were significantly less than those in unmilled seed. Total combined residues in crude and refined oil and soap stock were 0.2, 0.02, and 0.9 mg/kg, respectively.

Table 101. Residues in glyphosate tolerant soya beans and processed commodities (USA) (Goure and Steinmetz 1994 MSL 13463).

Location (Year)	Application Rate (kg ae/ha)[1]	Application volume (L/ha)	PHI (days)	Sample	Glyphosate (mg/kg)[3]	AMPA (mg/kg)[3]	Glyphosate PF	Total PF
USA, 1992	6.4	148	91	unmilled seed	2.4	3.5	-	-
	1.7	144	(xx-xx)	coarse dust	5.5	2.4 c0.06	2.3	1.2
				medium dust	4.1	2.3 c0.07	1.7	0.99
				fine dust	2.5	1.3 c0.05	1.0	0.58
				hulls	9.2	6.6 c0.06	3.8	2.1
				dehulled seed	2.4	3.4	1.0	0.98
				meal	1.9	3.6	0.8	0.95
				crude oil	0.04	0.17	0.02	0.04
				refined oil	0.01	0.01	< 0.01	< 0.01
				soapstock	0.26	0.66 c0.06	0.1	0.16

PHI is the average pre-harvest interval in days between the late post-emergence application and sample harvest.
Values are the average of replicate analysis (typically duplicate), and are not corrected for recovery
Concentration factors were calculated by dividing the average glyphosate and AMPA residues found in each processed fraction by that found in unmilled seed.
Coarse dust = >2540 microns, medium >1190 to <2540 microns, fine <1190 microns.

Maize – Conventional

Glyphosate 360 g/L SL formulation was applied to conventional maize during the 1993 growing season as a single, pre-harvest treatment six or seven days before harvest to plots in Illinois and Iowa, respectively. The actual herbicide application rates were 2.5 kg ae/ha in spray solution volumes of 135 and 190 L/ha for the Illinois and Iowa sites, respectively.

Treated and control grain samples were collected six or seven days after ground-applied, broadcast applications and were frozen within two hours of collection. The corn grain (191 kg shelled corn Illinois; 131 kg shelled corn Iowa per study) was processed using simulated industrial practices for dry and wet milling to provide commercially representative samples. Whole grain samples were dried and cleaned by aspiration and screening with light impurities classified as chaff and grain dust.

Dry milling. Grain was conditioned to a moisture content of 20–22% prior to impact milling after which the cornstock was dried at 54–71 °C for 30 minutes, cooled and screened (3.2 mm) to produce on sifting medium (> 2 mm) and small grits (1.4–2 mm)), coarse meal (0.6–1.4 mm), meal (0.24–0.6 mm) and flour (< 0.24 mm). The retained material in the screen (> 3.2 mm) was further processed by aspiration to separate hulls from hulls with germ and germ and large grits.

To extract oil, germ was conditioned to 12% moisture content, heated to 88–104 °C, flaked and pressed to give crude oil and presscake. The presscake was extracted with hexane and the miscella (hexane and crude oil) separated, the crude oil heated to 73–94 °C to remove residual hexane. The presscake was dried under a stream of warm air to remove residual solvent and ground to produce meal. The combined crude oil (press and solvent extracted) was caustic refined by addition of NaOH to yield soapstock and refined oil. The following dry milled fractions were analyzed: cleaned grain, grain dust, grain screenings, grits, meal, flour, and crude and refined oils. The grain dust analyzed was a composite sample made by combining an equal fraction (by weight) of each of the screened grain dust subsamples. The grain screenings, consisting of material with particle sizes > 2.5 mm was analyzed separately. The large, medium and small grits were combined into a composited grits sample and the coarse meal and meal into a composited meal sample.

Wet milling Cleaned grain was steeped in water (49–54°C; 0.1–0.2% SO_2) for 22–48 h and ground to give cornstock which was flooded in salt water to remove the germ. The grinding process was repeated and the recovered germ dried at 74–91 °C to a constant moisture content of 7–10%. The cornstock was ground and passed through a 3.2 mm screen separate the hull material (bran). The

cornstock passing through the screen is ground several times and sieved, material > 0.6 mm is added to the hulls, material not passing through a 43 micron screen is coarse gluten-starch and dried to a final moisture content of 15%. Material passing through the screen is refrigerated for > 12 hours to allow the starch and gluten to settle, the water removed and the starch separated from the gluten by centrifugation. Oil was extracted from germ in the same process as for dry milled grain. Samples analyzed as a result of the wet milling process were starch, crude oil, and refined oil.

Recoveries from laboratory-fortified corn processed commodity control samples spiked with glyphosate and AMPA over the range of 0.05 to 20 mg/kg averaged 85% for glyphosate, and ranged from 65% to 104%. The recoveries of AMPA from the same samples averaged 85%, and ranged from 60% to 117%.

Table 102. Effects of industrial processing on the nature and magnitude of residues (Over-the-top applications to conventional maize Oppenhuizen 1995 MSL13655) SAI 3 to 391 days.

Location (Year) variety	Application Rate (kg ae/ha)[1]	Application volume (L/ha)	PHI (days)	Sample	Glyphosate (mg/kg)[3]	AMPA (mg/kg)[3]
Warren Co. Illinois, USA, (1993) Asgrow 707/623	2.5	135	6	Grain	< 0.05	0.08 c0.07
				Clean grain	0.05	0.10 c0.05
				Dry milled crude oil	< 0.05	< 0.05
				Dry milled refined oil	< 0.05	< 0.05
				Flour	< 0.05	0.07 c0.06
				Grain dust	8.3 c0.14	1.6 c1.3
				Grain dust screenings	14 c0.19	1.7 c1.8
				Grits	< 0.05	< 0.05
				Meal	< 0.05	0.07 c0.07
				Starch	< 0.05	< 0.05
				Wet milled crude oil	< 0.05	< 0.05
				Wet milled refined oil	< 0.05	< 0.05
Des Moines Co. Iowa USA (1993) Querna 7670	2.5	190	7	Grain	< 0.05	0.12 c0.12
				Clean grain	< 0.05	0.09 c0.06
				Dry milled crude oil	< 0.05 c0.05	< 0.05 c0.07
				Dry milled refined oil	< 0.05	< 0.05
				Flour	< 0.05	< 0.05
				Grain dust	0.64 c0.28	< 0.05
				Grain dust screenings	0.40 c0.15	< 0.05
				Grits	< 0.05	0.05 c0.08
				Meal	< 0.05	< 0.05
				Starch	< 0.05	< 0.05
				Wet milled crude oil	< 0.05	< 0.05
				Wet milled refined oil	< 0.05	< 0.05

Values are the average of replicate analysis (typically duplicate), and are not recovery corrected
Concentration factors were not calculated as the residues in grain, between LOD and LOQ, were too low to obtain meaningful results.
Illinois 15 m × 30 m, backpack CO_2 sprayer, flat fan 11002 nozzles; Iowa 9.1 m × 58 m, Hi-Boy CO_2 sprayer, flat fan 8003 nozzles

Maize – Glyphosate Tolerant

Glyphosate tolerant corn received a pre-emergence application of glyphosate at 4.2 kg ae/ha, followed by two post-emergence over-the-top applications of 0.84 and 1.68 kg ae/ha. At the processing facility, the grain was dried, and then cleaned to generate aspirated grain dust. The cleaned grain underwent both dry milling and wet milling processing. Dry milling fractions included: bran, flour, solvent-extracted presscake, grits, meal, and refined oil. Wet milling fractions included: bran, solvent-extracted presscake, gluten, refined oil, starch, and steepwater concentrate.

The process for dry (267 kg) and wet (258 kg) milling of grain was essentially as described above for conventional corn with the exception of refined oil which was bleached and deodorised using activated bleaching earth and citric acid.

The only fractions with glyphosate concentration factors greater than 1.5 were aspirated grain dust (1.6), solvent extracted presscake (2.5) and steepwater concentrate (2.4).

Table 103. Glyphosate Residue Data and Processing Factors for Glyphosate Tolerant Corn Processed Fractions (Kunda and Bleeke 2005 MSL16757).

Location (Year) variety	Application Rate (kg ae/ha)[1]	Application volume (L/ha)	PHI (days)	Sample	Glyphosate (mg/kg)	AMPA (mg/kg)	Glyphosate PF	Total residues PF
Carlyle, Illinois, USA (2000) DK626 RR	4.2 PRE 0.84 EPO 1.7 LPO	157 134 153	108	Grain Dried grain Cleaned grain Aspirated grain dust Dry milling Bran Flour Extracted presscake Grits Meal Refined oil Wet milling Bran Extracted presscake Gluten Refined oil Starch Steepwater	0.15 0.20 0.19 0.23 0.18 0.17 0.37 0.12 0.17 < 0.05 0.07 0.13 < 0.05 < 0.05 < 0.05 0.36	< 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 0.11 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 0.14 c0.09	- 1.3 1.3 1.6 1.2 1.1 2.5 0.82 1.1 < 0.33 0.45 0.85 < 0.33 < 0.33 < 0.33 2.4	 1.3 1.3 1.6 1.2 1.1 3.6 0.82 1.1 < 0.33 0.45 0.85 < 0.33 < 0.33 < 0.33 3.8

PRE = pre-emergent but after planting; EPO = corn plants at V5 20 cm stage; LPO = corn plants V7-V8 stage, 61-76 cm tall.
A non-ionic surfactant was added to the spray mixture at 0.5% together with ammonium sulfate.
Plot 9.1 m × 91 m; application by side mount boom (power-take-off pressure source) Teejet flat fan nozzles
Values are the average of replicate analysis (typically duplicate), and are not recovery corrected.
PHI is the average pre-harvest interval in days between the late post-emergence application and sampling. PHI includes a 5 day drying period after harvest and before sampling, during which the grain was air-dried to an appropriate moisture content of 18%.
Prior to generation of aspirated grain dust at the processing facility, the corn grain was further dried to 10-13% moisture content.

Oats

Grain samples were obtained following treatment with rates ranging from 0.36 kg ae/ha to 1.4 kg ae/ha, with or without addition of the additive, Frigate. Samples of oat grains were harvested during the field trial AS/22056/CN for processing into rolled oats. Oat samples were processed in the pilot plants of a manufacturer of machinery for oat processing, according to commercial practices. The LOQ for the method were 0.03 mg/kg for grain, kernels, and rolled oats; and 0.05 mg/kg for hulls.

The method was validated by fortification of oat grains, kernels (groats), and flakes (rolled oats) with glyphosate at levels ranging from 0.05 mg/kg to 10 mg/kg. Four to six samples of each matrix were fortified. The concentration level of fortified hulls ranged from 0.5 mg/kg to 18 mg/kg (5 spiked samples). The mean procedural recovery for all fortified samples was 93%, with a coefficient of variation of 9.5% (n = 20). The mean recovery rates for glyphosate in different spiked materials were 88% in hulls (CV= 17.1%, n = 5); 95% in grain (CV = 1.7%, n = 4); 93% in kernels (CV = 0.7%, n = 6); and 91% in rolled oats (CV = 9.7%, n = 5).

Oat grain was aspirated and screened to remove light impurities, sticks, seeds and dust from grain. Grain (4-5 kg) was milled and aspirated and screened to separate hulls from kernels. Heat and steam treatment of kernels inactivated fat-splitting enzymes and the moisture adjusted prior to flaking in a two roller mill. Rolled oats were dried in a fluid bed dryer (50 °C). The residues determined in the processed fractions are summarized in Table 104. No residues were detected in the untreated samples except in hulls. Residues in treated samples were dependent on the application rate of glyphosate.

They indicate that the major part of the residue was located on the surface of the grains and could be separated with the hulls. Processing factors were calculated from the ratio of the residues in the processed fraction to those in the raw agricultural commodity. The average processing factors were 1.9 for hulls, 0.2 for kernels (groats) and 0.2 for rolled oats (flakes).

Table 104. Residues in oats processed fractions (Zietz 1995 IF-94/00453-01 300 GLY).

Application rate	Matrix	Glyphosate Residues (mg/kg)	Processing factor (PF)
0.72 kg ae/ha	Grain	2.5	
	Hull	5.7 c0.1	2.3
	Kernel	0.60	0.2
	Rolled oats (flakes)	0.81	0.3
1.4 kg ae/ha	Grain	6.6	
	Hull	13 c0.1	2.0
	Kernel	1.6	0.2
	Rolled oats (flakes)	0.43	0.1
0.36 kg ae/ha + 0.825 kg/ha Frigate	Grain	1.9	
	Hull	3.3 c0.1	1.7
	Kernel	0.39	0.2
	Rolled oats (flakes)	0.32	0.2
0.72 kg ae/ha + 0.825 kg/ha Frigate	Grain	2.9	
	Hull	4.3 c0.1	1.5
	Kernel	0.63	0.2
	Rolled oats (flakes)	0.51	0.2
			Average PF
Hull	Hull		1.9, median 1.8
Kernel	Kernel		0.2
Rolled oats (flakes)	Rolled oats (flakes)		0.2

The oat samples provided for processing were stored at room temperature to simulate common practice in the industry. On the day of shipments to the mill, a portion was taken from each sample and stored deep-frozen until the processed samples were analysed. The stored oats were analysed at the same time as the processed samples. The residue data from these samples were compared to the results of the present study.

The results of storage stability tests for all samples analysed showed that the conditions of storage of oats prior to processing did not significantly affect the content of glyphosate in the samples processed. The average residue in samples stored frozen was 3.1 mg/kg while that for samples stored at room temperature was 3.5 mg/kg. Table 105 summarizes the results.

Table 105. Storage stability data for oat grain samples for processing.

Field treatment	Residues (mg/kg) from samples stored deep-frozen from harvest	Residue (mg/kg) from samples stored at room temperature and processed
Untreated samples	< 0.03	0.03
720 g ae/ha treatment	3.2	2.5
1440 g ae/ha treatment	4.9	6.6
360 g ae/ha + 825 g/ha Frigate	0.8	1.9
720 g ae/ha + 825 g/ha Frigate	3.4	2.9
Average from all treatments	3.1	3.5

Sorghum

Grain harvested from glyphosate treated sorghum crops trials in Kansas and Texas in 1992 at a target rate of 1.7 kg ae/ha 6 to 8 days before grain harvest were used for a processing study (Oppenhuizen 1994 MSL13038). Sorghum grain was stored frozen until processing. For dry processing, the grain (64-67 kg) was cleaned by aspiration and screening to give clean grain and grain dust. The cleaned grain was abrasively milled (decortified) to remove the majority of the bran and grits (coarse ground hulled grain between 1678 and 2540 microns) from the seed, the latter was ground into flour (<520 micron). For wet processing the aspirated and screened grain (clean grain) was steeped in water and then milled to recover germ (floating portion of ground steeped grain), hulls, coarse gluten starch, gluten and starch.

Table 106. Residues in Glyphosate sorghum (USA) SAI ≤ 626 days (Oppenhuizen 1994 MSL13038).

Location (year) variety	Application			Sample	PHI (days)	Residues (mg/kg)			Report/ reference
	N	kg ae/ha	kg ae/hL			glyphosate	AMPA	Total	
Chautauqua Co., Kansas USA (1992) Garst 5319	1	1.7		Grain	6	4.5	< 0.05	4.5	MSL13038
				Bran		18	0.22	18	
				Clean grain		5.9	0.10	6.0	
				Flour		1.5	< 0.05	1.5	
				Germ		< 0.05	< 0.05	< 0.05	
				Grain dust		28	0.29	28	
				Grits, medium		2.7	< 0.05	2.7	
				Starch		< 0.05	< 0.05	< 0.05	
				Steepwater		3.3	0.10	3.4	
Burleson Co., Texas, USA (1992) 522DR	1	1.7		Grain	8	1.1	< 0.05	1.1	MSL13038
				Bran		6.4	0.12	6.6	
				Clean grain		1.1	< 0.05	1.1	
				Flour		0.35	< 0.05	0.35	
				Germ		< 0.05	< 0.05	< 0.05	
				Grain dust		3.8	0.07	3.9	
				Grits, medium		0.35	< 0.05	0.35	
				Starch		< 0.05	< 0.05	< 0.05	
				Steepwater		0.39	< 0.05	0.39	

* Values are the mean of two or three determinations, and are uncorrected for recovery.

Table 107. Processing Factors for Glyphosate Residues in Sorghum Fractions.

	Glyphosate PF			Total Residues PF		
Commodity	Kansas	Texas	Mean PF	Kansas	Texas	Mean PF
Bran	4.0	5.9	5.0	4.0	6.0	5.0
Clean Grain	1.3	1.0	1.2	1.3	1.0	1.2
Flour	0.34	0.33	0.34	0.33	0.32	0.32
Germ	0.01	0.02	0.02	< 0.01	< 0.05	< 0.03
Grain Dust	6.3	3.5	4.9	6.2	3.5	4.8
Grits, Medium	0.61	0.32	0.47	0.60	0.32	0.46
Starch	0.01	0.01	0.01	< 0.01	< 0.05	< 0.03
Steepwater	0.73	0.36	0.55	0.76	0.35	0.56

* Processing Factors are calculated by dividing the glyphosate residue in each commodity by that in the Raw Grain.

Wheat

Samples of wheat grain were obtained from four trials conducted in 1991 in Germany, where plants receiving one application at the rate of 1.8 kg ae/ha of an SL formulation containing 360 g/L of glyphosate. Samples of approximately 10 kg collected from treated and untreated plots were processed into wholemeal, flour, bran, and wholemeal bread, using procedures simulating commercial processing conditions (Zietz, E., 1993 IF-92/11567-01 149 GLY).

Table 108. Concurrent mean recoveries in different matrices.

Matrix	Mean recoveries of Glyphosate (%)
Wheat whole meal	70
Wheat flour	82
Wheat bran	72
Whole meal bread	82

The analyses demonstrated that residues of glyphosate do not concentrate in wheat whole meal, flour, and bread. A slight concentration occurs in wheat bran.

Table 109. Processing Factors for Glyphosate Residues in Wheat Fractions (Zietz E. 1993 IF-92/11567-01 149 GLY).

Location (year) variety	Rate (kg ae/ha)	PHI (days)	Sample	Glyphosate	AMPA	Glyphosate PF	Total residue PF
Goch-Nierswalde, Germany (1992) Glyphos	1.8	21	Grain	0.28	< 0.03		
			Wholemeal	0.13	< 0.05	0.46	0.46
			Wholemeal bread	0.12	0.08	0.43	0.86
			Flour (550)	< 0.05	< 0.05	< 0.18	< 0.18
			Bran	0.36	< 0.05	1.3	1.3
Angermünde, Germany (1992) Glyphos	1.8	21	Grain	0.49	< 0.03		
			Wholemeal	0.16	< 0.05	0.33	0.33
			Wholemeal bread	0.11	< 0.05	0.22	0.22
			Flour (550)	< 0.05	< 0.05	< 0.10	< 0.10
			Bran	0.25	< 0.05	0.51	0.51
Goch-Nierswalde, Germany (1992) Roundup 360 g/L SL	1.8	21	Grain	0.18	< 0.03		
			Wholemeal	0.16	< 0.05	0.89	0.89
			Wholemeal bread	0.12	0.08	0.67	1.3
			Flour (550)	< 0.05	< 0.05	< 0.28	< 0.28
			Bran	0.43	< 0.05	2.4	2.4
Angermünde, Germany (1992) Roundup 360 g/L SL	1.8	21	Grain	1.0	< 0.03		
			Wholemeal	0.16	< 0.05	0.16	0.16
			Wholemeal bread	0.14	< 0.05	0.14	0.14
			Flour (550)	< 0.05	< 0.05	< 0.05	< 0.05
			Bran	0.45	< 0.05	0.45	0.45

Mean glyphosate processing factors for wholemeal, flour, bran and whole meal bread were 0.46, < 0.15, 1.2 and 0.36 respectively. The corresponding factors for total residues were 0.46, < 0.15, 1.2 and 0.63 respectively

Mestdagh (1981 MLL30069) studied the effect of processing on residues of glyphosate in wheat flour and bread. Wheat grain from supervised field trials conducted in the UK was milled according to standard industrial procedures at the Flour Milling and Baking Research Association, Chlorleywood, UK and bread loaves produced (no description of milling or baking provided).

Table 110. Glyphosate Residues in Wheat Processed Fractions (Mestdagh 1981 MLL30069).

Location (year) variety	Rate (kg ae/ha)	Glyphosate residues (mg/kg)				
		Whole grain	Bran	Offal	Flour	Loaves**
Holbeach Hurn, Lincolnshire UK (1980) Bounty	1.4	0.5	1.7	0.9	< 0.05	< 0.05
	4.3	1.1	1.9	2.7	0.10	0.07
Peterborough, Cambridgeshire UK (1980) Armada	1.4	0.3	0.5	0.3	< 0.05	< 0.05
	4.3	1.0	1.7	1.5	0.10	0.06
Swineshead, Lincolnshire UK (1980) Hustler	1.4	0.9	1.7	1.3	0.10	0.05
	4.3	1.6	3.4	4.9	0.35	0.15

*AMPA residues were all < 0.05 in grain and also in derived commodities
**no indication of type of bread, wholemeal, white etc.

Processing factors were calculated as the ratio of the residues in processed fractions to the residues in the raw untreated wheat grain. The analyses demonstrated that residues of glyphosate do not concentrate in wheat flour or bread. A slight concentration occurs in offal and wheat bran.

Table 111. Glyphosate Processing Factors in Wheat Processed Fractions.

Location (year) variety	Rate (kg ae/ha)	Glyphosate residues (mg/kg)				
		Whole grain	Bran	Offal	Flour	Loaves
Holbeach Hurn, Lincolnshire UK (1980) Bounty	1.4	-	3.4	1.8	< 0.1	< 0.1
	4.3	-	1.7	2.4	0.09	0.64
Peterborough, Cambridgeshire UK (1980) Armada	1.4	-	1.7	1.0	< 0.17	< 0.17
	4.3	-	1.7	1.5	0.10	0.06
Swineshead, Lincolnshire UK (1980) Hustler	1.4	-	1.9	1.4	0.11	0.06
	4.3	-	2.1	3.1	0.22	0.09
Mean			2.1	1.9	0.13	0.21

Cotton – Glyphosate Tolerant

Oppenhuizen (1995 MSL13884) studied the processing of bulk cottonseed obtained from the 1994 Uvalde, Texas trial in glyphosate tolerant cotton. Ginned seed was processed in 30–33 kg batches. The ginned seed was saw-delinted to reduce the lint content of the seed from 11-15% to 3% prior to mechanically hulling to separate the majority of the hull from the kernel. The moisture content of the kernels was adjusted to 12% and the kernels flaked and heated to 77–82 °C and held at this temperature for 15–30 minutes. The kernel material was extruded with steam injected during this process. The resulting collets were extracted three times with hexane at 49–60 °C. After draining the hexane the spent collets were toasted to remove residual hexane. Some of the miscella (crude oil and hexane mixture) was evaporated to remove the hexane and obtain crude oil. The remaining miscella was adjusted to a 60:40 ratio crude oil to hexane and refined by addition of NaOH, centrifugation to

remove the soapstock, removal of the hexane by evaporation under vacuum and the refined oil bleached by heating with activated bleaching earth followed by hydrogenisation over a silver catalyst and deodorisation by heating under vacuum to yield bleached deodorised refined oil.

Table 112. Glyphosate Residue Data and Processing Factors for Glyphosate Tolerant Cotton Processed Fractions SAI 35-53 days from processing to analysis (Oppenhuizen 1995 MSL13884).

Location (Year)	Application			Sample	Glyphosate (mg/kg)	AMPA (mg/kg)	PHI (days)	Glyphosate PF	Total residue PF
	Type[1]	kg ae/ha	Water L/ha						
Uvalde, Texas, USA (1994)	PRE	3.4	112	undelinted seed [5]	3.7	< 0.05	7		
	EPO	0.84	94	delinted seed	0.63	< 0.05		0.17	0.17
	MPO	1.3	113	cotton kernels	0.24	< 0.05		0.07	0.07
	PD	1.3	94	cotton hulls	1.2	< 0.05		0.33	0.33
	PH	1.7	114	cotton meal	0.39	< 0.05		0.11	0.11
				crude oil	< 0.05	< 0.05		< 0.1	< 0.1
				soapstock	< 0.05	< 0.05		< 0.1	< 0.1
				refined oil	< 0.05	< 0.05		< 0.1	< 0.1
				bleached oil	< 0.05	< 0.05		< 0.1	< 0.1

[1]Application type: PRE = pre-emergence, EPO = early post-emergence, MPO = mid post-emergence; PD = post directed, PH = pre-harvest

Linseed / Flax

Linseed obtained from crop treated 5 days before harvest was crushed and extracted with hexane in a continuous Soxhlet extractor. The resulting oil and meal fractions were analyzed.

Table 113. Residue Levels in Linseed / Flax Processed Fractions (Mestdagh P. 1983 MLL30106).

Site	Application rate (kg ae/ha)	PHI (days)	Glyphosate Residue (mg/kg)			
			Seeds	Capsules	Cake (meal)	Oil
Arbroath Scotland, UK	1.44	5	1.3	250	2.1	< 0.05
	2.88	5	2.2	230	2.4	< 0.05
Backboath Scotland, UK	1.44	5	1.3	103	1.6	< 0.05
	2.88	5	4.0	85	6.3	< 0.05

Table 114. Processing Factors for Linseed / Flax Processed Fractions.

Site	Capsules	Cake (meal)	Oil
Arbroath Scotland, UK	192	1.6	< 0.04
	104	1.1	< 0.02
Backboath Scotland, UK	79	1.2	< 0.04
	21	1.6	< 0.01
Mean Processing Factor	99	1.4	< 0.03

Oilseed Rape

Samples of rape seed were processed to meal and oil according to an industrial process. The resulting crude and refined oil, plus the extracted meal (cake) were analyzed (ML30104 see residue table).

Table 115. Residue Levels in Rape / Canola Processed Fractions Mestdagh P. 1983 ML30104.

Site	Application. rate (kg ae/ha)	PHI (days)	Glyphosate Residue (mg/kg)			
			Seed	Cake	Crude Oil	Refined Oil
Bottisham, Cambridgeshire UK (1982) Brutor	1.4	14	0.16	0.34	< 0.05	< 0.05
	2.9	14	0.48	3.4	< 0.05	< 0.05
Easton Cambridgeshire UK (1982) Jet Neuf	1.4	14	1.5	1.7	< 0.05	< 0.05
	2.9	14	3.2	4.9	< 0.05	< 0.05
UK - Easton Cambs 1982/15 Site 2	1.4	14	2.7	3.1	< 0.05	< 0.05
	2.9	14	4.0	8.9	< 0.05	< 0.05

Table 116. Processing Factors for Rape Processed Fractions.

Site	Cake	Crude Oil	Refined Oil
Bottisham, Cambridgeshire UK (1982) Brutor	2.1	< 0.3	< 0.3
	7.0	< 0.1	< 0.1
Site 1 Easton Cambridgeshire UK (1982) Jet Neuf	1.2	< 0.03	< 0.03
	1.5	< 0.02	< 0.02
Site 2 Easton Cambridgeshire UK (1982) Jet Neuf	1.1	< 0.02	< 0.02
	2.2	< 0.01	< 0.01
Mean Processing Factor	2.5	< 0.1	< 0.1

Coffee

The data for the fate of glyphosate residues in roasted coffee beans and instant coffee were included in the same report with data on the Raw Agricultural Commodity coffee beans. Coffee beans were roasted, ground, percolated-extracted and dried to obtain instant coffee (FR 434 see residue table).

Table 117. Glyphosate Residue levels in Coffee Beans, Roasted Beans and Instant Coffee (FR 434].

Site	Rate (kg ae/ha)	PHI (days)	Residue Glyphosate (mg/kg)			PF	
			Beans	Roasted Beans	Instant Coffee	Roasted Beans	Instant Coffee
Cali Colombia	1 × 2.2	49	0.27	0.07	0.23	0.26	0.85
	1 × 4.5	49	0.32	0.11	0.34	0.34	1.1
Kona Hawaii	2 × 4.5	28	0.58	0.06	0.20	0.10	0.34

Mean processing factors for roasted beans and instant coffee are 0.23 and 0.76 respectively.

Tea

Tea leaves were withered, reducing the moisture content from ca. 75% to 35% over a period of 6-8 hours. The leaves were partially ground by rolling, sifted to separate the midribs and larger leaf sections from rolled leaves. The leaves were further roller ground prior to fermentation and final

firing in a dryer to reduce moisture from ca. 25% to ca. 3%. The tea leaves were extracted with hot water and then the extract was dried to a powder referred to as “instant tea”.

Table 118. Glyphosate Residue levels in Processed Tea Leaves and Instant Tea (Brasziz *et al.* 1979, 1981 MSL01582, MSL0980].

Site	Application rate (kg ae/ha)	PHI (days)	Residue Glyphosate (mg/kg)		
			Leaves	Instant Tea	PF Instant Tea
Assam India	3×2.2	1	0.36	1.5	4.3
	3×2.2	14	< 0.08	< 0.33	<4.1
Lin-Kou Taiwan	3×2.2	1	0.29	1.6	5.6
	3×2.2	15	0.15	< 0.33	<2.2
Talawakele Sri Lanka - St. Coombs, Tri	3×2.2	1	6.7	19	2.9
	3×2.2	15	0.46	1.9	4.2

The mean processing factor for instant tea was 3.8.

Sugar cane

Sugar cane samples in the study were processed into bagasse, molasses, and raw sugar. Some were also processed into refined sugar. The applications rates of 1.1 and 2.2 kg/ha exceed modern GAP.

Table 119. Glyphosate residue data for sugar cane processed fractions Beasley 1978 MSL0264.

Site	**kg/ha**	**PHI**	**Glyphosate Residue (mg/kg)**				
		(days)	Cane	Bagasse	Molasses	Raw Sugar	Refined Sugar
Oahu, Hawaii 1	1.1	10	0.40	0.34	11	0.96	
		28	0.97	0.18	5.2	0.36	< 0.05
	2.2	10	2.2	0.48	15	1.5	< 0.05
		28	0.82	0.20	7.4	0.41	
Oahu, Hawaii 2	1.1	10	1.0	0.33	14	0.89	
		28	0.69	0.20	5.8	1.3	
	2.2	10	3.8	0.69	12	2.5	< 0.05
		28	0.94	0.24	7.6	0.63	
Weslaco Texas	0.56	10	0.31	0.14	2.4	0.38	0.07
		28	0.24	0.06	2.2	0.26	0.19
	1.1	10	0.15	0.08	2.3	0.83	0.36
		28	0.21	0.08	2.1	0.51	0.31
St. Martinsville, Louisiana	0.56	10	0.29	0.09	2.5	0.19	
		35	0.21	< 0.05	1.6	0.06	< 0.05
	1.1	10	0.67	0.17	3.6	0.24	< 0.05
		35	0.28	0.27	3.2	0.26	
Pakohe, Florida	0.56	10	0.11	< 0.05	0.81	0.08	< 0.05
		28	< 0.05	< 0.05	0.32	0.05	
	1.1	10	0.17	0.11	1.4	0.21	< 0.05
		28	0.13	0.07	0.87	0.08	
Bell Glade, Florida	0.56	10	0.07	< 0.05	0.28	0.11	< 0.05
		28	< 0.05	< 0.05	0.16	0.06	
	1.1	10	0.36	0.12	2.1	0.60	< 0.05
		28	0.07	< 0.05	0.31	< 0.05	

Arecibo, Puerto Rico	0.56	10	< 0.05	< 0.05	0.16	< 0.05	
		28	< 0.05	< 0.05	0.18	< 0.05	
	1.1	10	0.20	0.18	1.7	0.25	< 0.05
		28	0.27	0.10	1.6	0.40	< 0.05

Table 120. Processing factors for glyphosate residues in sugar cane processed fractions.

		PHI	Processing factor			
		(days)	Bagasse	Molasses	Raw Sugar	Refined Sugar
Oahu, Hawaii 1	1.1	10	0.85	27	2.4	
		28	0.19	5.4	0.37	< 0.05
	2.2	10	0.22	7.1	0.68	< 0.02
		28	0.24	9.0	0.50	
Oahu, Hawaii 2	1.1	10	0.32	14	0.87	
		28	0.29	8.4	1.9	
	2.2	10	0.18	3.2	0.64	< 0.01
		28	0.26	8.1	0.67	
Weslaco Texas	0.56	10	0.45	7.7	1.2	0.23
		28	0.25	9.2	1.1	0.79
	1.1	10	0.53	15	5.5	2.4
		28	0.38	10	2.4	1.5
St. Martinsville, Louisiana	0.56	10	0.31	8.8	0.66	
		35	< 0.24	7.7	0.29	< 0.24
	1.1	10	0.25	5.4	0.36	0.07
		35	0.96	11	0.93	
Pakohe, Florida	0.56	10	< 0.45	7.4	0.73	< 0.45
		28		< 6.4		
	1.1	10	0.65	8.4	1.2	< 0.29
		28	0.54	6.7	0.62	
Bell Glade, Florida	0.56	10		4.0	1.6	< 0.71
		28		< 3.2		
	1.1	10	0.33	5.8	1.7	< 0.14
		28		4.4		
Arecibo, Puerto Rico	0.56	10		< 3.2		
		28		< 3.6		
	1.1	10	0.90	8.6	1.2	< 0.25
		28	0.37	6.1	1.5	< 0.19

Table 121. Total glyphosate residue data (glyphosate + AMPA) for sugar cane processed fractions Beasley 1978 MSL0264.

Site	**kg/ha**	**PHI**	**Glyphosate Residue (mg/kg)**				
		(days)	Cane	Bagasse	Molasses	Raw Sugar	Refined Sugar
Oahu, Hawaii 1	1.1	10	0.40	0.34	11	0.96	
		28	0.97	0.18	5.5	0.36	< 0.05
	2.2	10	2.2	0.48	16	1.5	< 0.05
		28	0.82	0.20	7.8	0.41	
Oahu, Hawaii 2	1.1	10	1.0	0.33	15	0.89	
		28	0.69	0.20	6.1	1.3	

	2.2	10	3.8	0.69	13	2.6	< 0.05
		28	0.94	0.24	8.0	0.63	
Weslaco Texas	0.56	10	0.31	0.14	2.5	0.38	0.07
		28	0.24	0.06	2.3	0.26	0.19
	1.1	10	0.15	0.08	2.4	0.83	0.36
		28	0.21	0.08	2.2	0.51	0.31
St. Martinsville, Louisiana	0.56	10	0.29	0.09	2.6	0.19	
		35	0.21	< 0.05	1.7	0.06	< 0.05
	1.1	10	0.67	0.17	3.8	0.24	< 0.05
		35	0.28	0.27	3.4	0.26	
Pakohe, Florida	0.56	10	0.11	< 0.05	0.92	0.08	< 0.05
		28	< 0.05	< 0.05	0.32	0.05	
	1.1	10	0.17	0.11	1.6	0.21	< 0.05
		28	0.13	0.07	0.87	0.08	
Bell Glade, Florida	0.56	10	0.07	< 0.05	0.28	0.11	< 0.05
		28	< 0.05	< 0.05	0.16	0.06	
	1.1	10	0.36	0.12	2.2	0.60	< 0.05
		28	0.07	< 0.05	0.31	< 0.05	
Arecibo, Puerto Rico	0.56	10	< 0.05	< 0.05	0.16	< 0.05	
		28	< 0.05	< 0.05	0.18	< 0.05	
	1.1	10	0.20	0.18	1.7	0.25	< 0.05
		28	0.27	0.10	1.7	0.40	< 0.05

Table 122. Processing factors total residues in sugar cane processed fractions.

		PHI	Processing factor			
		(days)	Bagasse	Molasses	Raw Sugar	Refined Sugar
Oahu, Hawaii 1	1.1	10	0.85	28	2.4	
		28	0.19	5.7	0.37	< 0.05
	2.2	10	0.22	7.3	0.68	< 0.02
		28	0.24	9.5	0.50	
Oahu, Hawaii 2	1.1	10	0.32	15	0.87	
		28	0.29	8.8	1.9	
	2.2	10	0.18	3.4	0.68	< 0.01
		28	0.26	8.5	0.67	
Weslaco Texas	0.56	10	0.45	8.1	1.2	0.23
		28	0.25	9.6	1.1	0.79
	1.1	10	0.53	16	5.5	2.4
		28	0.38	10	2.4	1.5
St. Martinsville, Louisiana	0.56	10	0.31	9.0	0.66	
		35	< 0.24	8.1	0.29	< 0.24
	1.1	10	0.25	5.7	0.36	0.07
		35	0.96	12	0.93	
Pakohe, Florida	0.56	10	< 0.45	8.4	0.73	< 0.45
		28		<6.4		
	1.1	10	0.65	9.4	1.2	< 0.29
		28	0.54	6.7	0.62	
Bell Glade, Florida	0.56	10		4.0	1.6	< 0.71

		28		< 3.2		
	1.1	10	0.33	6.1	1.7	< 0.14
		28		4.4		
	0.56	10		< 3.2		
		28		< 3.6		
Arecibo, Puerto Rico	1.1	10	0.90	8.6	1.2	< 0.25
		28	0.37	6.3	1.5	< 0.19

RESIDUES IN ANIMAL COMMODITIES

Farm animal feeding studies

Lactating Cow

Nineteen lactating Holstein dairy cows (444–642 kg bw), each producing 13–29 kg of milk per day, were acclimatised for 14 days prior to incorporation of glyphosate and AMPA in the feed (Manning and Wilson 1987 MSL6729). The animals were divided into a untreated control group of four animals and three treated tests groups of five animals each. The control group received basal rations without glyphosate and AMPA. The basal rations for the three treated test groups contained a 9:1 mixture of glyphosate and AMPA at total combined daily dietary levels of 40, 120, and 400 ppm (mg of test materials per kg of ration). The basal diet was composed of alfalfa hay and a concentrated commercial milking ration. The concentrated milking ration was limit fed daily at a rate of 1 kg of ration to 2.5 kg of milk produced, with half given at the a.m. milking and the remainder at the p.m. milking. Alfalfa hay and water were supplied ad libitum.

The concentrated milking ration was used to deliver the test material. The animals were fed the treated concentrate as 25% of their total daily dry matter feed consumption. Therefore, the concentrated milking rations were fortified at the following levels which are four times the levels of the total daily dose: 160 ppm for test group 1; 480 ppm for test group 2; and 1600 ppm for test group 3. The amount of fortified concentrate fed to each animal was based on the average dry matter feed intake for the first five days of the previous week. Glyphosate and AMPA were thoroughly blended with the commercial concentrated milking ration to assure a uniform distribution. Analysis of samples from the top, middle and bottom portions of the mixed feed for each dose level demonstrated homogeneity of the mixing. Although the feed mix was shown to be stable for at least 14 days, new batches were mixed at 7 day intervals.

Milk samples were taken from each cow on the day prior to initiation of dosing (test day –1) and on test days 1, 2, 4, 7, 14, 21, and 28 for analysis. On the day following the 28th day of dosing, three cows from each test group were sacrificed.

The remaining animals for each test group were placed on a 28 day depuration period. One animal from each of the treated test groups was sacrificed after a seven day depuration period and the remaining animals in the control and treated test groups were sacrificed after a 28 day depuration period. Milk samples were taken from each of the depurated cows on the depuration test days 1, 2, 4, 7, 14, 21, and 28.

Samples of liver, kidney, fat, and skeletal muscle were collected from each animal for analysis. Fat samples were a composite of equal amounts of omental and subcutaneous back fat. Muscle samples were a composite of equal amounts of triceps, gracilis, and longissimus dorsi muscle.

Table 123. Analytical recovery data for glyphosate and AMPA in cow tissues and milk from fortified control samples (Manning and Wilson 1987 MSL6729.

Matrix	Fortification Range (mg/kg)	Mean % Recovery ± sd*	
		Glyphosate	AMPA
Milk	0.025	96 ± 5.6	99 ± 5.6
Muscle	0.05	94 ± 5.1	94 ± 6.1
Fat	0.05	96 ± 1.5	89 ± 8.2
Liver	0.05 – 1.00	83 ± 10.8	90 ± 6.5
Kidney	0.05 – 5.00	95 ± 1.9	90 ± 4.2

Glyphosate and AMPA residues were non-detectable (less than 0.025 mg/kg) in all milk samples collected from cows dosed at the highest dose level. Since glyphosate and AMPA were not detected in the highest dosed milk samples, analysis of the low and medium dosed milk samples was not conducted.

Table 124. Glyphosate and AMPA residues in tissues of cow fed a diet incorporating 9:1 mixtures of glyphosate and AMPA for 28 consecutive days (Manning and Wilson 1987 MSL6729.

Tissue and Sampling Time (days)		Residue (mg/kg)					
		Diet Dose 40 ppm		Diet Dose 120 ppm		Diet Dose 400 ppm	
		Glyphosate	AMPA	Glyphosate	AMPA	Glyphosate	AMPA
Fat	28	< 0.05 (3)	< 0.05 (3)	< 0.05 (3)	< 0.05 (3)	< 0.05 (2)	< 0.05 (2)
	+7	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	+28	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Muscle	28	< 0.05 (3)	< 0.05 (3)	< 0.05 (3)	< 0.05 (3)	< 0.05 (2)	< 0.05 (2)
	+7	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	+28	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Liver	28	< 0.05 (2) 0.06	< 0.05 (3)	0.07 0.05 < 0.05	< 0.05 (2) 0.05	0.21 0.20	0.12 0.18
	+7	< 0.05	< 0.05	< 0.05	< 0.05	0.11	0.08
	+28	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Kidney	28	0.32 0.24 0.16	0.07 (2) < 0.05	0.69 0.74 0.82	0.19 0.13 0.24	2.7 3.3	0.91 0.79
	+7	< 0.05	< 0.05	< 0.05	< 0.05	0.05	0.07
	+28	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

*during the 2nd week of dosing, animals in the 120 ppm feed group mistakenly received 160 ppm, returning to 120 ppm for the rest of the study.

Analysis of tissues following the 7 and 28 day depuration period demonstrated that glyphosate and AMPA are rapidly eliminated. Following a 7-day depuration period, glyphosate and AMPA residues were less than 0.05 mg/kg in all samples except the kidney and liver samples from animals dosed at the highest dose level. Glyphosate residues in kidney and liver samples from the 7 day depurated animal dosed at the highest dose level were 0.13 and 0.06 mg/kg, respectively, and 0.08 mg/kg AMPA was found in both samples. At the end of the 28 day depuration period glyphosate and AMPA residues were non-detectable (less than 0.05 mg/kg) in all samples from all treatment levels.

Poultry

One hundred female, single comb, White Leghorn chickens, 20-28 weeks of age, 1.7 kg bw, egg laying efficiency 85%, were selected for use in this study (Manning and Wilson 1987 MSL6676). The hens were divided into one control group of forty hens and three treatment groups with twenty hens each. The hens in the control and treatment groups were further subdivided into four sub-sets of five hens each that shared a communal feeder and waterer. Eggs and tissue samples from each sub-set were separately composited for analysis.

All hens were subjected to a 14-day acclimation period prior to dosing, and were housed in individual laying cages throughout the study. Each animal received a physical examination by a

veterinarian at the beginning of the acclimation period, at the beginning of the dosing period, and just prior the sacrifice.

The basal diet contained 25.25% Purina Accu-line Chicken Blend Concentrate®, 67.25% ground yellow corn, and 7.50% ground limestone. The control treatment group received basal rations without glyphosate and AMPA. The basal rations for the three treated test groups contained a 9:1 mixture of glyphosate and AMPA at total combined dietary levels of 40, 120, and 400 ppm (mg of test materials per kg of ration), respectively. Glyphosate and AMPA were thoroughly blended with the diet to assure a uniform distribution. The diet and water were supplied ad libitum. Feed consumption was 110-140 g/day.

Eggs were collected on the day prior to initiation of dosing (test day –1) and on test days 1, 2, 4, 7, 14, 21, and 28 for analysis. On the day following the 28th day of dosing, twenty hens from the control group and ten hens from each test group were sacrificed. The remaining animals were placed on a 28 day depuration period. During the depuration period all hens were fed a untreated basal diet. After a seven day depuration period, ten hens from the control group and five hens from each test group were sacrificed. The remaining hens in the control and treated test groups were sacrificed after a 28 day depuration period. Egg samples were collected from the depurated hens on days 1, 2, 4, 7, 14, 21, and 28 of the depuration period.

Tissues were collected for analysis: kidneys, liver, thigh and breast muscle, and abdominal fat. Tissues were pooled from each subset of five birds within each control or treatment group.

Table 125. Analytical recovery data for glyphosate and AMPA in chicken tissues and eggs from fortified control samples (Manning and Wilson 1987 MSL6676).

Matrix	Fortification Range (mg/kg)	Mean % Recovery ± sd*	
		Glyphosate	AMPA
Fat	0.05 – 0.10	85 ± 1.4	85 ± 2.6
Muscle	0.05	96 ± 6.5	95 ± 1.6
Liver	0.05 – 1.00	78 ± 3.1	79 ± 3.7
Kidney	0.05 – 5.00	84 ± 10.9	87 ± 1.9
Eggs	0.025 – 0.10	89 ± 8.3	86 ± 8.2

* sd= standard deviation (%)

The residue levels of glyphosate and AMPA in tissues and eggs are summarized in Tables 126 and 127. Glyphosate and AMPA residues were non-detectable (less than 0.05 mg/kg) in all fat and muscles samples from all treatment levels, with the exception of two fat tissue samples from the highest dose level following the 28 day dosing period that contained 0.06 and 0.07 mg/kg of glyphosate. The highest glyphosate and AMPA residues were found in kidneys. At the end of the 28-day dosing period average glyphosate residues were 0.38, 1.17, and 4.54 mg/kg in the kidneys of animals dosed at the low, medium, and high dose levels, respectively. AMPA residue levels in the same tissues were < 0.05, 0.06, and 0.33 mg/kg, respectively. Significantly lower levels of glyphosate and AMPA were found in liver tissues collected at the end of the 28 day dosing period. For the low, medium, and high dose level liver samples, glyphosate residues were 0.07, 0.20, and 0.78 mg/kg, respectively. AMPA residues in the same tissues were < 0.05, 0.10, and 0.38 mg/kg, respectively.

Analysis of tissues following the 7 and 28 day depuration period demonstrated that glyphosate and AMPA are rapidly eliminated. Following a 7 day depuration period, AMPA residues were less than 0.05 mg/kg in all samples except the liver samples from hens dosed at the highest level, which contained 0.15 mg/kg. Glyphosate residues in the 7 day depurated animal were non-detectable (less than 0.05 mg/kg) in all tissues except kidney samples at all three dose levels and liver samples from the highest dose level. Glyphosate residues in the high dose level liver samples and the low, medium, and high dose level kidney samples were 0.15, 0.06, 0.23, and 0.35 mg/kg, respectively. At the end of the 28 day depuration period, glyphosate and AMPA residues were non-detectable (less than 0.05 mg/kg) in all samples from all treatment levels, except kidney samples from animals dosed

at the medium and highest dose levels that contained glyphosate residues of 0.17 and 0.08 mg/kg, respectively.

Table 126. Glyphosate and AMPA residues in tissues of chicken fed a diet incorporating 9:1 mixtures of glyphosate and AMPA for 28 consecutive days (Manning and Wilson 1987 MSL6676).

Tissue and Sampling Time (days)		Residue (mg/kg)					
		Diet Dose 40 ppm		Diet Dose 120 ppm		Diet Dose 400 ppm	
		Glyphosate	AMPA	Glyphosate	AMPA	Glyphosate	AMPA
Fat	28	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)
	+7	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	+28	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Muscle	28	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)
	+7	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
	+28	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Liver	28	0.06 < 0.05	< 0.05 (2)	0.14 0.17	0.07 0.08	0.61 0.59	0.33 0.27
	+7	< 0.05	< 0.05	< 0.05	< 0.05	0.11	0.11
	+28	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Kidney	28	0.27 0.35	< 0.05 (2)	0.73 1.2	< 0.05 0.06	3.3 4.3	0.27 0.30
	+7	< 0.05	< 0.05	0.19	< 0.05	0.29	< 0.05
	+28	< 0.05	< 0.05	0.14	< 0.05	0.07	< 0.05

Glyphosate and AMPA residues were non-detectable (less than 0.025 mg/kg) in all egg samples collected from hens dosed at the low dose level. In the eggs of hens dosed at the medium dose level, low residues of glyphosate (0.026–0.029 mg/kg) were found on test days 7, 14, 21, and 28. AMPA residues in these same samples were less than 0.025 mg/kg in all cases. Eggs from hens dosed for 28 days at the highest dose level contained glyphosate residues that ranged from 0.076–0.103 mg/kg on days 7, 14, 21, and 28. With the exception of two egg samples collected on test day 21 that contained AMPA residues of < 0.027 and 0.031 mg/kg, AMPA residues were less than 0.025 mg/kg in all egg samples from hens dosed at the highest dose level.

Analysis of eggs during the depuration period demonstrated that glyphosate and AMPA are rapidly eliminated. AMPA residues were non-detectable (less than 0.025 mg/kg) in all samples at all three dose levels. Glyphosate residues were non-detectable (less than 0.025 mg/kg) in all egg samples from hens dosed and the low dose level. For hens dosed at the medium dose level, glyphosate residues were 0.030 mg/kg in eggs collected for the first two days of the depuration period, and then declined to non-detectable (less than 0.025 mg/kg) in all subsequent samples. For hens dosed at the highest dose level, glyphosate residues in eggs collected on depuration days 1, 2, 4, and 7 were 0.088, 0.093, 0.067, and < 0.026 mg/kg, respectively. All subsequent samples of eggs from hens dosed at the high dose level contained less than 0.025 mg/kg glyphosate.

Table 127. Glyphosate and AMPA residues in eggs of chicken fed a diet incorporating 9:1 mixtures of glyphosate and AMPA for 28 consecutive days (Manning and Wilson 1987 MSL6676).

		Residue (mg/kg)					
		Diet Dose 40 ppm		Diet Dose 120 ppm		Diet Dose 400 ppm	
Sampling Time (days)		Glyphosate	AMPA	Glyphosate	AMPA	Glyphosate	AMPA
Dosing Days	1	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)
	2	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)
	4	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)
	7	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	< 0.025 (4)	0.06 (2) 0.08 0.07	< 0.025 (4)
	14	< 0.025 (4)	< 0.025 (4)	0.026 (3) < 0.025	< 0.025 (4)	0.10 0.07 0.09 0.08	< 0.025 (4)
	21	< 0.025 (4)	< 0.025 (4)	0.026 0.027 < 0.025 (2)	< 0.025 (4)	0.08 (3) 0.12	< 0.025 (2) 0.026
	28	< 0.025 (4)	< 0.025 (4)	0.026 0.027 < 0.025 (2)	< 0.025 (4)	0.08 (2) 0.10 0.07	< 0.025 (4)
Depuration Days	1	< 0.025 (2)	< 0.025 (2)	0.028 < 0.025	< 0.025 (2)	0.08 0.08	< 0.025 (2)
	2	< 0.025 (2)	< 0.025 (2)	0.026 0.027	< 0.025 (2)	0.08 0.08	< 0.025 (2)
	4	< 0.025 (2)	< 0.025 (2)	< 0.025 (2)	< 0.025 (2)	0.06 0.06	< 0.025 (2)
	7	< 0.025 (2)	< 0.025 (2)	< 0.025 (2)	< 0.025 (2)	< 0.025 (2)	< 0.025 (2)
	14	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
	21	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
	28	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025

Swine

Sixteen crossbred swine (eight gilts 71–81 kg and eight barrows, 65–81 kg) were acclimatised for 15 days (Manning and Wilson 1987 MSL6627). The animals were divided into four test groups of four animals each: a control test group and three treated test groups. Each test group contained two gilts and two barrows. The control group received basal rations without glyphosate and AMPA. The basal rations for the three treated test groups contained a 9:1 mixture of glyphosate and AMPA at total combined daily dietary levels of 40, 120, and 400 ppm (mg of test materials per kg of ration). The basal diet was a mixture of 18.5% Ralston Purina Farm Blend Hog Chow® and 81.5% ground yellow corn. Glyphosate and AMPA were thoroughly blended with the diet to assure a uniform distribution confirmed by analysis of samples in the mixer. Although glyphosate and AMPA were demonstrated to be stable in the feed mix for at least 12 days at 25 °C, new batches were prepared every 7 days. Diets and water were supplied to each animal ad libitum. Individual feed consumption was 1.7–4.3 kg/day for the barrows and 1.1–3.8 kg for the gilts. Animals in all three treated test groups were fed dosed feed for 28 consecutive days. Within 24 hours after receiving their last dose, one gilt and one barrow from each test group were sacrificed. The remaining animals for each test group were placed on a 28 day depuration period. Each animal received untreated feed during the depuration period. At the end of the 28 day depuration period, the remaining animals in each test group were sacrificed and samples of liver, kidney, fat, and skeletal muscle were collected for analysis. Fat samples were a composite of omental and subcutaneous fat. Muscle samples were a composite of triceps, gracilis, and longissimus dorsi muscle.

Samples of liver, kidney, muscle, and fat were analyzed for AMPA and glyphosate residues according to Residue Method 2 (Table 128). The analytical method was validated at 0.05 mg/kg each of glyphosate and AMPA in all tissues. Recovery data for glyphosate and AMPA from fortified control samples analyzed concomitantly with treated samples are summarized in Table 128.

Table 128. Analytical recovery data for glyphosate and AMPA in swine tissues from fortified control samples (Manning and Wilson 1987 MSL6627).

Matrix	Fortification Range (mg/kg)	Mean % Recovery ± sd*	
		Glyphosate	AMPA
Fat	0.05 – 0.10	97 ± 6.8	87 ± 7.1
Muscle	0.05	90 ± 11.6	90 ± 2.4
Liver	0.05 – 0.50	80 ± 8.4	85 ± 2.7
Kidney	0.05 – 2.50	98 ± 4.6	91 ± 6.0

* sd= standard deviation (%)

The residue levels of glyphosate and AMPA in tissues are summarized in Table 129. Glyphosate and AMPA residues were non-detectable (less than 0.05 mg/kg) in all fat and muscles samples from all treatment levels, with the exception of three of six muscle samples from the highest dose level following the 28 day dosing period that each contained 0.06 mg/kg of glyphosate. The highest glyphosate and AMPA residues were found in kidneys. At the end of the 28 day dosing period average glyphosate residues were 0.37, 2.6, and 7.8 mg/kg in the kidneys of animals dosed at the low, medium, and high dose levels, respectively. AMPA residue levels in the same tissues were < 0.07, 0.29, and 0.96 mg/kg, respectively. Significantly lower levels of glyphosate and AMPA were found in liver tissues collected at the end of the 28 day dosing period; < 0.05, 0.21, and 0.75 mg/kg respectively for glyphosate in the low, medium, and high dose level liver samples and < 0.05, 0.12, and 0.39 mg/kg, respectively for AMPA.

Table 129. Glyphosate and AMPA residues in tissues of swine fed a diet incorporating 9:1 mixtures of glyphosate and AMPA for 28 consecutive days (Manning and Wilson 1987 MSL6627).

Tissue and Sampling Time (days)		Residue (mg/kg)					
		Diet Dose 40 (36:4) ppm		Diet Dose 120 (108:12) ppm		Diet Dose 400 (360:40) ppm	
		Glyphosate	AMPA	Glyphosate	AMPA	Glyphosate	AMPA
Fat	28	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)
	+28	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)
Muscle	28	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	0.06 < 0.05	< 0.05 (2)
	+28	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)
Liver	28	< 0.05 (2)	< 0.05 (2)	0.17 0.15	0.11 0.09	0.72 0.48	0.45 0.22
	+28	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)	< 0.05 (2)
Kidney	28	0.14 0.60	< 0.05 0.08	2.9 2.1	0.31 0.22	9.1 6.1	0.97 0.77
	+28	< 0.05 (2)	< 0.05 (2)	0.10 < 0.05	< 0.05 (2)	0.16 0.20	< 0.05 (2)

Analysis of tissues following the 28-day depuration period demonstrated that glyphosate and AMPA are rapidly eliminated. Following a 28-day depuration period, AMPA residues were less than 0.05 mg/kg in all samples. Glyphosate residues in the 28-day depurated animal tissues were less than 0.05 mg/kg in all tissues except kidney samples at the medium and high dose levels that contained average glyphosate residues of 0.08 and 0.18 mg/kg, respectively.

APPRAISAL

Glyphosate is a herbicide with uses on many crops. Glyphosate has been evaluated several times with the initial evaluation in 1986 and the latest in 1997. It was listed under the Periodic Re-evaluation Programme of the 34th Session of the CCPR for residue review by 2005 JMPR (ALINORM 03/24). The Meeting received information on glyphosate metabolism and environmental fate, methods of residue analysis, freezer storage stability, national registered use patterns, supervised residue trials on conventional and glyphosate tolerant crops and national MRLs.

The 2004 JMPR concluded that the metabolite AMPA is of no greater toxicological concern than the parent glyphosate and established an ADI for the sum of glyphosate and AMPA of 0-1 mg/kg bw. The same meeting considered an ARfD unnecessary.

Some information on GAP and national MRLs were submitted by Australia and The Netherlands.

The following abbreviations are used for the metabolites discussed below:

AMPA	aminomethyl phosphonic acid
N-methyl AMPA	[(N-methylamino)methyl]phosphonic acid

Glyphosate is available in a variety of different salt forms including as the sodium, potassium, ammonium and isopropylamine salts. To assist uniform interpretation of GAP application rates have been expressed in terms of glyphosate acid equivalents (ae). Applications of glyphosate can be made at different stages of crop growth. The following abbreviations are used for the main stages of application:

PRE = pre-emergent or pre crop emergence

EPO = early post-emergence

LPO = late post-emergence

PH = pre-harvest, specifically within a few weeks prior to harvest

Animal metabolism

The Meeting received metabolism studies for glyphosate in rats, lactating goats and laying hens.

The biotransformation and degradation pathways in the goat and hen are similar to those established in rat metabolism. In animals, ^{14}C-glyphosate is excreted unchanged. The only residue identified in tissues of goats and laying hens was glyphosate although there were indications that small amounts of AMPA may be formed. A significant proportion of the ^{14}C in the goat and hen metabolism experiments was retained on columns used for separation and characterization. The possible identity of the retained ^{14}C activity was not explored. Metabolism studies on rats samples were analysed both with and without clean-up on cation and anion columns detecting only unchanged glyphosate and small amounts of AMPA. Experiments on rats determined that no AMPA was formed following intravenous administration suggesting that microbial degradation on oral administration may be responsible for the minor amounts of AMPA detected.

Plant metabolism

The Meeting received plant metabolism studies for glyphosate on coffee, corn, cotton, soya beans, wheat, pasture grasses and alfalfa as well as on the glyphosate tolerant crops cotton, soya beans and sugar beet. Pre-emergent application of ^{14}C-glyphosate at application rates equivalent to 4.5 kg ae/ha resulted in low levels of ^{14}C in plants collected 4–8 weeks after application. Control plants also contained ^{14}C probably from incorporation of $^{14}CO_2$ liberated during soil microbial degradation of ^{14}C-glyphosate.

For the same crops grown hydroponically and exposed to sublethal doses of ^{14}C-glyphosate in the growth solution, glyphosate was the major component of the total radioactive residue (TRR) in the aerial parts of the plants (21–69%). Other compounds identified were AMPA (4.2–28%), N-methyl AMPA (0–2.0%) as well as small amounts of natural products. The proportion of ^{14}C extracted with water was higher for aerial parts (70–90%) compared with roots (36–87%). In the case of roots, glyphosate was the major compound detected (7.6-57%) together with smaller amounts of AMPA (2.8–7.4%), N-methyl AMPA (0–0.4%) and natural products (1–11%). In summary, several minor metabolites were present at < 2% TRR (N-methyl AMPA, methylphosphonic acid and N-methyl glyphosate) though their origin was unclear; *in vivo* metabolism, microbial degradation or impurities in the material administered.

The metabolism of ^{14}C-glyphosate on both immature and mature coffee plants following uptake from soil, from hydroponic solution, stem injection and foliar application was studied. ^{14}C was translocated from the sites of application. In all cases glyphosate was the major component of the ^{14}C residue. For example 5 weeks after foliar application to mature coffee plants glyphosate comprised

72–99% of the residue in leaves, 91% in stems, 96% in roots and 94% in beans. Residues of AMPA were 5% or less of the TRR and were generally present in ratios with glyphosate comparable to that present in the administered formulation.

Only low levels of radioactivity were recovered in grasses, alfalfa and clover grown on ^{14}C-glyphosate treated soil or in soil into which ^{14}C-glyphosate treated quackgrass was incorporated. Glyphosate was the only component of the ^{14}C residue of foliar treated grass and alfalfa extracted with water, a process that recovered > 95% of the TRR. Small amounts of AMPA were detected in grass samples following foliar application of ^{14}C-glyphosate. Drying grass and alfalfa to form hay did not alter the ^{14}C residues.

Metabolism studies have been completed in glyphosate tolerant soya beans, sugar beet, and cotton crops that contain the CP4-EPSPS gene. In tolerant soya beans, glyphosate is metabolized substantially to AMPA, the latter can be conjugated with natural plant constituents to give trace level metabolites, or degraded to one carbon fragments that are incorporated into natural products. None of the trace level metabolites account for greater than 2% of the TRR in any soya bean raw agricultural commodity. Glyphosate plus AMPA account for at least 66% of the total radioactive residues in forage, hay, and grain. Glyphosate residues differ among the plant components accounting for about 90% of the TRR in forage but only about 25% of the TRR in grain. AMPA accounted for only 6.8% of the TRR in forage, but was the major ^{14}C compound in grain accounting for up to 49% of the TRR. About 9% of the TRR in grain was shown to be due to incorporation of ^{14}C into natural products; in the oil as fatty acids, in the aqueous extract as soluble components, and in the acid hydrolysate of the extracted grain as amino acids and natural organic acids.

In glyphosate tolerant cotton, glyphosate and AMPA account respectively for 91-95% and 0.7–1.6% of the TRR in forage. In cottonseed glyphosate is the major extractable radiolabeled compound (12–24 % of the TRR) and only trace levels of AMPA are present (< 2% of the TRR). A significant fraction of the residues in the seed are attributed to incorporation into natural products; 10–12% of the TRR was characterized as saponifiable fatty acids in oil and 54–75% of the TRR was present as natural products.

The metabolism of ^{14}C-glyphosate in tolerant sugar beet was very similar to soya beans and cotton. Glyphosate is partially metabolized to AMPA and low levels of AMPA conjugates. Glyphosate and AMPA together account for at least 99 and 81% of the TRR in roots and tops, respectively. AMPA is further converted, to a limited degree, to low levels of simple conjugates. In addition to conjugation, ^{14}C is broadly incorporated into a wide variety of natural products and plant constituents.

The results of all the studies demonstrate that the metabolic fate of glyphosate in tolerant plants is the same as in non-tolerant plants.

Environmental fate

The Meeting received information on the behaviour and fate of glyphosate during solution photolysis and aerobic soil metabolism. Consistent with the policy outlined by the 2003 JMPR only the environmental fate data relevant to the residues of glyphosate in crops were evaluated.

Crop rotation studies were not provided. However, aerobic soil metabolism of glyphosate was rapid with inferred degradation half-lives of 3.6–25 days depending on the soil system studied. The major metabolite formed was AMPA which was further degraded to CO_2. In aqueous solution glyphosate is stable to hydrolysis. The rate of degradation in field and in aquatic environments is such that glyphosate is not expected to persist in the environment.

Methods of analysis

Glyphosate and AMPA residues are measured as derivatives following clean-up of aqueous extracts by cation and anion exchange, the derivatization reaction varying with the chromatographic method used for separation (GC, HPLC) and detection system employed (FPD in phosphorous mode,

fluorescence detector, UV, MS and MS/MS). Satisfactory recoveries at the LOQs of 0.05 mg/kg for both glyphosate and AMPA were reported for numerous commodities.

Stability of pesticide residues in stored analytical samples

The Meeting received information on the stability of glyphosate residue samples during storage of analytical samples at freezer temperatures. The available storage stability data indicate that residues of glyphosate and AMPA are stable under frozen storage conditions (-20°C) in/on the following commodities (storage interval in parentheses): beans, rape and linseed (18 months), wheat grain and straw, rye grain and straw (1349 days), pasture grass (362 days), soya bean seed (183 days) soya bean straw (398 days), corn grain (944 days), sorghum forage (958 days), sorghum straw (958 days), clover (944 days) and tomatoes (938 days). Residues were stable in animal commodities (pig, cow and chicken tissues and milk) for at least 700 days. For eggs residues were stable for 431 days.

Residues of AMPA are stable under frozen storage conditions (-20°C) in/on the following commodities (storage interval in parentheses): pasture grass (362 days), soya bean seed (183 days) soya bean straw (398 days), corn grain (944 days), sorghum forage (958 days), sorghum straw (958 days), clover (944 days) and tomatoes (938 days). Residues were stable in animal commodities (pig, cow and chicken tissues and milk) for at least 700 days. For eggs residues were stable for 431 days.

Definition of the residue

The metabolism studies in coffee, corn, cotton, soya beans, wheat, pasture grasses and alfalfa as well as on the glyphosate tolerant crops cotton, soya beans and sugar beet patterns of metabolites were similar in different species of plants. The main metabolite found in plant metabolism studies was AMPA. The Meeting agreed that glyphosate together with AMPA should be regarded as the residues of toxicological concern.

For the purposes of estimation of dietary intake and to enable comparison of the calculated intakes with the ADI it is preferable to express the residues in terms of glyphosate (glyphosate = 1.5 × AMPA).

Currently, the residue definition for glyphosate is “glyphosate”. In national systems the residue definition for glyphosate is generally also the parent compound.

The Meeting agreed that the residue definition applicable to glyphosate would continue to be the parent compound. As for estimation of dietary intake and the risk assessment component relating to exposure, the 2004 JMPR concluded that AMPA was of no greater toxicological concern than its parent compound and set a group ADI of 0-1 mg/kg bw for the sum of glyphosate and AMPA.

For glyphosate STMR estimation, residue = glyphosate + 1.5 × AMPA

Definition of glyphosate residue (for compliance with MRLs): *glyphosate*

Definition of glyphosate residue (for estimation of dietary intake): *sum of glyphosate and AMPA, expressed as glyphosate.*

These definitions apply to plant and animal commodities.

Results of supervised trials on crops

The Meeting received data from supervised trials on the following crops: olives, bananas, kiwifruit, beans (dry), peas (dry), lentils, soya beans (conventional and tolerant), sugar beet (glyphosate tolerant), barley, maize (conventional and tolerant), oats, rye, sorghum, wheat, sugarcane, almonds, pecan, macadamia, walnuts, cotton (conventional and tolerant), linseed, mustard, rape, sunflower, coffee, tea, alfalfa and grasses.

Glyphosate may be applied prior to crop emergence (pre-emergence = PRE), shortly after crop emergence (early post-emergence = EPO), between EPO and a few weeks before harvest (late post-emergence = LPO) and prior to harvest (pre-harvest = PH). In addition glyphosate may be applied to weeds in the crop as a spot treatment or by wiper application to weeds in which case the area treated is generally less than 10% of the area planted and a directed sprays in which the crop is not exposed. The Meeting considered these later methods of application as unlikely to result in significant residues in crops. As such spot, wiper and directed sprays (e.g., hooded sprayers) were not included in consideration of GAP.

When applied as pre-harvest residues in the raw agricultural commodity (RAC) are mainly determined by applications made when the plant is growing and transport from the application site to the RAC occurs, rather than applications made to senescing crops where the RAC is protected from the spray, such as beans in pods. For commodities that are exposed and glyphosate is applied as a pre-harvest application to senescent crops, it is the pre-harvest spray that has the greatest influence on residues. If a range of application protocols involving different numbers of sprays, timing and application rates were used for a crop grown at a single location, the highest residue from any trial at the location and carried out with numbers of applications and rates within the range permitted by GAP was selected.

The limits of detection of glyphosate and AMPA are typically 0.05 mg/kg. When glyphosate and AMPA were summed, AMPA was converted to glyphosate equivalents (AMPA mg/kg × 1.5). If AMPA residues are < 0.05, they are not summed with glyphosate, because they are typically much less than glyphosate residues. If both glyphosate and AMPA are < LOQ, then sum is < LOQ of glyphosate. The exception is where there is evidence that AMPA residues are comparable to glyphosate residues such as for soya beans in which case the residues are summed and if both glyphosate and AMPA residues are < LOQ, the sum is less than the combined LOQs for glyphosate and AMPA.

Olives

Trials on olives were conducted in Greece (no GAP provided), Italy (GAP 4.3 kg ae/ha; no PHI specified) and Spain (directed sprays/spot sprays GAP 2.5 kg ae/ha, PHI not specified, assumed 0 days or 4.3 kg ae/ha, PHI 7 days for fruit on the ground, the lower rate, shorter PHI was taken to be the critical use for Spain). Two trials from Italy and two from Spain matched Italian GAP. Glyphosate residues found in fruit, harvested from the ground one or more days after application were 0.39 and 0.66 mg/kg, for the Italian trials, and 0.17 and 0.12 mg/kg for the Spanish trials. Residues of AMPA were not measured in these trials. Four trials from Spain matched that countries GAP (2.5 kg ae/ha). Residues in fruit collected from the ground were 6.7, 12, 12 and 12 mg/kg for glyphosate. Residues of AMPA were all < 0.05 mg/kg; the sum of glyphosate and AMPA residues were 6.7, 12, 12 and 12 mg/kg.

The Meeting decided that the residues from trials complying with the GAP of Italy and Spain were from different populations and that they could not be combined for estimating a maximum residue level. The Meeting agreed that the number of residue trials was insufficient to estimate a maximum residue level for olives.

Bananas

Trials on bananas were conducted in Brazil (GAP of 4.3 kg ae/ha, with a PHI of 30 days), Honduras, Panama, Colombia and Ecuador (no GAP supplied). For three trials from Brazil that matched Brazilian GAP residues found of glyphosate and AMPA were < 0.05 mg/kg. In four trials conducted in Honduras, Panama, Colombia and Ecuador, at applications rates higher than Brazilian GAP, residues found in pulp and peel, when expressed as whole bananas, were < 0.05 mg/kg for both glyphosate and AMPA. The Meeting decided to utilize the trials at higher application rates in support

of the Brazil trials to recommend a maximum residue level of 0.05 (*) for glyphosate in bananas. The HR and STMR for total residues are both 0.05 mg/kg.

Kiwifruit

Trials on kiwifruit were conducted in Italy (GAP of 4.3 kg ae/ha ground directed spray, with no PHI specified). None of the trials matched GAP. The Meeting agreed to withdraw its previous recommendation of 0.1 (*) mg/kg for kiwifruit.

Beans, dry

Trials on beans, dry were conducted in Belgium (no GAP provided), Denmark (no GAP provided), the UK (GAP of 1.4 kg ae/ha when grain moisture is < 30% generally applied 7–14 days before harvest), the USA (GAP 0.43–4.2 kg ae/ha pre-emergent). The Netherlands GAP is 0.72–2.2 kg ae/ha, PHI 7 days. In Canada GAP is 0.9 kg ae/ha when grain moisture is < 30% generally 7–14 days before harvest. Trials from Belgium and Denmark were evaluated against UK GAP.

Five trials from the UK matching GAP had residues of 0.11, 0.12, 0.16, 0.20 and 1.8 mg/kg. One trial each from Belgium and Denmark matched UK GAP with residues of < 0.05 and 0.17 mg/kg respectively. Residues of AMPA were < 0.05 mg/kg.

None of the USA trials matched GAP for that country and were evaluated against the GAP of Canada. Thirteen trials conducted in the USA approximated Canadian GAP. Residues found in beans (dry) were < 0.05, 0.07, 0.09, 0.10, 0.11, 0.13, 0.19, 0.30, 0.32, 0.37, 0.38, 0.68 and 1.6 mg/kg. Residues of AMPA were all < 0.05 mg/kg.

The Meeting considered that the field trials conducted according to the GAP of the UK and the USA were from similar residue populations and could be combined for the purposes of estimating a maximum residue level. Glyphosate residues, in ranked order were (n = 19) : < 0.05, < 0.05, 0.07, 0.09, 0.10, 0.11, 0.12, 0.13, 0.16, 0.17, 0.19, 0.20, 0.30, 0.32, 0.37, 0.38, 0.68, 1.6 and 1.8 mg/kg. The Meeting confirmed its previous recommendation of a maximum residue level for glyphosate in beans (dry) of 2 mg/kg.

As residues of AMPA were < 0.05 mg/kg, total residues for the purposes of estimating an STMR and highest residues are the same as the glyphosate values. The highest residue and STMR are estimated to be1.8 and 0.17 mg/kg respectively.

Peas, dry

Trials on peas, dry were conducted in Belgium (no GAP provided), Canada (GAP of 0.9 kg ae/ha, when grain moisture is < 30% generally applied, 7–14 days before harvest), Denmark (no GAP provided), the UK (GAP 1.4 kg ae/ha, when grain moisture is < 30% generally 7–14 days before harvest) and the USA (GAP 0.43–4.2 kg ae/ha pre-emergent). The Netherlands GAP is 0.72–2.2 kg ae/ha, PHI 7 days. Trials from Belgium and Denmark were evaluated against UK GAP.

Residues in six UK trials that approximated GAP of that country were 0.13, 0.16, 0.17, 1.7, 1.8 and 2.1 mg/kg. Residues in a single trial from Belgium and Denmark that approximated the UK GAP were 0.17 and 0.5 mg/kg respectively. When measured, residues of AMPA were < 0.05 (4) mg/kg.

In four trials from Canada that approximated GAP of that country, residues of glyphosate were 0.5, 0.82, 1.4 and 8.9 mg/kg. AMPA residues were < 0.05 mg/kg.

The Meeting considered that the field trials conducted according to the GAP of the UK and Canada were from similar residue populations and could be combined for the purposes of estimating a maximum residue level. Glyphosate residues, in ranked order were (n=11): 0.13, 0.16, 0.17, 0.17, 0.5,

0.5, 0.82, 1.4, 1.7, 1.8 and 2.1 mg/kg. The Meeting estimated a maximum residue level for glyphosate in peas (dry) of 5 mg/kg confirming its previous recommendation.

As residues of AMPA were < 0.05 mg/kg, total residues for the purposes of estimating an STMR and highest residue are the same as the glyphosate values. The STMR is estimated to be 0.5 mg/kg and highest residue 2.1 mg/kg.

Lentils

Trials on lentils were conducted in Canada (GAP of 0.9 kg ae/ha, when crop has < 30% grain moisture content and lowermost pods (bottom 15%) are brown and seeds rattle, with a 7-14 days PHI). Two trials matched GAP of Canada with residues of glyphosate of < 0.05 and 3.0 mg/kg and AMPA of < 0.05 mg/kg. The total residues were < 0.05 and 3.0 mg/kg.

The Meeting considered there were insufficient trials to recommend a maximum residue level for lentils.

Soya beans

Trials on conventional soya beans were conducted in the US (GAP of 4.2 kg ae/ha PRE, 4.2 kg ae/ha PH, with a PHI of 7 days). Four trials approximated GAP for the USA had glyphosate residues of 0.45, 5.4, 13 and 17 mg/kg. Corresponding AMPA residues were < 0.05, 1.2, 1.9 and 1.8 mg/kg respectively.

Additionally, trials were conducted on glyphosate tolerant soya beans (GAP of 0.43–4.2 kg ae/ha PE, 1.7 kg ae/ha LPO, 0.83 kg ae/ha PH, combined LPO+PH < 2.5 kg ae/ha, PHI 14 days). GAP allows pre-harvest applications together with post-emergent directed sprays as well as pre-harvest over the top sprays. The Meeting considered that a single pre-harvest application made close to harvest would not give rise to residues in beans (dry) representative of GAP as when the last application is made the crop has entered into senescence, limiting transport of residues to the seed. Only trials that included pre-emergent and in-crop applications were considered as compliant with US GAP. The Meeting also noted that in trials conducted in the USA the pre-emergent application was typically at a higher rate than permitted by GAP, 6.4 versus 4.2 kg ae/ha, but considered the difference in application rates to account for less than 10% difference in the residue at harvest and that the later post-emergent sprays determined the residue. In a metabolism study on soya beans residues in seed after a single pre-emergent application at 5.4 kg ae/ha were < 0.01 mg/kg. While residues found after one or two post-emergent applications at 0.84 or 1.7 kg ae/ha, with the last application occurring 61 days prior to harvest, were 0.04 and 4.4 mg/kg respectively. Thirty-two trials from the USA approximated GAP of that country. Residues of glyphosate were 0.27, 0.28, 0.34, 0.37, 0.42, 0.44, 0.51, 0.56, 0.60, 0.70, 1.0, 1.1, 1.4, 1.4, 1.5, 1.7, 1.8, 1.9, 1.9, 1.9, 2.0, 2.6, 2.7, 2.7, 3.0, 3.3, 3.5, 3.6, 3.7, 4.4, 5.3 and 5.6 mg/kg. Total residues were 0.59, 0.78, 0.89, 1.0, 1.1, 1.1, 1.2, 1.2, 1.5, 1.6, 2.4, 3.2, 4.0, 4.0, 4.3, 4.7, 4.9, 5.1, 5.4, 5.7, 6.2, 6.6, 7.1, 7.6, 7.6, 7.9, 8.2, 8.5, 11, 11, 11 and 17 mg/kg.

The Meeting considered that the field trials conducted on conventional and glyphosate tolerant soya beans according to the GAP of the USA to be from similar residue populations and could be combined for the purposes of estimating a maximum residue level. Glyphosate residues, in ranked order were (n = 36): 0.27, 0.28, 0.34, 0.37, 0.42, 0.44, 0.45, 0.51, 0.56, 0.60, 0.70, 1.0, 1.1, 1.4, 1.4, 1.5, 1.7, 1.8, 1.9, 1.9, 1.9, 2.0, 2.6, 2.7, 2.7, 3.0, 3.3, 3.5, 3.6, 3.7, 4.4, 5.3, 5.4, 5.6, 13 and 17 mg/kg. The Meeting confirmed its previous recommendation of a maximum residue level for glyphosate in soya beans (dry) of 20 mg/kg.

Total residues were (n = 36): 0.45, 0.59, 0.78, 0.89, 1.0, 1.1, 1.1, 1.2, 1.2, 1.5, 1.6, 2.4, 3.2, 4.0, 4.0, 4.3, 4.7, 4.9, 5.1, 5.4, 5.7, 6.2, 6.6, 7.1, 7.2, 7.6, 7.6, 7.9, 8.2, 8.5, 11, 11, 11, 16, 17 and 20 mg/kg. The highest residue and STMR for total residues are 20 and 5.0 mg/kg respectively.

No residue data was available for immature seed and the Meeting agreed to recommend withdrawal of its previous recommendation for soya bean (immature seed) of 0.2 mg/kg.

Sugar beet (glyphosate tolerant)

Trials on sugar beet (glyphosate tolerant) were conducted in the US (GAP of 0.43–4.2 kg ae/ha PRE, 1.3 kg ae/ha EPO from emergence to 8-leaf stage, 0.87 kg ae/ha from 8-leaf stage to canopy closure, 3.8 kg ae/ha combined maximum rate for all applications from emergence to harvest, PHI 30 days). The metabolism study indicated that pre-emergent applications of glyphosate do not make a significant contribution to the residue in sugar beet roots at harvest. An examination of the trial data indicated that it was probable that the last application contributed most to the residue at harvest. The Meeting considered that none of the trials matched GAP.

Cereal grains

The Meeting decided to evaluate the residue trial data for barley, maize, oats, rye, sorghum and wheat for a possible cereal grains recommendation. Estimates of values for total residues (HR and STMR) that are required for dietary intake and animal dietary burden calculations are discussed under each commodity while maximum residue level estimation is discussed at the end after wheat.

Barley

Trials on barley were conducted in Belgium (no GAP provided), France (no GAP provided) and the UK (GAP of 0.54–1.4 kg ae/ha, when grain moisture is < 30% generally 7–14 days before harvest). Trials conducted in Belgium and France were evaluated against the GAP of the Netherlands (GAP of 0.72–2.2 kg ae/ha, with a PHI of 7 days).

Residues of glyphosate in four UK trials approximating UK GAP were 1.4, 3.3, 4.4 and 11 mg/kg. Total residues were 1.4, 3.3, 4.4 and 11 mg/kg. Residues in two trials from Belgium (10 and 20 mg/kg), two from the UK (6.3 and 8.4 mg/kg) and nineteen from France (1.5, 2.2, 2.8, 2.9, 3.3, 5.5, 5.9, 6.3, 6.7, 7.2, 7.9, 8.5, 9.6, 13, 14, 15, 19, 19 and 19 mg/kg) approximated the GAP of the Netherlands.

The Meeting considered the trials to all be from similar populations and decided to combine the results for the purpose of maximum residue level recommendation. Glyphosate residues in rank order were (n=27): 1.4, 1.5, 2.2, 2.8, 2.9, 3.3, 3.3, 4.4, 5.5, 5.9, 6.3, 6.3, 6.7, 7.2, 7.9, 8.4, 8.5, 9.6, 10, 11, 13, 14, 15, 19, 19, 19 and 20 mg/kg. Total residues (where glyphosate and AMPA were reported) were (n=22): 1.1, 2.2, 2.8, 3.0, 3.3, 3.3, 4.4, 5.6, 6.0, 6.8, 7.3, 8.0, 8.6, 9.7, 10, 11, 14, 15, 19, 19, 19 and 20 mg/kg. The Meeting estimated a high residue and STMR for total residues in barley of 20 and 7.65 mg/kg respectively.

Maize

Trials on conventional maize were conducted in the US (GAP of 0.43-4.2 kg ae/ha PRE, 0.87 kg ae/ha directed spray when the crop is > 30 cm tall and 2.5 kg ae/ha PH when grain moisture is < 35%, with a PHI of 7 days).

Trials on conventional maize were conducted in the US (GAP of 0.43–4.2 kg ai/ha PRE, 0.87 kg ai/ha directed spray when crop > 30 cm tall and 2.5 kg ai/ha PH grain moisture < 35%, with a PHI of 7 days). From 21 trials that approximated US GAP, which involved a single pre-harvest application to conventional maize residues of < 0.05 (12), 0.05 (2), 0.06 (2), 0.07, 0.09, 0.19, 0.54 and 3.0 mg/kg were found. Corresponding total residues were < 0.12 (11), < 0.14 (2), 0.14, < 0.16, 0.19, < 0.23, < 0.25, < 0.26, < 0.62 and 3.0 mg/kg respectively.

Additionally, trials were conducted on glyphosate tolerant maize (GAP 0.43–4.2 kg ae/ha PRE, 0.83 kg ae/ha EPO, 1.7 kg ae/ha LPO, total EPO and LPO applications < 2.5 kg ae/ha, 0.87 kg ae/ha PH < 35% grain moisture, PHI 7 days). None of the trials on glyphosate tolerant maize

incorporated a pre-harvest application. Trials on conventional maize showed that pre-harvest applications made a significant contribution to the final residues found. The Meeting considered that none of the trials on glyphosate tolerant maize matched GAP of the USA.

Oats

Trials on oats were conducted in Canada (GAP of 0.18–4.3 kg ae/ha PRE, 0.9 kg ae/ha PH, application at < 30% grain moisture typically 7–14 days before harvest), Denmark (no GAP provided) and the UK (GAP 0.54-1.4 kg ae/ha, < 30% grain moisture typically 7–14 days before harvest). Three trials from Canada matched GAP of that country with glyphosate residues of 0.70, 3.1 and 4.6 mg/kg (total residues 0.70, 3.2 and 4.8 mg/kg). Eight trials from the UK and three from Denmark approximated UK GAP with glyphosate residues of 0.9, 3.4, 3.4, 4.1, 4.9, 4.9, 5.2, 6.0, 8.1, 8.6 and 14 mg/kg. Total residues in three trials that also measured AMPA levels were 3.5, 6.1 and 8.4 mg/kg.

The Meeting considered the trials approximating GAP in Canada and the UK to be from the same population and decided to combine the results for the purpose of estimating the maximum residue level and STMR. Residues of Glyphosate in ranked order were (n = 14): 0.7, 0.9, 3.1, 3.4, 3.4, 4.1, 4.6, 4.9, 4.9, 5.2, 6.0, 8.1, 8.6 and 14 mg/kg. AMPA residues were only measured in six of the fourteen trials considered giving total residues of 0.7, 3.2, 3.5, 4.8, 6.1 and 8.4 mg/kg. The Meeting estimated a high residue of 14 mg/kg and an STMR of 4.15 mg/kg.

Rye

Trials on rye were conducted in Denmark (no GAP provided) and were evaluated against the GAP of the UK (GAP 0.54–1.4 kg ae/ha, < 30% grain moisture PHI 7–14 days). Three trials approximated UK GAP with glyphosate residues of 1.6, 1.6 and 2.2 mg/kg (AMPA not measured).

The Meeting considered three trials insufficient to estimate a maximum residue level for rye.

Sorghum

Trials on sorghum were conducted in the USA (GAP of 0.43–4.2 kg ae/ha PRE, 0.87 kg ae/ha directed spray when crop > 30 cm tall and 1.7 kg ae/ha PH grain moisture < 35%, PHI 7 days). Thirteen trials matched GAP for the USA with glyphosate residues of 1.1, 1.3, 1.4, 1.7, 1.8, 4.4, 4.6, 5.3, 6.0, 6.3, 6.4, 12 and 13 mg/kg (total residues 1.1, 1.4, 1.6, 1.8, 1.8, 4.5, 4.8, 5.4, 6.2, 6.6, 6.6, 12 and 13 mg/kg). The Meeting estimated a highest residue of 13 mg/kg and an STMR of 4.8 mg/kg for total residues in sorghum grain.

Wheat

Trials on wheat were conducted in Belgium (no GAP provided), France (no GAP provided) and the UK (GAP of 0.54–1.4 kg ae/ha, < 30% grain moisture with a PHI of 7 days). Trials conducted in Belgium and France were evaluated against the GAP of the Netherlands (GAP is 0.72–2.2 kg ae/ha, PHI 7–14 days). Seven trials approximated GAP of the UK with glyphosate residues of 0.1, 0.1, 0.3, 0.3, 0.5, 0.7 and 1.0 mg/kg (residues of AMPA were all < 0.05 mg/kg). Two trials from Belgium (1.7 and 3.6 mg/kg), two from the UK (1.1 and 1.2 mg/kg) and nineteen from France (0.16, 0.53, 0.66, 0.80, 0.90, 0.99, 1.1, 1.2, 1.3, 1.5, 1.7, 2.1, 2.4, 3.8, 3.9, 4.0, 4.9, 6.3 and 9.5) approximated GAP of the Netherlands.

The Meeting decided that the residues conducted according to GAP of the Netherlands and the UK could be combined for the purposes of STMR and maximum residue level recommendation. Residues of glyphosate in rank order were (n = 30): 0.1, 0.1, 0.16, 0.3, 0.3, 0.5, 0.53, 0.66, 0.7, 0.80, 0.90, 0.99, 1.0, 1.1, 1.1, 1.2, 1.2, 1.3, 1.5, 1.7, 1.7, 2.1, 2.4, 3.6, 3.8, 3.9, 4.0, 4.9, 6.3 and 9.5 mg/kg. Total residues were (n=24): 0.1, 0.1, 0.24, 0.3, 0.3, 0.5, 0.53, 0.66, 0.7, 0.80, 0.90, 1.0, 1.1, 1.1, 1.2, 1.5, 1.9, 2.2, 3.7, 3.8, 3.9, 4.0, 4.9 and 6.5 mg/kg where measured. The Meeting recommended a high residue of 9.5 mg/kg and an STMR of 1.05 mg/kg for total residues in wheat grain.

Data are available for a large range of cereal grains and the Meeting considered it appropriate to estimate a group maximum residue level for cereal grains. As the residues of glyphosate in maize are much lower than in the other cereal grains due to the protection afforded by the husk and also the absence of data for rice, the Meeting decided to recommend a group maximum residue level for cereal grain except maize and rice of 30 mg/kg. The estimated maximum residue level replaces the previous recommendations for barley, oats and sorghum of 20 mg/kg and wheat of 5 mg/kg.

Total residues for cereal grains except maize and rice were (n = 65) 0.1, 0.1, 0.24, 0.3, 0.3, 0.5, 0.53, 0.66, 0.7, 0.7, 0.80, 0.90, 1.0, 1.1, 1.1, 1.1, 1.1, 1.2, 1.4, 1.5, 1.6, 1.8, 1.8, 1.9, 2.2, 2.2, 2.8, 3.0, 3.2, 3.3, 3.3, 3.5, 3.7, 3.8, 3.9, 4.0, 4.4, 4.5, 4.8, 4.8, 4.9, 5.4, 5.6, 6.0, 6.1, 6.2, 6.5, 6.6, 6.6, 6.8, 7.3, 8.0, 8.4, 8.6, 9.7, 10, 11, 12, 13, 14, 15, 19, 19, 19 and 20 mg/kg. The Meeting estimated an STMR of 3.7 mg/kg for total residues in cereal grains except maize and rice. This STMR value will be used in the dietary intake calculations for cereal grain commodities other than barley, maize, oats, sorghum and wheat.

Using the results for conventional maize of (n = 21) < 0.05 (12), 0.05 (2), 0.06 (2), 0.07, 0.09, 0.19, 0.54 and 3.0 mg/kg and corresponding total residues of < 0.12 (11), < 0.14 (2), 0.14, < 0.16, 0.19, < 0.23, < 0.25, < 0.26, < 0.62 and 3.0 mg/kg, the Meeting recommended a maximum residue level of 5 mg/kg for maize. The Meeting estimated highest residue and STMR levels for total residues in maize of 3.0 and < 0.12 mg/kg respectively.

Sugarcane

Trials on sugarcane were conducted in the USA (GAP of 0.49 kg ae/ha, PHI 21–35 days, 0.84 kg ae/ha; PHI 28–70 days). Seven trials from the USA matched GAP with residues 0.07, 0.13, 0.21, 0.27, 0.28, 0.69 and 0.97 mg/kg (total residues 0.07, 0.13, 0.21, 0.27, 0.28, 0.69 and 0.97 mg/kg).

The Meeting recommended a maximum residue level of 2 mg/kg for residues of glyphosate in sugarcane. The high residue and STMR levels for total residues are 0.97 and 0.27 mg/kg respectively.

Tree nuts

Trials on tree nuts (almonds, pecans, macadamias and walnuts) were conducted in the USA (GAP 0.43–4.3 kg ae/ha, directed applications, PHI 3 days). None of the trials matched GAP.

Cottonseed

Trials on conventional cotton were conducted in the US (GAP of 0.43–4.2 kg ae/ha PRE, 0.43–4.2 kg ae/ha directed spray and 0.43–1.7 kg ae/ha PH, PHI 7 days). No trials matched GAP for conventional cotton.

Additionally, trials were conducted on glyphosate tolerant cotton (US GAP of 0.43–4.2 kg ae/ha PRE do not exceed 4.2 kg ae/ha/season for pre-emergent application, 0.83 kg ae/ha for in-crop directed applications which must not exceed 3.3 kg ae/ha/season, 1.7 kg ae/ha PH do not exceed 1.7 kg ae/ha/season for pre-harvest application; combined applications must not exceed 6.6 kg ae/ha/season, PHI 7 days). US GAP allows pre-harvest applications together with post-emergent directed sprays as well as pre-harvest over the top sprays. The Meeting considered that a single pre-harvest application would not give rise to residues in cottonseed representative of GAP as the timing last application coincides with crop senescence, limiting potential transport of residues to the seed. Only trials that included pre-emergent and in-crop applications were considered as compliant with US GAP.

Twenty-three trials from the USA approximated US GAP with glyphosate residues of 0.46, 0.50, 0.69, 1.2, 1.3, 2.5, 2.8, 3.6, 4.2, 4.6, 4.9, 5.0, 7.2, 7.5, 9.7, 13, 16, 18, 18, 18, 21, 22 and 28 mg/kg (total residues 0.46, 0.58, 0.69, 1.2, 1.4, 2.5, 2.9, 3.7, 4.4, 4.6, 5.1, 5.2, 7.5, 7.9, 9.8, 14, 17, 18, 19, 19, 22, 23 and 28 mg/kg). The Meeting estimated a maximum residue level of 40 mg/kg for

glyphosate to replace its previous recommendation of 10 mg/kg and estimated a highest residue of 28 mg/kg and an STMR of 5.2 mg/kg for total residues in cottonseed.

Linseed (flax)

Trials on linseed were conducted in the UK (GAP 1.1–1.4 kg ae/ha, < 30% grain moisture PHI 7–28 days). Two trials from the UK matched GAP from that country with glyphosate residues of 2.0 and 4.6 mg/kg. The Meeting agreed the number of trials was insufficient for the purposes of estimating a maximum residue level.

Mustard seed

Trials on mustard were conducted in the UK (GAP 1.1–1.4 kg ae/ha, < 30% grain moisture, with a PHI of 8–10 days). Two trials matched GAP in the UK with glyphosate residues of 0.25 and 2.6 mg/kg (total residues 0.25 and 2.6 mg/kg). The Meeting considered two trials insufficient to estimate a maximum residue level.

Rape (Canola)

Trials on rape were conducted in Belgium (no GAP provided), Canada (0.18–4.3 kg ae/ha PRE; 0.9 kg ae/ha PH, < 30% grain moisture, with a PHI of 7–14 days), Denmark (no GAP provided), Finland (no GAP provided) France (no GAP provided), Sweden (no GAP provided) and the UK (GAP 1.1–1.4 kg ae/ha, < 30% grain moisture with a PHI of 14–21 days). Trials from Belgium, France, Denmark, Finland and Sweden were evaluated against the GAP of the UK.

Four trials from Canada matched GAP of that country with residues found of 0.61, 1.8, 2.1 and 3.6 mg/kg (total residues 0.61, 1.8, 2.1 and 3.7 mg/kg). Two trials from Belgium (0.23 and 4.6 mg/kg), ten trials from France (0.21, 0.23, 0.35, 0.50, 0.87, 0.93, 0.96, 1.4, 1.9 and 5.6 mg/kg), ten from the UK (0.16, 0.4, 0.35, 0.60, 0.7, 0.7, 0.80, 0.9, 1.5 and 2.7 mg/kg), five from Denmark (4.1, 6.7, 8.6, 10 and 12 mg/kg), one from Finland (1.5 mg/kg) and three from Sweden (0.40, 2.0 and 2.8 mg/kg) approximated GAP from the UK. The Meeting agreed that the residue populations for trials approximating the GAP of Canada and the UK could be combined for the purpose of recommending maximum residue levels and STMRs.

Residues of glyphosate in ranked order were (n = 35): 0.16, 0.21, 0.23, 0.23, 0.4, 0.35, 0.35, 0.40, 0.50, 0.60, 0.61, 0.7, 0.7, 0.80, 0.87, 0.9, 0.93, 0.96, 1.4, 1.5, 1.5, 1.8, 1.9, 2.0, 2.1, 2.7, 2.8, 3.6, 4.1, 4.6, 5.6, 6.7, 8.6, 10 and 12 mg/kg. The Meeting recommended a maximum residue level of 20 mg/kg for glyphosate residues in rape seed. The new recommendation replaces the previous recommendation of 10 mg/kg.

Total residues in rank order were (n = 31): 0.16, 0.21, 0.23, 0.23, 0.35, 0.35, 0.4, 0.40, 0.50, 0.60, 0.7, 0.7, 0.80, 0.87, 0.9, 0.93, 0.96, 1.4, 1.5, 1.6, 1.9, 2.0, 2.7, 3.0, 4.1, 4.6, 5.7, 6.7, 8.6, 10 and 12 mg/kg. The Meeting estimated a highest residue of 12 mg/kg and an STMR of 0.93 mg/kg for total residues in rape seed.

Sunflower

Trials on sunflowers were conducted in Hungary (GAP 0.54–4.3 kg ae/ha PRE, 1.8 kg ae/ha PH 20-30% grain moisture, with a PHI of 6 days if rate is 0.54 kg ae/ha PH, otherwise a PHI of 21 days). Eight trials matched GAP of Hungary with glyphosate residues of < 0.05, < 0.05, 0.16, 0.39, 0.40, 3.7, 4.9 and 5.6 mg/kg. Total residues in the three trials that also measured AMPA were < 0.05, < 0.05 and 0.39 mg/kg. The Meeting estimated a maximum residue level of 7 mg/kg for residues in sunflower seed. Available evidence suggests residues of AMPA in sunflower seed are unlikely to exceed 10% of the glyphosate residue. The Meeting decided to utilize the glyphosate residues to estimate a highest residue and an STMR for total residues in sunflower seed of 5.6 and 0.395 mg/kg respectively.

Coffee beans

Trials on coffee were conducted in Brazil (no GAP provided), Columbia (no GAP provided), Costa Rica (no GAP provided) and the USA (GAP 0.43-4.3 kg ae/ha PRE and as directed sprays, with a PHI of 28 days). All trials were evaluated against the GAP of the USA yielding four trials that approximated GAP with glyphosate residues of < 0.05, < 0.05, 0.30 and 0.58 mg/kg (total residues < 0.05, < 0.05, 0.30 and 0.58 mg/kg). The Meeting considered four trials insufficient to estimate a maximum residue level for coffee beans.

Tea

Trials on tea were conducted in China (no GAP provided), India (no GAP provided), Sri Lanka (no GAP provided) and Japan (GAP single application at 0.9–2.3 kg ae/ha directed spray, with a PHI of 7 days). All trials were evaluated against the GAP of Japan. Four trials from Sri Lanka matched GAP for Japan with glyphosate residues of 0.12, 0.21, 0.27 and 0.42 mg/kg (total residues 0.12, 0.21, 0.27 and 0.42 mg/kg). The Meeting considered four trials insufficient to estimate a maximum residue level for tea.

Alfalfa

Trials on alfalfa were conducted in Canada (GAP of 0.9-1.8 kg ae/ha, PHI not specified but typically 3–7 days before last cut before rotation of renovation) and the USA (GAP 0.43-4.3 kg ae/ha PRE, 1.7 kg ae/ha PH for renovation, PHI 1.5 days).

Twenty trials approximated the GAP of the USA with glyphosate residues (as received) in forage of 54, 54, 55, 57, 58, 61, 64, 66, 70, 74, 76, 77, 85, 94, 98, 99, 107, 114, 122 and 153 mg/kg. Total residues were 54, 54, 55, 57, 58, 61, 64, 66, 71, 74, 76, 78, 86, 95, 99, 100, 108, 115, 123 and 154 mg/kg. The Meeting estimated a high residue of 154 mg/kg together with a median residue of 75 mg/kg for total residues in alfalfa forage all on an as received basis. The Meeting agreed to withdraw its previous recommendation for alfalfa forage.

Three trials from Canada matched GAP of that country with glyphosate residues in fodder (hay) of 57, 77 and 78 mg/kg (total residues 58, 78 and 79 mg/kg). Residues in hay from USA trials that matched GAP were 0.45, 83, 97, 97, 117, 131, 148, 187, 189, 195, 196, 204, 208, 214, 219, 256, 257, 280, 335 and 341 mg/kg. Total residues were: 0.79, 84, 98, 98, 119, 132, 149, 188, 190, 197, 197, 206, 210, 215, 221, 260, 259, 282, 338 and 344 mg/kg.

Residues of glyphosate in alfalfa fodder (hay) in ranked order were (n = 23): 0.45, 57, 77, 78, 83, 97, 97, 117, 131, 148, 187, 189, 195, 196, 204, 208, 214, 219, 256, 257, 280, 335 and 341 mg/kg (as received). Total residues in rank order were; 0.79, 58, 78, 79, 84, 98, 98, 119, 132, 149, 188, <u>190</u>, 197, 197, 206, 210, 215, 221, 260, 259, 282, 338 and 344 mg/kg.

The Meeting recommended maximum residue level of 500 mg/kg (dry weight basis) for glyphosate in alfalfa fodder based on a high residue of 383 mg/kg (341 mg/kg ÷ 0.89 default dry matter content) together with highest residue and median residue levels of 344 and 190 mg/kg (as received) respectively for total residues.

Grass pasture

Trials on grass pasture were conducted in the USA (GAP of 0.31–4.3 kg ae/ha PRE, 4.3 kg ae/ha PH for pasture renovation, if application is less than 2.3 kg ae/ha no grazing or harvest interval is required, if > 2.3 kg ae/ha a waiting period 8 weeks applies before grazing or harvesting). Thirteen trials matching USA GAP were provided. Residues of glyphosate found in forage (from grass 15–20 cm high to boot stage) were 431, 456, 527, 616, 657, 664, 689, 713, 773, 869, 881, 884 and 1093 mg/kg (dry weight basis). Total residues were 435, 460, 530, 623, 660, 668, <u>691</u>, 718, 777, 875, 881, 891 and 1099 mg/kg. The Meeting decided to utilize the averages of residues over 7 days (263, 273, 311, 333, 348, 430, <u>431</u>, 449, 449, 478, 511, 612 and 615 mg/kg) to estimate a highest residue level of

615 mg/kg and a median residue of 431 mg/kg for total residues in grass forage, both on a dry weight basis.

Residues found in hay, cut when the grass was at boot to early head growth stage, were (n = 13): 7.3, 38, 66, 75, 100, 122, 187, 203, 212, 215, 233, 244 and 259 mg/kg (as received). Total residues were: 9.9, 39, 67, 77, 101, 124, 190, 210, 214, 218, 240, 248 and 262 mg/kg. The Meeting recommended a maximum residue level of 500 mg/kg (dry weight basis) for glyphosate based on a high residue of 294 mg/kg (259 mg/kg ÷ 0.88 default dry matter content) and highest and median residue levels of 262 and 190 mg/kg (as received) respectively for total residues in hay or fodder (dry) of grasses. The recommended maximum residue level replaces the previous recommendation of 50 mg/kg.

Bean fodder

Trials on beans haulm/straw were conducted in Belgium (no GAP provided) and the UK (GAP of 1.4 kg ae/ha, with a PHI of 7 days). Trials from Belgium were evaluated against UK GAP. Residues of glyphosate in haulm/straw at harvest were (n = 10): 3.4, 4.4, 7.8, 16, 17, 28, 46, 50, 51 and 93 mg/kg. AMPA was measured in four of the trials, with AMPA residues found to be less than 10% of the glyphosate residues. The therefore, Meeting agreed to use glyphosate residues to estimate the high and median residue levels. The Meeting estimated a maximum residue level of 200 mg/kg (dry weight basis) based on a highest residue of 103 mg/kg (93 mg/kg ÷ 0.90 default dry matter content) and high and median residue levels of 93 and 22.5 mg/kg (as received) for bean fodder.

Pea fodder

Trials on pea haulm/straw were conducted in Belgium (no GAP provided), Canada (GAP of 0.9 kg ae/ha, when the crop has < 30% grain moisture content and lower most pods (bottom 15%) are brown and seeds rattle, with a 7–14 days PHI) and the UK (GAP of 1.4 kg ae/ha, with a PHI of 7 days). Some trials from the UK conducted at higher rates were evaluated against the GAP of the Netherlands (0.72–2.2 kg ae/ha, PHI 7 days). Trials from Belgium were evaluated against the GAP of the UK. Residues in pea straw from Canada (16, 19, 20 and 28 mg/kg) appeared to be from a different population to that data approximating the GAP of the UK and the Netherlands; the latter were used for the purposes of maximum residue level estimation. Residues in ranked order were (n = 10): 27, 27, 31, 78, 79, 125, 154, 179, 200 and 320 mg/kg (as received). Total residues were 79, 80, 127, 155 and 181 mg/kg. AMPA was measured in five of the trials, with AMPA residues found to be less than 10% of the glyphosate residues. The Meeting therefore agreed to use glyphosate residues to estimate the high and median residue levels. The Meeting estimated a maximum residue level of 500 mg/kg (dry weight basis) based on a highest residue of 364 mg/kg (320 mg/kg ÷ 0.88 default dry matter content) and high and median residue levels of 320 and 102 mg/kg (as received) respectively for pea hay or fodder (dry).

Lentil fodder

Trials on lentil straw were conducted in Canada (GAP of 0.9 kg ae/ha, when crop has < 30% grain moisture content and lowermost pods (bottom 15%) are brown and seeds rattle, with a 7–14 days PHI). Residues of glyphosate were < 0.05 and 11 mg/kg. The Meeting considered two trials inadequate for the purposes of estimating an MRL for lentil straw.

Soya bean forage and fodder

Trials on conventional soya beans were conducted in the US (GAP 3.7 kg ae/ha for PH use, do not graze or harvest treated hay or fodder for livestock feed within 25 days of last application. If application rate for PH is less than 0.74 kg ae/ha the livestock feed interval is reduced to 14 days after last application). The Meeting considered that pre-harvest application would give rise to residues in bean forage and fodder representative of GAP. Four trials approximating GAP for the USA had glyphosate residues in hay of 2.5, 3.4, 8.5 and 9.9 mg/kg (as received). Corresponding AMPA

residues were 0.16, 0.18, 0.30 and 0.1 mg/kg respectively. The Meeting considered four trials insufficient to estimate a maximum residue level for soya bean hay. The Meeting agreed to withdraw its previous recommendation of 200 mg/kg for soya bean fodder.

Additionally, trials were conducted on glyphosate tolerant soya beans (GAP 1.7 kg ae/ha LPO; 0.83 kg ae/ha PH, do not graze or harvest treated hay or fodder for livestock feed within 14 days of last application). Residues of glyphosate in forage in trials that approximated USA GAP were 4.1, 4.5, 9.1, and 12 mg/kg (as received). No trials matched GAP for hay. The Meeting considered four trials inadequate for the purpose of estimating a maximum residue level and agreed to withdraw the previous recommendation of 5 mg/kg for soya bean forage.

Sugar beet tops

Trials were provided on sugar beet (glyphosate tolerant) from the US (GAP 0.43–4.2 kg ae/ha PRE, 0.43–1.3 kg ae/ha LPO, 0.43–0.87 kg ae/ha PH, PHI 30 days). No trials matched GAP.

Barley straw

Trials on barley straw were conducted in Belgium (no GAP provided), France (no GAP provided) and the UK (GAP of 0.54–-1.4 kg ae/ha, PHI 7 days). Trials conducted in Belgium, France as well as some UK trials were evaluated against the GAP of the Netherlands (GAP is 0.72–2.2 kg ae/ha, PHI 7 days). Residues in straw in four UK trials that matched the GAP of that country were 13, 41, 47 and 62 mg/kg. In twenty-three trials that matched GAP of the Netherlands residues of glyphosate in straw were 29 and 86 mg/kg for Belgium trials, 6.0, 6.9, 12, 15, 17, 33, 39, 40, 43, 59, 71, 80, 96, 102, 110, 126, 140, 147 and 160 mg/kg for trials conducted in France and 22 and 56 mg/kg for two UK trials.

The Meeting considered the residues to be from the same population and decided to pool the results. Residues of Glyphosate in barley straw in ranked order were (n = 27): 6.0, 6.9, 12, 13, 15, 17, 22, 29, 33, 39, 40, 41, 43, 47, 56, 59, 62, 71, 80, 86, 96, 102, 110, 126, 140, 147 and 160 mg/kg (as received). Total residues, where measured, were: 6.1, 6.9, 13, 14, 15, 17, 22, 30, 34, 39, 41, 42, 44, 48, 56, 61, 64, 73, 82, 89, 100, 105, 115, 126, 142, 151 and 162 mg/kg (as received). The Meeting recommended a maximum residue level for glyphosate of 400 mg/kg (dry weight basis) based on a highest residue of 180 mg/kg (160 mg/kg ÷ 0.88 default dry matter content) and highest and median residue levels for total residues of 162 and 48 mg/kg (as received) for residues in barley straw.

Maize forage and fodder

Trials on conventional maize were conducted in the US (GAP 4.2 kg ae/ha PRE; 0.87 kg ae/ha hooded sprayers, Do not graze or feed maize forage or fodder following hooded sprayer applications; 2.5 kg ae/ha PH grain moisture < 35%, PHI 7 days). Glyphosate residues in stover/fodder 7 days after a pre-harvest application according to US GAP were 2.1, 2.6, 3.4, 3.7, 4.8, 6.7, 8.4, 8.8, 11, 18, 23, 28, 35, 43, 43, 44, 53, 54, 55, 82, and 92 mg/kg. Total residues were: 2.1, 2.6, 3.5, 3.8, 4.8, 6.8, 8.8, 9.0, 11, 18, 24, 29, 36, 44, 45, 45, 54, 55, 56, 83 and 93 mg/kg.

Additionally, trials were conducted on glyphosate tolerant maize (GAP 4.2 kg ae/ha PRE; 1.7 kg ae/ha LPO, allowing a minimum of 50 days between application and harvest of corn forage; 0.87 kg ae/ha PH < 30% grain moisture, combined LPO+PH < 2.5 kg ae/ha, PHI 7 days). Seventeen trials on forage but no trials on tolerant maize fodder matched GAP. Glyphosate residues were (n = 17): 0.30, 0.50, 0.54, 0.66, 0.73, 0.79, 0.87, 0.92, 1.1, 1.1, 1.2, 1.3, 1.3, 1.8, 1.8, 2.2 and 4.6 mg/kg. Total residues were: 0.35, 0.50, 0.54, 0.75, 0.78, 0.84, 0.92, 0.98, 1.2, 1.2, 1.3, 1.4, 1.4, 1.9, 1.9, 2.4 and 4.7 mg/kg.

Using the residue trials for conventional maize crops, the Meeting recommended a maximum residue level of 150 mg/kg (dry weight basis) for maize fodder based on a highest residue of 111 mg/kg (92 mg/kg ÷ 0.83 default dry matter content). The Meeting also estimated a highest residue of 93 mg/kg and a median residue of 24 mg/kg for total residues in maize fodder, both on an as received basis.

The highest and median residues for total residues in maize forage were 4.7 and 1.2 mg/kg respectively, both on an as received basis. The Meeting considered that maize forage is not traded and agreed to withdraw its previous recommendation of 1 mg/kg.

Oat straw

Trials on oats straw were conducted in Canada (GAP 0.9 kg ae/ha PH, PHI growth stage dependent < 30% grain moisture 7–14 days) and the UK (GAP 0.54–1.4 kg ae/ha, < 30% grain moisture PHI 7–14 days). Residues in the trials from Canada conducted according to GAP were 3.5, 27 and 33 mg/kg. Residues in the UK trials were 12, 16, 21, 25, 33, 35, 49 and 64 mg/kg. Total residues where AMAP residues were also measured were: 26, 28, 34, 37 and 50 mg/kg. In all cases AMPA residues were much less than 10% of the glyphosate residue. The Meeting decided to pool the data from the Canada and UK trials to estimate a maximum residue level for glyphosate in oat straw of 100 mg/kg (dry weight basis weight) based on a highest residue of 71 mg/kg (64 mg/kg ÷ 0.90 default dry matter content) and to utilize the glyphosate residues to estimate highest and median residue levels of 64 and 27 mg/kg (as received).

Rye straw

Trials on rye straw were conducted in Denmark (no GAP provided) and were evaluated against the GAP of the UK (GAP 0.54–1.4 kg ae/ha, < 30% grain moisture PHI 7–14 days). No trials matched GAP.

Sorghum fodder and hay

Trials on sorghum were conducted in the USA (GAP of 1.7 kg ae/ha PH grain moisture < 35%, PHI 7 days). Residues of glyphosate in fodder (stover) in trials approximating USA GAP were (n = 10): 2.9, 7.0, 8.2, 16, 16, 21, 28, 29, 30 and 33 mg/kg (total residues 2.9, 7.1, 8.4, 16, 16, 22, 28, 29, 30 and 33 mg/kg). The Meeting recommended a maximum residue level for residues of glyphosate in sorghum fodder of 50 mg/kg (dry weight basis) based on a highest residue of 37.5 mg/kg (33 mg/kg ÷ 0.89 default dry matter content) and total residues highest and median levels of 33 and 19 mg/kg (as received) respectively.

Wheat straw

Trials on wheat were conducted in Belgium (no GAP provided), France (no GAP provided) and the UK (GAP of 0.54-1.4 kg ae/ha, < 30% grain moisture PHI 7 days). Trials conducted in Belgium, France and some UK trials were evaluated against the GAP of the Netherlands (GAP is 0.72–2.2 kg ae/ha, PHI 7–14 days).

Five trials in the UK matched GAP of that country with residues in straw of 6.3, 7.3, 18, 47 and 47 mg/kg (total residues 6.5, 7.8, 18, 48 and 48 mg/kg).

In four trials conducted in the UK according to GAP of the Netherlands residues in straw were 23, 27, 68 and 109 mg/kg. Two trials from Belgium matched GAP of the Netherlands with residues of 103 and 198 mg/kg (total residues 105 and 202 mg/kg). In eighteen trials conducted in France matching the GAP of the Netherlands glyphosate residues in straw were 7.8, 16, 20, 23, 24, 25, 25, 32, 46, 58, 70, 77, 90, 96, 98, 107, 120 and 130 mg/kg (total residues 7.9, 17, 23, 24, 25, 26, 26, 33, 60, 71, 78, 90, 101, 111, 123 and 132 mg/kg).

The Meeting considered the residues from trials conducted according to the GAP of the UK and the Netherlands to be from the same population and to combine the residues for the purposes of estimation of a maximum residue level and STMR. Residues in wheat straw, in rank order were (n = 29): 6.3, 7.3, 7.8, 16, 18, 20, 23, 23, 24, 25, 25, 27, 32, 46, 47, 47, 58, 68, 70, 77, 90, 96, 98, 103, 107, 109, 120, 130 and 198 mg/kg (where measured total residues were 6.5, 7.8, 7.9, 17, 18, 23, 24, 25, 26, 26, 33, 48, 48, 60, 71, 78, 90, 101, 105, 111, 123, 132 and 202 mg/kg). The Meeting recommended a

maximum residue level for glyphosate in wheat straw of 300 mg/kg (dry weight basis) based on a highest residue of 225 mg/kg (198 mg/kg ÷ 0.88 default dry matter content) as well as highest and median values for total residues of 202 and 48 mg/kg respectively, both on an as received basis.

The Meeting agreed to withdraw its previous recommendation for straw and fodder (dry) of cereal grains of 100 mg/kg.

Almond hulls

Trials on tree nuts (almonds, pecans, macadamias and walnuts) were conducted in the USA (GAP of 0.43–4.3 kg ae/ha, directed applications, with a PHI of 3 days). No trials matched GAP.

Cotton gin by-products

Trials on conventional cotton were conducted in the US (GAP of 1.7 kg ae/ha, with a PHI of 7 days). No trials matched GAP for conventional cotton.

Trial data on glyphosate tolerant cotton (GAP 1.7 kg ae/ha, PHI 7 days) was also submitted. Residues of glyphosate in cotton gin by-products were found to be (n = 16): 5.8, 8.6, 16, 19, 21, 31, 34, 36, 37, 41, 42, 67, 70, 84, 91 and 126 mg/kg (total residues 5.9, 8.7, 16, 19, 21, 31, 35, 37, 37, 41, 42, 68, 71, 85, 92 and 128 mg/kg).

The Meeting estimated a highest residue level for cotton by-products of 128 mg/kg and a median level of 37 mg/kg, both on an as received basis.

Rape straw

Trials on conventional rape were conducted in the Sweden (No GAP) and were evaluated against the GAP of the UK (GAP 1.4 kg ae/ha, PHI 14 days). One trial matched GAP of the UK with residues in straw of 30 mg/kg The Meeting considered a single trial insufficient for estimation of a maximum residue level.

Fate of residues during processing

The Meeting received processing studies for glyphosate in olives, soya beans, sugar beet, barley, maize, oats, sorghum, wheat, cotton seed, linseed, rape seed, sugarcane, coffee beans and tea leaves, investigating the effects of washing and further processing on incurred residues of glyphosate and AMPA in a range of processing fractions. Only the processing studies relevant to commodities for which maximum residue levels were estimated are reported below.

In trials from the US conventional and glyphosate tolerant soya beans were processed according to simulated commercial practices into hulls, meal and oil (crude and refined). Median processing factors for hulls, meal and oil prepared according to commercial procedures were 4.5 (n = 3, range 3.8–5.2) for hulls, 1.0 (n = 3, range 0.8–1.0) for meal and < 0.01 (n = 4, range < 0.01–0.02) for crude and refined oil. Median processing factors for total residues were 4.1 (n = 3, range 2.1–5.0) for hulls, 0.89 (n = 3, range 0.83–0.95) for meal and < 0.02 (n = 4, range 0.01–< 0.04) for crude and refined oil.

The Meeting considered that using the median processing factors from the various studies would be appropriate, to reflect the different commercial practices, and estimated soya bean processing factors for glyphosate of 4.5 in hulls, 1.0 in meal and < 0.01 in oil. For total residues, processing factors of 4.1 in hulls, 0.89 in meal and < 0.02 in oil are established. As residues did not concentrate in oil the Meeting did not consider it necessary to recommend a maximum residue level.

Processing studies for barley to beer and distilled spirit were reported however the reported processing factors would exceed the theoretical maximum transfer and the results were not considered further.

In a study on processing (wet and dry milling) of glyphosate tolerant maize, processing factors for aspirated grain dust were 1.6 for both glyphosate and total residues. For bran, the processing factor for dry milling was 1.2 and for wet milling 0.45. Flour and meal had processing factors of 1.1 for glyphosate and total residues while the processing factors for gluten, starch and refined oil were all < 0.05 for glyphosate and < 0.33 for total residues.

Median processing factors for glyphosate in oat processed commodities for hulls, kernels and rolled oats were 1.8 (n = 4, range 1.5–2.3), 0.2 (n = 4, range 0.2-0.2) and 0.2 (n = 4, range 0.1–0.3) respectively.

Sorghum was processed in a study that approximated commercial practices to yield bran, flour, germ, grain dust, grits (medium) and starch. Mean processing factors (n = 2) for glyphosate residues were 5.0, 0.34, 0.02, 4.9, 0.47 and 0.01 respectively for bran, flour, germ, grain dust, grits (medium) and starch.

Four wheat processing studies were made available to the Meeting. Median glyphosate or best estimates of processing factors for bran, whole meal, flour and whole meal bread were 1.7, 0.46, 0.105 and 0.36. As residues concentrate in bran, the Meeting decided to estimate highest anticipated residues in bran based on the highest residue found from trials used to estimate the maximum residue level and mean processing factor. The Meeting confirmed its previous recommendation of a maximum residue level for wheat bran (unprocessed) of 20 mg/kg based on a high glyphosate residue of 9.5 × 1.7 = 16 mg/kg. The Meeting agreed to withdraw its recommendations for other processed commodities for which residues did not concentrate, i.e., wheat flour and wheat wholemeal.

Data on processing of sugar cane approximating commercial practices were made available to the Meeting. Although the application rates used on the cane processed to bagasse, molasses, raw and refined sugar were higher than the current GAP in the USA the Meeting decided to use the processing data for cane harvested 28 to 35 days after the last application. Median or best estimates of glyphosate processing factors for bagasse, molasses, raw and refined sugar were: 0.275, 8.25, 0.80 and 0.24 respectively. Using the STMR of 0.27 and high residue of 0.97 for sugar cane and the relevant processing factors, the Meeting estimated a maximum residue level for glyphosate of 10 mg/kg for sugar cane molasses together with a median residue of 2.3 mg/kg for total residues.

In a cotton processing study approximating commercial practices glyphosate processing factors for kernels, hulls, meal, crude oil, refined oil and bleached oil were 0.07, 0.33, 0.11, < 0.1, < 0.1 and < 0.1 respectively. As residues of AMPA were all below the limit of quantification, the processing factors for total residues are the same as for glyphosate. Residues did not concentrate in cotton seed oil. The Meeting agreed to withdraw its previous recommendations for the commodities cotton seed oil (crude) and cotton seed oil (edible).

Processing factors and high residue values relevant to maximum residue estimation (glyphosate) and STMR and median residue based on total residues are summarized below in Table 130.

Table 130. Calculated processing factors.

Commodity	$HR_{glyphosate}$ (mg/kg)	$PF_{glyphosate}$	High residue (mg/kg)	$STMR_{total}$ (mg/kg)	$PF_{total\ residue}$	STMR-P/ median residue (mg/kg)
Soya beans	17			5.0		
Meal		1.0			0.89	4.45
Hulls		4.5			4.1	20.5
Crude oil		< 0.01			< 0.02	< 0.1
Maize	3.0			< 0.12		
Aspirated grain dust		1.6			1.6	0.19
Bran		1.2	3.6		1.2	0.14
Flour		1.1	3.3		1.1	0.13
Meal		1.1			1.1	0.13
Gluten		< 0.05			< 0.33	0.04
Refined oil		< 0.05			< 0.33	0.04
Starch		< 0.05			< 0.33	0.04
Oats	14			4.75		
Hull		1.8				8.55a
Kernel		0.2				0.95a
Rolled oats		0.2				0.95a
Sorghum	13			4.8		
Bran		5.0	65		5.0	24
Flour		0.34			0.32	1.5
Germ		0.02			< 0.03	0.14
Grain dust		4.9			4.8	23
Grits		0.47			0.46	2.2
Starch		0.01			< 0.03	0.14
Wheat	9.5			1.05		
Whole meal		0.46			0.46	0.48
Flour		0.105			0.105	0.11
Bran		1.7	16		1.7b	1.8
Whole meal bread		0.36			0.36	0.38
Cottonseed	28			5.2		
Kernels		0.07			0.07	0.36
Hulls		0.33			0.33	1.7
Meal		0.11			0.11	0.57
Crude oil		< 0.1			< 0.1	0.52
Refined oil		< 0.1			< 0.1	0.52
Bleached oil		< 0.1			< 0.1	0.52
Rape	12			0.93		
Seedcake		2.5				2.3a
Crude oil		< 0.1				
Refined oil		< 0.1				
Sugarcane	0.97			0.27		
Raw sugar		0.8			0.8	0.216
Refined sugar		< 0.24			< 0.24	0.065
Molasses		8.25	8.29		8.65	2.3
Bagasse		0.275			0.275	0.074

a = processing factors for total residues were not available, however residue data suggests AMPA is either present at less than 10% of the glyphosate residue level or not detected at levels above the limit of quantitation. In these cases the glyphosate processing factors and total residue processing factors would not be significantly different

b where residues of AMPA were measured they were <LOQ. The Meeting decided to use the larger database of glyphosate processing factors to estimate the median processing factor for total residues

Farm animal dietary burden

The Meeting estimated the farm animal dietary burden of glyphosate residues using the diets in Appendix IX of the *FAO Manual* (FAO 2002).

The calculation from the MRLs provides the feed levels suitable for animal commodity MRL estimation, while the calculation from feed STMRs is suitable for estimation of animal commodity

STMRs. DM is dry matter. The percent dry matter (DM) is taken as 100% where MRLs and STMRs are already expressed on a dry weight.

Table 131. Calculation of the dietary burden for maximum residue estimation

Commodity	Highest residue/ STMR	Group	% DM	HR/STMR ÷DM	Diet content (%)				Residue contribution, mg/kg			
					Beef cattle	Dairy cows	Swine	Poultry	Beef cattle	Dairy cows	Swine	Poultry
Alfalfa forage	154	AL	35	440								
Alfalfa hay	344	AL	89	383								
Barley grain	20	GC	88	22.73	15	15	80	75	3.41	3.41	18.18	17.05
Barley straw	162	AS	89	182								
Maize grain	3	GC	88	3.41								
Maize aspirated grain fractions	0.19	CF	85	0.22								
Maize milled by-products (meal)	0.13	CF	85	0.15								
Maize fodder (stover)	43	AS	83	51.8								
Maize forage	4.7	AF	40	11.7								
Cotton seed	28	SO	88	33.38	25	25			8.35	8.35		
Cotton gin by-products	37	AM	90	41.11								
Cotton seed meal	0.57	AM	89	0.64								
Cotton seed hulls	1.7	AM	90	1.89								
Grass forage	615	AS		615	60	60			369	369		
Grass hay	262	AS	88	298								
Oats grain	14	GC	89	15.73								
Oats straw	64	AS	90	71.11								
Pea seed	2.1	VD	90	2.33								
Pea hay	320	AL	88	363.64								
Sorghum grain	13	GC	86	15.12								
Sorghum fodder (stover)	33	AS	88	37.50								
Sorghum aspirated grain fraction	23	CF	85	27								
Soya bean grain	20	VD	89	22.5			20	20			4.5	4.5
Soya bean meal	4.45	AL	92	4.84								
Soya bean hulls	20.5	AL	90	22.78				5				1.14
Sugar cane molasses	2.3	DM	75	3.07								
Wheat grain	9.5	GC	89	10.67								
Wheat straw	202	AS	88	230								
Wheat milled by-products (bran)	1.8	CF	88	2.05								
TOTAL					100	100	100	100	**381**	**381**	**22.7**	**22.7**

Table 132. Calculation of the dietary burden for STMR estimation

Commodity	STMR/ STMR-P residue	Group	% DM	STMR/ STMR-P ÷DM	Diet content (%)				Residue contribution, mg/kg			
					Beef cattle	Dairy cows	Swine	Poultry	Beef cattle	Dairy cows	Swine	Poultry
Alfalfa forage	75	AL	35	214.29								
Alfalfa hay	190	AL	89	213.5								
Barley grain	7.65	GC	88	8.69	20	20	80	75	1.74	1.74	6.95	6.52
Barley straw	48	AS	89	53.9								
Maize grain	0.12	GC	88	0.14								
Maize aspirated grain fractions	0.19	CF	85	0.22								
Maize milled by-products (meal)	0.14	CF	85	0.16								

Commodity	STMR/ STMR-P residue	Group	% DM	STMR/ STMR-P ÷DM	Diet content (%)				Residue contribution, mg/kg			
					Beef cattle	Dairy cows	Swine	Poultry	Beef cattle	Dairy cows	Swine	Poultry
Maize fodder (stover)	24	AS	83	28.92								
Maize forage	1.2	AF	40	3.0								
Cotton seed	5.2	SO	88	5.91								
Cotton gin by-products	37	AM	90	41.11								
Cotton seed meal	0.57	AM	89	0.64								
Cotton seed hulls	1.7	AM	90	1.89								
Grass forage	431	AS		431	60	60			258.6	258.6		
Grass hay	190	AS	88	215.9								
Oats grain	4.15	GC	89	4.66								
Oats straw	27	AS	90	30								
Pea seed	0.5	VD	90	0.56								
Pea hay	102	AL	88	115.91								
Sorghum grain	4.8	GC	86	5.58								
Sorghum fodder (stover)	19	AS	88	21.59								
Sorghum aspirated grain fraction	23	CF	85	27	20	20			5.41	5.41		
Soya bean grain	5.0	VD	89	5.62				5				0.28
Soya bean meal	4.45	AL	92	4.84								
Soya bean hulls	20.5	AL	90	22.78			20	20			4.56	4.56
Sugar cane molasses	2.3	DM	75	3.07								
Wheat grain	1.05	GC	89	1.18								
Wheat straw	48	AS	88	54.55								
Wheat milled by-products (bran)	1.8	CF	88	2.05								
TOTAL					100	100	100	100	**266**	**266**	**11.5**	**11.4**

The glyphosate dietary burdens for animal commodity MRL and STMR estimation (residue levels in animal feeds expressed on dry weight, figures in brackets are for STMRs) are: beef and dairy cattle 381 (266) ppm, swine 23 (11.5) ppm and poultry 23 (11.4) ppm.

Farm animal feeding studies

The Meeting received information on the residue levels arising in animal tissues and milk when dairy cows were fed rations containing a 9:1 mixture of glyphosate and AMPA at total combined daily dietary levels of 40, 100 and 400 ppm. No residues were detected in milk from animals receiving the highest feed level. Tissue residues in single animals slaughtered after 28 days of feeding treated rations were < 0.05 mg/kg at all feed levels in fat and muscle for both glyphosate and AMPA. Glyphosate residues in liver were 0.06, 0.07 and 0.21 mg/kg for the 40, 100 and 400 ppm feed levels respectively (total residues 0.06, 0.07 and 0.47 mg/kg). In kidney, glyphosate residues were 0.32, 0.82 and 3.3 mg/kg for the three feed levels (total residues 0.42, 1.2 and 4.5 mg/kg). By 28 days after feeding treated rations ceased, residues in tissues were < 0.05 mg/kg in all tissues and milk.

The Meeting also received information on the residue levels arising in tissues when pigs were fed a ration with glyphosate and AMPA in a 9:1 ratio for 28 days at 40, 120 and 400 ppm in the diet. No residues above LOQ were detected in fat at any feed level. Maximum residues in tissue samples were for animals fed at 400 ppm and were liver 0.72 (total residue 1.4) mg/kg, kidney 9.1 (11) mg/kg, muscle 0.06 (0.06) mg/kg and fat < 0.05 (< 0.05) mg/kg. At the 40 ppm feed level, maximum residues were liver 0.06 (total residue 0.06) mg/kg, kidney 0.32 (0.42) mg/kg, muscle < 0.05 (< 0.05) mg/kg and fat < 0.05 (< 0.05) mg/kg. Residues in tissues were < 0.05 mg/kg for all feed levels at 28 days after access to treated feed was stopped.

A residue study on laying hens fed a diet incorporating glyphosate and AMPA in a 9:1 ratio at 40, 120 and 400 ppm for periods of up to 28 days was made available to the Meeting. At the highest feeding levels, maximum glyphosate residues in eggs were 0.12 (total residues 0.16) mg/kg, no residues were detected in eggs at the lowest feeding level. Maximum residues in tissues at the highest feeding level were < 0.05 mg/kg for fat and muscle and 0.61 (total residue 1.1) mg/kg for liver and 4.3 (4.8) mg/kg for kidney. At the lowest feed level of 40 ppm maximum residues in tissues were < 0.05 mg/kg for fat and muscle and 0.06 (total residue 0.06) mg/kg for liver and 0.35 (0.35) mg/kg for kidney

Animal commodity maximum residue levels

The dietary burdens used for maximum residue and STMR estimation for beef and dairy cattle at 381 and 266 ppm are close to the maximum feed level of 400 ppm and this feed level was used to estimate residue levels in milk and cattle tissues. Maximum residues of glyphosate expected in tissues are: fat < 0.05 mg/kg, muscle < 0.05 mg/kg, liver 0.20 mg/kg, kidney 3.1 mg/kg and the mean residue for milk < 0.05 mg/kg. The STMR dietary burden for beef and dairy cattle is 266 ppm. The Meeting estimated STMR values for total residues from the mean total residues obtained at the 400 ppm feeding level. The estimated STMRs were: meat < 0.05 mg/kg, fat < 0.05 mg/kg, kidney 2.9 mg/kg, liver 0.29 mg/kg and milks < 0.05 mg/kg.

Table 133. Estimated and actual residue levels in milk and cattle tissues.

Dietary burden (mg/kg)[1] Feeding level [ppm][2]		Residues[3] (mg/kg)								
		Milk	Fat		Muscle		Liver		Kidney	
		Mean	HR	Mean	HR	Mean	HR	Mean	HR	Mean
MRL beef	(381) [400]		*(< 0.05)* < 0.05		*(< 0.05)* < 0.05		*(0.20)* 0.21		*(3.1)* 3.3	
MRL dairy	(381) [400]	*(< 0.05)* < 0.05								
STMR beef	(266) [400]			*(< 0.05)* < 0.05		*(< 0.05)* < 0.05		*(0.29)* 0.43		*(2.9)* 4.3
STMR dairy	(266) [400]	*(< 0.05)* < 0.05								

[1] Values in parentheses are the estimated residues at the dietary burdens

[2] Values in square brackets are the actual feeding levels in the transfer study

[3] Residue values in parentheses in italics are obtained from the dietary burden, feeding levels in the transfer study and the residues found in the transfer study. Mean is mean animal tissue (or milk) residue in the relevant feeding group. The residues for HR calculations are glyphosate residues while those for STMR calculations are total residues (glyphosate + 1.5×AMPA).

The maximum dietary burden for pigs is 23 ppm. The levels of residues in tissues other than kidney all expected to be < 0.05 mg/kg for both glyphosate and AMPA when fed at this level. Residues in kidney at the 40 ppm feed level were a maximum of 0.6 mg/kg (total residues 0.72 mg/kg, mean total residues 0.43 mg/kg). Residues of glyphosate in kidney of animals fed at 23 ppm in the diet are estimated to be 0.345 mg/kg. Mean total residues in kidney of animals fed at 11.5 ppm in the diet are estimated to be 0.12 mg/kg. The STMR values for pig meat and pig edible offal as estimated to be 0 and 0.12 mg/kg.

The Meeting estimated a maximum residue level of 0.5 mg/kg for pig edible offal. The Meeting also estimated maximum residue levels for meat (from mammals other than marine mammals) of 0.05 (*) mg/kg; edible offal mammalian [except pigs] of 5 mg/kg and milks 0.05 (*) mg/kg. The recommendations replace the previous recommendations of 0.1 (*) mg/kg for cattle meat, 2 mg/kg for cattle edible offal, 0.1 (*) mg/kg for cattle milk, 0.1 (*) mg/kg for pig meat and 1 mg/kg for pig, edible offal.

The maximum dietary burden for poultry is 23 ppm. The levels of glyphosate and AMPA residues in fat, muscle and eggs are all expected to be < 0.05 mg/kg when fed at this level. Residues of glyphosate in liver and kidney at the 40 ppm feed level were 0.06 mg/kg for liver and 0.35 mg/kg for kidney. Mean total residues in liver and kidney at the 40 ppm feed level were 0.055 and 0.31 mg/kg respectively. Residues of glyphosate in liver and kidney of birds fed at 23 ppm in the diet are estimated to be < 0.05 and 0.20 mg/kg. Mean total residues in liver and kidney of birds fed at 11.4 ppm are estimated to be < 0.05 and 0.088 mg/kg.

The Meeting estimated maximum residue levels for poultry meat 0.05 (*) mg/kg; poultry edible offal 0.5 and eggs 0.05 (*) mg/kg. The recommendation for poultry meat and eggs replace the previous recommendation, both 0.1 (*) mg/kg. As no residues are expected at the dietary burden for STMR estimation, the poultry meat and eggs STMRs are zero. The STMR for liver and kidney are estimated to be 0.05 and 0.088 mg/kg respectively.

RECOMMENDATIONS

On the basis of the data from supervised trials the Meeting concluded that the residue levels listed below are suitable for establishing maximum residue limits and for IEDI assessment.

Definition of the residue (for compliance with MRLs): *glyphosate*

Definition of the residue (for estimation of dietary intake): *sum of glyphosate and AMPA expressed as glyphosate*.

Table 134. Summary of Recommendations.

Commodity		Recommended MRL (mg/kg)		STMR or STMR-P (mg/kg)
CCN	**Name**	**New**	**Previous**	
AL 1020	Alfalfa fodder	500		
AL 1021	Alfalfa forage	W		
FI 0327	Banana	0.05 (*)		0.05
GC 0640	Barley	W	20	7.65
AS 0640	Barley straw and fodder, dry	400		
VD 0071	Beans (dry)	2	2	0.17
Al 0061	Bean fodder	200		
MM 0812	Cattle meat	W	0.1 (*)	
ML 0812	Cattle milk	W	0.1 (*)	
MO 0812	Cattle, Edible offal of	W	2	
GC 0080	Cereal grains [except maize and rice]	30		3.7
SO 0691	Cotton seed	40	10	5.2
OC 0691	Cotton seed oil, Crude	W	0.05 (*)	
OR 0691	Cotton seed oil, Edible	W	0.05 (*)	
MO 0105	Edible offal (mammalian) (except pigs)	5		2.9
PE 0112	Eggs	0.05 (*)	0.1 (*)	0
AS 0162	Hay or fodder (dry) of grasses	500	50	
FI 0341	Kiwifruit	W	0.1 (*)	
GC 0645	Maize	5		0.12
AF 0645	Maize forage	W	1	
AS 0645	Maize fodder	150		
MM 0095	Meat (from mammals other than marine mammals)	0.05 (*)		0.05
ML 0106	Milks	0.05 (*)		0
GC 0647	Oats	W	20	4.15
AS 0647	Oat straw and fodder, dry	100		
VD 0072	Peas (dry)	5	5	0.5
AL 0072	Pea hay or pea fodder (dry)	500		
MM 0818	Pig meat	W	0.1 (*)	0
MO 0818	Pig, Edible offal of	0.5	1	0.12
PM 0110	Poultry meat	0.05 (*)	0.1 (*)	0

Commodity		Recommended MRL (mg/kg)		STMR or STMR-P (mg/kg)
CCN	Name	New	Previous	
PO 0111	Poultry, Edible offal of	0.5		0.05 liver 0.088 kidney
SO 0495	Rape seed	20	10	0.93
GC 0649	Rice	W	0.1 (*)	
GC 0651	Sorghum	W	20	4.8
AS 0651	Sorghum straw and fodder, dry	50		
VD 0541	Soya bean (dry)	20	20	5.0
VP 0541	Soya bean (immature seed)	W	0.2	
AL 0541	Soya bean fodder	W	200	
AL 1265	Soya bean forage (green)	W	5	
AS 0081	Straw and fodder (dry) of cereal grains	W	100	
GS 0659	Sugar cane	2		0.27
DM 0659	Sugar cane molasses	10		2.0
SO 0702	Sunflower seed	7		0.395
VO 0447	Sweet corn (corn-on-the-cob)	W	0.1 (*)	
GC 0654	Wheat	W	5	1.05
CM 0654	Wheat bran, Unprocessed	20	20	1.8
CF 1211	Wheat flour	W	0.5	
AS 0654	Wheat straw and fodder, dry	300		
CF 1212	Wheat wholemeal	W	5	

* the MRL is estimated at or about the LOQ

DIETARY RISK ASSESSMENT

Short-term intake

The 2004 JMPR concluded that it was unnecessary to establish an ARfD for glyphosate. The Meeting therefore concluded that short-term dietary intake of glyphosate residues is unlikely to present a risk to consumers.

Long-term intake

The evaluation of glyphosate has resulted in recommendations for MRLs and STMRs for raw and processed commodities. Consumption data was available for 32 food commodities and were used in the dietary intake calculation.

The International Estimated Daily Intakes for the five GEMS/Food regional diets, based on estimated STMRs were in the range 0–1% of the maximum ADI of 1 mg/kg bw for the sum of glyphosate and AMPA. The Meeting concluded that the long-term intake of residues of glyphosate and AMPA from uses that have been considered by the JMPR is unlikely to present a public health concern. The results are shown in Annex 3 of the JMPR 2005 Report.

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GLY 215	Schultz and Mirbach	1994
GLY 218	Schultz and Mirbach	1994c
GLY 221	Schultz and Mirbach	1994b
GLY 222	Schultz and Mirbach	1994a
GLY 261	Leak	1994b
GLY 262	Leak	1994
GLY 267	Leak	1994c
GLY 270	Schultz	1994
GLY 282	Leak	1994a
GLY 296	Schultz	1995a

GLY 297	Schultz	1995
GLY 305	Schultz	1993
GLY 418	Schultz	1997a
GLY 528	Schultz	1999
IF-92/11567-01 149 GLY	Zietz	1993
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MLL 30069	Mestdagh	1981
MLL 30087	Mestdagh	1982
MLL 30104	Mestdagh	1983b
MLL 30106	Mestdagh	1983a
MLL 30109	Mestdagh	1983
MLL 30131	Mestdagh	1984
MLL 30150	Mestdagh	1985
MLL 30180	Reding	1987
MLL 30281	Hontis	1991
MLL 30297	Hontis	1992
MLL 30319	Hontis	1993
MLL 30321	Hontis	1993a
MLL 30463	Hontis	1996
MLL 30464	Hontis	1996a
MLL 30469	Hontis	1996b
MLL 30815	Gustin	1999
MLL 30817	Gustin	1999a
MLL 31336	Gustin	2000
MLL 31337	Vanbellinghen	2000
MLL 31678	Belvaux	2002
MON/GLY/2000.01	Royer *et al.*	2001
MSL 00694	Taylor *et al.*	1979
MSL 01582	Baszis *et al.*	1981
MSL 0264	Beasley	1978
MSL 0980	Baszis *et al.*	1979
MSL 10843	Mueth	1991
MSL 11022	Manning	1991
MSL 11519	Steinmetz	1991
MSL 12617	Goure	1993
MSL 1283	Baszis	1980
MSL 12953	Oppenhuizen	1993
MSL 13037	Oppenhuizen	1993a
MSL 13038	Oppenhuizen	1994a
MSL 13283	Oppenhuizen	1994
MSL 13462	Goure and Steinmetz	1994
MSL 13463	Goure and Steinmetz	1994b
MSL 13464	Goure and Steinmetz	1994a
MSL 13520	Goure *et al.*	1994
MSL 13654	Oppenhuizen	1995
MSL 13655	Oppenhuizen	1995b
MSL 13884	Oppenhuizen	1995a
MSL 14113	Bleeke	1997
MSL 14542	Bleeke and McCann	1996
MSL 14917	McCann	1999
MSL 14918	McCann	1998
MSL 14992	Steinmetz	1999
MSL 15334	Culkin	1999
MSL 16087	Steinmetz and Bleeke	1999
MSL 16247	Mehrsheikh	2000
MSL 16757	Kunda and Bleeke	2005
MSL 17194	Kurtzweil and Kunda	2002
MSL 17635	Bleeke	2003
MSL 3259	Kunstman	1983
MSL 9398	Horner	1989
MSL-6627	Manning and Wilson	1987b
MSL-6676	Manning and Wilson	1987a
MSL-6729	Manning and Wilson	1987
MSL7358	Pijanowski	1988

MSL7420	Feng and Patanella	1988a
MSL7458	Feng and Patanella	1988
MSL7515	Manning and Mueth,	1991a
MSL7586	Bodden	1988
MSL7591	Bodden	1988a
RJ2217B	Jones and Alevra	1996
RJ2218B	Jones and Volpi	1995
RJ2383B	Anderson *et al.*	1997
RJ2397B	Anderson *et al.*	1997
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