FLUENSULFONE (265)

First draft prepared by Mr D Lunn, Ministry for Primary Industries, New Zealand

EXPLANATION

Fluensulfone is a heterocyclic fluoroalkenyl sulfone nematicide. The mode of action is through feeding inhibition and paralysis of adults and juveniles. The IUPAC name for fluensulfone is 5-chloro-1,3-thiazol-2-yl 3,4,4-trifluorobut-3-en-1-yl sulfone.

Fluensulfone was evaluated for toxicology by JMPR in 2013 and 2014.

An ADI of 0-0.01 mg/kg bw and an ARfD of 0.3 mg/kg bw were established by the 2014 JMPR. Residues were evaluated by the JMPR in 2014 and 2016. The 2016 JMPR established the following residue definitions:

For compliance with MRLs for plant commodities: *Sum of fluensulfone and 3,4,4-trifluorobut-3-ene-1-sulfonic acid (BSA), expressed as fluensulfone equivalents*.

For estimation of dietary exposure for plant commodities: Fluensulfone.

For compliance with MRLs and for estimation of dietary exposure for animal commodities: *Fluensulfone.*

The residue is fat-soluble.

The 2014 JMPR agreed that the exposure risks from the metabolite MeS should be assessed using the Threshold of Toxicological Concern (TTC) approach and the 2016 JMPR confirmed that the TTC approach for this metabolite remained appropriate.

Fluensulfone was scheduled at the Fiftieth Session of the CCPR for evaluation of additional uses by the 2019 JMPR. The Meeting received new supporting data and/or GAP information for citrus, pome fruit, stone fruit, grapes, guava, tree nuts, coffee, sugar cane and black pepper, additional rotational crop studies, frozen storage stability studies, processing studies and a livestock feeding study for the BSA/TSA metabolites.

METABOLISM AND ENVIRONMENTAL FATE

Field rotational crop studies

The 2014 JMPR evaluated confined rotational crop studies where radish, lettuce and wheat were planted at intervals of 30, 120 and 360 or 390 days after bare soil treatments of radiolabelled fluensulfone (equivalent to about 4 kg ai/ha). In these studies, the major residues were the BSA and TSA metabolites, with low levels of the parent compound observed in lettuce, radish root, radish foliage, and wheat forage, hay, and straw (but not grain). Fluensulfone, when found, was typically 1 to 2 orders of magnitude less than the BSA or TSA residue levels. In all cases, residues of fluensulfone and BSA were not quantifiable after the 120-day PBI whereas residues of TSA persisted at quantifiable levels for at least one year, ranging from 0.13 mg eq/kg (immature lettuce) to 11 mg eq/kg (wheat hay).

The 2014 JMPR concluded that overall, fluensulfone can be expected to dissipate rather rapidly in the environment, with a concomitant increase in residues of BSA, TSA, and to a much lesser extent, MeS. BSA residues should then decline but TSA appears to be stable for an extended period; may accumulate in soils following repeated uses of fluensulfone and may occur in follow-on crops at plant-back intervals exceeding one year after treatment.

The 2016 JMPR evaluated a field rotational cropping study where a single application of fluensulfone was made to bare soil at 4.0 kg ai/ha, with following crops (wheat, radish, lettuce and beans) planted at intervals of 28, 60, 120, 180, 270 and 365 days after application. Based on this study, to accommodate residues arising in rotational crops, maximum residue levels were

recommended for root and tuber vegetables, leafy vegetables and legume vegetables not elsewhere specified.

The current Meeting received a new field crop rotation study reported by Jones, 2016 [Ref: R-31415], involving 56 field trials carried out during 2013–2014 in Canada and the USA. In these trials, fluensulfone was applied as a 15% granular formulation to bare soil (sandy, silt or clay loam soil) at a nominal rate of 4 kg ai/ha and rotational cereal crops (maize, rice, sorghum and spring wheat) were planted into the treated soil to reflect a plant-back interval of 10 months. Winter wheat was planted approximately 90 days after soil treatment.

Samples collected at normal commercial maturity were stored frozen (<-10 °C) for up to 16 months before LC-MS/MS analysis (Method MTH-083) for fluensulfone and metabolite BSA. Mean procedural recoveries carried out concurrently with the analyses of trial samples ranged from 72–111% in samples spiked with fluensulfone or BSA at 0.01–0.1 mg/kg (grains, processed maize and rice matrices), 0.01–0.5 mg/kg (maize forage, stover), 0.01–4.0 mg/kg (straws) and 0.01–6.0 mg/kg (hays). The LOQs for both analytes was 0.01 mg/kg.

After application of fluensulfone to bare soil the only quantifiable level of fluensulfone was 0.02 mg/kg in winter wheat hay planted 3 months after soil treatment. However, levels of BSA were quantifiable in the majority of samples, up to 0.07 mg/kg in grain, up to 2.4 mg/kg in forage, up to 4.0 mg/kg in hay and up to 2.4 mg/kg in straws and stovers. Highest residues were in the rotational winter wheat matrices.

Table 1 Fluensulfone and BSA metabolite residues in rotational crops (3 month plant-back intervals)

Crop/commodity		Fluensulfone (mg/kg)	BSA (mg/kg)	Total Residues (mg eq./kg)
Grain	Winter wheat grain (n=11)	ND (11)	ND (4), <0.01 (3), 0.01, 0.02, 0.02, 0.04	<0.025 (7), 0.03, 0.04 (2), 0.07
Forage	Winter wheat forage (n=11)	ND (11)	0.03, 0.04, 0.06, 0.12, 0.17, 0.3, 0.35, 0.48, 1.36, 1.6, 2.4	0.06, 0.07, 0.10, 0.19, 0.27, 0.47, 0.55, 0.74, 2.1, 2.5, 3.7
Hay	Winter wheat hay (n=11)	ND (10), 0.02	<0.01, 0.04, 0.12, 0.19, 0.25, 0.26, 2.0, 2.1, 2.6, 3.6, 4.0	<0.025, 0.07, 0.19, 0.30, 0.39, 0.41, 3.1, 3.3, 4.0, 5.5, 6.2
Straw & stover	Winter wheat straw (n=11)	ND (10), <0.01	0.01, 0.02, 0.05, 0.1(2), 0.11, 0.41, 0.88, 1.3, 1.5, 2.4	0.03, 0.04, 0.09, 0.16 (2), 0.18, 0.64, 1.4, 2.1, 2.3, 3.7

Total residues = sum of fluensulfone and BSA, expressed as fluensulfone-a molecular weight correction factor of 1.53 applied to BSA residues.

ND – not detected

Table 2 Fluensulfone and BSA metabolite residues in rotational crops (10 month plant-back intervals)

Crop/commodity		Fluensulfone	BSA (mg/kg)	Total Residues (mg eq./kg)
Grain	Sweetcorn (k+c wo h) (n=10)	ND (10)	ND (10)	<0.025 (10)
	Maize grain (n=18)	ND (18)	ND (15), <0.01, <0.01, 0.07	<0.025 (17), 0.12
	Rice grain (n=11)	ND (11)	ND (10), 0.02	<0.025 (10), 0.04
	Spring wheat grain (n=4)	ND (4)	ND, ND, <0.01, 0.01	<0.025 (3), 0.03
	Sorghum grain (n=9)	ND (9)	ND (4), <0.01 (4), 0.01	<0.025 (8), 0.03
Forage	Maize forage (n=20)	ND (20)	ND (4), <0.01 (4), 0.01 (2), 0.02 (2), 0.03, 0.05, 0.06, 0.09 (2),0.17, 0.23, 0.25	<0.025 (8), 0.03 (2), 0.04 (2), 0.06, 0.09.0.1, 0.15 (2), 0.27, 0.36, 0.39
	Spring wheat forage (n=4)	ND (4)	0.03, 0.08, 0.26, 0.72	0.06, 0.13, 0.41, 1.11

Crop/commodity		Fluensulfone	BSA (mg/kg)	Total Residues (mg eq./kg)
Hay	Spring wheat hay (n=4)	ND (4)	0.02, 0.05, 0.16, 0.42	0.04, 0.09, 0.25, 0.65
Straw & stover	Maize stover (n=20)	ND (20)	ND (8), <0.01 (3), 0.01, 0.02 (4), 0.05, 0.07, 0.23, 0.25	<0.025 (11), 0.03, 0.04 (4), 0.09, 0.12, 0.36, 0.39
	Rice straw (n=11)	ND (11)	ND (8), <0.01, 0.02 (2)	<0.025 (9), 0.04 (2)
	Spring wheat straw (n=4)	ND (4)	0.02 (2), 0.05, 0.27	0.04 (2), 0.09, 0.42

Total residues = sum of fluensulfone and BSA, expressed as fluensulfone-a molecular weight correction factor of 1.53 applied to BSA residues.

(k+c wo h) = kernels plus cobs, without husks

ND – not detected

METHODS OF RESIDUE ANALYSIS

Analytical methods

The 2014 JMPR reviewed and summarized analytical method descriptions and validation data for fluensulfone and metabolites BSA, TSA and MeS in crop and animal commodities. These methods, based on Method 1997W, used acetonitrile:water extraction and C18 solid-phase extraction (SPE) for clean-up (BSA and TSA only) and LC-MS/MS analysis. This method (also referenced as Method MTH-083), with minor modifications, was used in most of the new supervised residue trials.

The 2017 JMPR also reviewed modifications of this method to measure fluensulfone and BSA residues, using additional hexane and ethyl acetate partitioning steps when analysing orange oil and using methanol extraction (instead of acetonitrile:water) when analysing orange juice, citrus pulp and refined sugar.

Additional validation studies for this method were provided on representative commodities for the uses considered by the Meeting.

Table 3 Method 1997W (also referenced as Method MTH-083) validation data (fluensulfone and metabolite BSA)

Fortification level (mg/kg)	Fluensulfone Recovery					BSA Recovery				
	Fortification (mg/kg)	n	Range (%)	Mean (%)	RSD (%)	Fortification (mg/kg)	n	Range (%)	Mean (%)	RSD (%)
Coffee [Refs: RA 002 044 16B, RA 002 037 16B]										
Beans	0.01-0.1	14	98-113	103	5	0.01-0.1	14	98-120	107	6.0
Beans	0.01-0.1	11	93-190	141	19	0.01-0.1	11	72-120	93	17
Grapes [Ref: R-31459]										
Juice	0.01-0.1	6	95-112	103	6.5	0.01-0.1	6	90-106	98	5.8
Raisins	0.01-0.1	6	81-88	85	2.9	0.01-0.1	6	71-83	76	5.9
Raisins	0.01-0.1	2	94-100	97	-	0.01-0.2	4	76-83	80	3.9
Fruit	0.01-0.1	4	82-88	861	3.5	0.01-0.1	4	83-91	87	4.5
Fruit	0.01-0.1	4	70-82	76	5.2	0.01-0.5	6	83-92	89	4.0
Guava [Ref: R-35606]										
Fruit	0.08-0.8	14	89-110	102	5.5	0.01-0.1	12	103-119	111	4.9
Apple [Ref: R-35572]										
Fruit	0.01-0.1	6	74-82	79	3.5	0.01-0.1	6	73-83	79	4.6
Juice	0.01-0.1	6	92-107	97	6.0	0.01-0.1	6	89-101	96	5.0
Cherry [Ref: R-35573]										

Fortification level (mg/kg)	Fluensulfone Recovery					BSA Recovery				
	Fortification (mg/kg)	n	Range (%)	Mean (%)	RSD (%)	Fortification (mg/kg)	n	Range (%)	Mean (%)	RSD (%)
Fruit	0.01-0.1	6	75-96	80	10	0.01-0.1	6	84-97	88	5.9
Plum [Ref: R-35573]										
Juice	0.01-0.1	6	92-107	100	4.9	0.01-0.1	6	98-113	103	5.4
Prunes	0.01-0.1	6	86-93	90	3.1	0.01-0.1	6	84-94	90	3.8
Tree nuts [Ref: R-31458]										
Almond hulls	0.01-0.1	6	86-106	91	8.1	0.01-0.1	6	74-84	80	4.9
Pecan nutmeat	0.01-0.1	6	87-108	94	8.0	0.01-0.1	6	80-89	87	4.0
Maize [Ref: R-31415]										
Forage	0.01-0.1	6	88-110	97	9.5	0.01-0.1	6	90-95	93	2.1
Grain	0.01-0.1	6	90-103	97	4.7	0.01-0.1	6	85-91	88	2.6
Stover	0.01-0.1	6	79-86	82	4.4	0.01-0.1	6	88-95	93	2.8
Oil	0.01-0.1	6	105-117	110	4.1	0.01-0.1	6	105-109	107	1.6
Grits	0.01-0.1	6	90-98	95	3.4	0.01-0.1	6	77-82	80	2.3
Rice [Ref: R-31415]										
Grain	0.01-0.1	6	89-105	100	6.3	0.01-0.1	6	77-85	81	3.0
Straw	0.01-0.1	6	76-98	81	9.8	0.01-0.1	6	86-96	90	4.6
Husks	0.01-0.1	6	81-98	91	6.5	0.01-0.1	6	84-96	90	5.9

Table 4 Method 1997W (MTH-083) validation data (metabolites TSA and MeS)

Fortification level (mg/kg)	TSA Recovery					MeS Recovery				
	Fortification (mg/kg)	n	Range (%)	Mean (%)	RSD (%)	Fortification (mg/kg)	n	Range (%)	Mean (%)	RSD (%)
Coffee [Refs: RA 002 044 16B, RA 002 037 16B]										
Beans	0.01-0.1	14	84-108	98	8					
Beans	0.01-0.1	12	86-117	100	10					
Guava [Ref: R-35606]										
Fruit	0.08-0.8	13	102-115	108	5.3	0.08-0.8	13	98-113	103	3.7

STABILITY OF PESTICIDE RESIDUES IN STORED ANALYTICAL SAMPLES

Plant matrices

The stability of fluensulfone residues in various matrices during frozen storage was evaluated by the JMPR in 2014, 2016 and 2017. Residue stability of fluensulfone and metabolites BSA and TSA was demonstrated in dried potatoes and wet peel for at least 25 months, in potato tubers for at least 23 months, in capsicum, cucumber and melon for at least 16 months, in oranges for at least 18 months, in carrots for at least 17.5 months, in raw tomatoes for at least 15 months and in processed tomato commodities for at least 6 months. Fluensulfone and BSA residues were also shown to be stable in peanut matrices for at least 13 months and in sugar cane matrices for at least 2 months.

The current Meeting received additional analytical sample storage stability studies on grapes, sugar cane, tomatoes, soya beans, cereal grains and straw, oranges and dried broad beans.

Sugar cane

As part of a supervised field trial reported by Jones, 2016 [Ref: R35574], samples of sugarcane, blackstrap molasses and refined sugar were fortified with 0.1 mg/kg fluensulfone or BSA and stored at or below -10 °C for up to 6 months (185 days) before analysis using Method MTH-083, with an LOQ of 0.01 mg/kg for both analytes.

Table 5 Stability of fluensulfone residues in sugarcane matrices stored at -10 °C or below

Commodity (fortification)	Storage interval (days)	Fluensulfone residues remaining			Procedural recovery		
		residues (mg/kg)	range (%)	mean (%)	residues (mg/kg)	range (%)	mean (%)
Sugarcane (0.1 mg/kg)	0	0.0934, 0.0848	93.6, 84.8	89			
	30	0.0882, 0.0810	88.4, 81.2	85	0.0757, 0.0768	76.0, 76.8	76
	91	0.0962, 0.101	96.4, 101	99	0.0960, 0.103	96.0, 103	99
	185	0.0984, 0.100	98.4, 100	99	0.0942, 0.103	94.4, 103	99
Molasses (0.1 mg/kg)	0	0.0700, 0.0712	70.2, 71.2	71			
	30	0.0685, 0.0706	68.6, 70.8	70	0.0704, 0.0744	70.5, 74.4	73
	91	0.0886, 0.0774	88.7, 77.4	83	0.0834, 0.0813	83.6, 81.6	83
	185	0.0969, 0.0854	96.9, 85.5	91	0.0815, 0.107	81.9, 107	95
Refined sugar (0.1 mg/kg)	0	0.0944, 0.0940	94.8, 94.0	94			
	30	0.0889, 0.0948	89.6, 95.6	93	0.0976, 0.0932	98.4, 93.2	96
	91	0.0873, 0.0948	87.7, 95.6	92	0.0956, 0.0936	96.0, 94.0	95
	185	0.0996, 0.0928	100, 93.2	97	0.0881, 0.0952	88.8, 95.2	92

Table 6 Stability of metabolite BSA residues in sugarcane matrices stored at -10 °C or below.

Commodity (fortification)	Storage interval (days)	BSA residues remaining			Procedural recovery		
		residues (mg/kg)	range (%)	mean (%)	residues (mg/kg)	range (%)	mean (%)
Sugarcane (0.1 mg/kg)	0	0.0976, 0.0958	97.8, 95.8	97			
	30	0.0962, 0.0970	96.4, 97.2	97	0.0992, 0.0956	99.6, 95.6	98
	91	0.0824, 0.0845	85.0, 93.0	89	0.0850, 0.0928	85.0, 93.0	89
	185	0.0838, 0.0859	83.8, 86.2	85	0.0848, 0.0801	85.0, 80.4	83
Molasses (0.1 mg/kg)	0	0.0982, 0.0965	98.5, 96.5	97			
	30	0.0802, 0.0797	80.3, 79.9	80	0.0853, 0.0845	85.5, 84.5	85
	91	0.0912, 0.0900	91.3, 90.0	91	0.0967, 0.0942	96.9, 94.6	96
	185	0.102, 0.103	102, 103	103	0.0967, 0.0942	96.9, 94.6	96
Refined sugar (0.1 mg/kg)	0	0.0972, 0.0976	97.6, 97.6	98			
	30	0.0821, 0.0806	82.8, 71.3	82	0.0825, 0.0820	83.2, 82.0	83
	91	0.0944, 0.0960	94.8, 96.8	96	0.0944, 0.0924	94.8, 92.8	94
	185	0.0920, 0.0972	92.4, 97.6	95	0.0933, 0.0924	94.1, 92.4	93

Residues of fluensulfone and BSA were stable for at least 6 months in sugarcane, blackstrap molasses and refined sugar analytical samples stored at or below -10 °C.

Tomato, soya bean, cereal straw, cereal grain, dried broad bean and orange

In a study reported by Brown, 2018 [Ref: RES-00091], tomato, soya bean, cereal grain and straw, orange fruit and dry broad beans were fortified with 0.1 mg/kg fluensulfone, BSA, TSA or MeS and stored at or below -18 °C for up to 10 months (315 days) before analysis using a modification of Method 1977W (with an additional concentration step before re-dissolving the eluant in

methanol:water (50:50) for analysis of fluensulfone and MeS only). The LOQ for all analytes was 0.01 mg/kg in all matrices.

Table 7 Stability of fluensulfone residues in various matrices stored at -18 °C or below

Commodity (fortification)	Storage interval (days)	Fluensulfone			
		% residues remaining	mean (%)	% procedural recovery	mean (%)
Tomato (0.1 mg/kg)	0	85.0, 69.7, 81.8	79	81, 80	81
	186	84.7, 81.0, 84.1	83	86, 96	91
	311	78.8, 76.6, 77.6	78	69, 72	71
Soya bean (0.1 mg/kg)	0	84.6, 76.2, 88.8	83	75, 87	81
	193	67.3, 64.1, 60.3	64	71, 71	71
	309	75.1, 75.5, 80.0	77	94,96	95
Cereal straw (0.1 mg/kg)	0	68.6, 78.2, 74.4	74	73.8, 69.9	72
	200	91.7, 90.6, 89.7	91	88.0, 87.4	88
	316	84.4, 85.8, 77.9	83	81.3, 79.7	80
Cereal grain (0.1 mg/kg)	0	68.2, 72.1, 84.3	75	81.8, 77.6	80
	188	67.6, 67.5, 67.7	68	69.5, 72.3	71
	315	84.8, 78.3, 77.1	80	97, 86.2	92
Broad bean (dry) (0.1 mg/kg)	0	72.7, 74.2, 70.8	73	80.3, 82	81
	192	87.9, 80.1, 74.8	81	90.8, 98.7	95
	308	85.9, 64.2, 67.5	73	98.2, 94.2	96
Orange (fruit) (0.1 mg/kg)	0	75.3, 74.1, 77.5	76	74.8, 66.5	71
	187	86.7, 90.4, 83.4	87	86.6, 88	87
	310	87.6, 91.9, 83.6	88	90.5, 87.6	89

Table 8 Stability of TSA residues in various matrices stored at -18 °C or below.

Commodity (fortification)	Storage interval (days)	TSA			
		% residues remaining	mean (%)	% procedural recovery	mean (%)
Tomato (0.1 mg/kg)	0	92.7, 91.7, 94.8	93	88.5, 90.9	90
	186	90.0, 92.8, 94.3	92	91.2, 91.7	91
	311	87.1, 89.3, 91.8	89	92.7, 86.7	90
Soya bean (0.1 mg/kg)	0	111, 117, 110	113	99.8, 107.5	104
	193	98.0, 100, 108	102	102.4, 98.1	100
	309	99.0, 97.1, 105	100	106.5, 102.4	104
Cereal straw (0.1 mg/kg)	0	95.9, 96.5, 101	98	93.9, 95.5	95
	200	102, 106, 109	106	98.8, 101.1	100
	316	98.5, 98.3, 98.9	99	108.6, 104.1	106
Cereal grain (0.1 mg/kg)	0	92.7, 91.7, 94.8	94	91.8, 93.3	93
	188	90.0, 92.8, 94.3	98	96.1, 97	97
	315	87.1, 89.3, 91.8	99	93.8, 103.4	99
Broad bean (dry) (0.1 mg/kg)	0	111, 117, 110	100	96.8, 98.1	97
	192	98.0, 100, 108	80	96.4, 103.3	100
	308	99.0, 97.1, 105	80	96.8, 96.4	97
Orange (fruit) (0.1 mg/kg)	0	95.9, 96.5, 101	92	99.4, 94.1	97
	187	102, 106, 109	99	100.8, 96.1	98
	310	98.5, 98.3, 98.9	99	92.5, 87.5	90

Table 9 Stability of MeS residues in various matrices stored at -18 °C or below.

Commodity (fortification)	Storage interval (days)	MeS			
		% residues remaining	mean (%)	% procedural recovery	mean (%)
Tomato (0.1 mg/kg)	0	86.7, 83.3, 80.6	84	79.6, 80.1	80
	186	93.6, 97.9, 88.4	93	98.7, 98.1	98
	311	91.6, 89.0, 88.9	90	87.3, 88.3	88
Soya bean (0.1 mg/kg)	0	85.2, 84.5, 85.2	85	90.5, 88.3	89
	193	84.5, 78.9, 83.9	82	95.1, 81.1	88
	309	98.4, 97.4, 102	99	106.4, 117.4	112
Cereal straw (0.1 mg/kg)	0	115, 113, 107	112	105.5, 91.5	98
	200	91.2, 99.9, 90.7	94	83.9, 86.7	85
	316	107, 103, 104	105	96.6, 94.4	96
Cereal grain (0.1 mg/kg)	0	82.6, 60.1, 72.0	72	89.1, 85.1	87
	188	98.2, 101, 95.1	98	90.2, 92.9	92
	315	104, 111, 106	107	115.3, 108.6	112
Broad bean (dry) (0.1 mg/kg)	0	93.4, 74.9, 66.3	78	86,82.4	84
	192	90.5, 78.0, 84.0	84	102.8, 107.6	105
	308	77.4, 79.1, 78.9	78	76.4, 77	77
Orange (fruit) (0.1 mg/kg)	0	90.5, 95.2, 80.3	89	87.2, 84.7	86
	187	113, 104, 95.4	104	104.4, 99	102
	310	109, 108, 104	107	101.7, 89.1	95

Table 10 Stability of BSA residues in various matrices stored at -18 °C or below.

Commodity (fortification)	Storage interval (days)	BSA			
		% residues remaining	mean (%)	% procedural recovery	mean (%)
Tomato (0.1 mg/kg)	0	95.0, 93.4, 93.5	94	92.9, 92.6	93
	186	107, 110, 114	110	101.5, 98.7	100
	311	96.9, 93.9, 98.9	97	92.2, 91.9	92
Soya bean (0.1 mg/kg)	0	98.4, 99.5, 99.8	99	99.5, 97.5	98
	193	106, 103, 99.2	103	99.5, 100.9	100
	309	95.6, 93.1, 99.3	96	102,7, 100.8	102
Cereal straw (0.1 mg/kg)	0	95.4, 98.5, 98.7	98	94.4, 94.2	94
	200	104, 105, 104	104	101.2, 105.8	104
	316	106, 105, 107	106	109, 111	110
Cereal grain (0.1 mg/kg)	0	98.0, 96.2, 97.7	97	96.3,96.3	96
	188	108, 111, 109	109	99.7, 99.8	100
	315	94.1, 95.5, 104	98	98.7, 102.5	101
Broad bean (dry) (0.1 mg/kg)	0	100, 98.4, 101	100	99.8, 104.1	102
	192	96.3, 97.0, 100	98	97.4, 101.4	99
	308	87.2, 90.0, 90.2	89	101.9, 102.9	102
Orange (fruit) (0.1 mg/kg)	0	106, 99.8, 99.9	102	103.6, 99	101
	187	105, 105, 106	105	106.7, 99.5	103
	310	100, 100, 104	101	93.6, 89.9	92

Residues of fluensulfone, TSA, MeS and BSA were stable for at least 10 months in tomato, soya bean, cereal straw and grain, dried broad beans and orange (whole fruit) samples stored at or

below -18 °C. These matrices represent high water, high oil, high starch, high protein and high acid commodities.

USE PATTERNS

New information on GAP in Australia, Brazil and the USA was provided to the Meeting for soil applications of EC formulations of fluensulfone. For the crops for which residue data are available, the GAP information from the available labels is summarized in following table.

Table 11 Registered uses of fluensulfone – EC formulations

Crop	Country	Application [a]		Max/season		PHI (days)	Remarks
		kg ai/ha (max)	water L/ha (min)	no	kg ai/ha		
Citrus fruits							
Citrus fruits	Brazil	0.96	500				2m within-row soil band (established trees, ideally at the beginning of the rainy season)
Citrus fruit [b]	USA	3.92		2	3.92	60	Soil band or chemigation, pre-flower and/or after harvest
Pome fruits							
Pome fruit [c]	USA	3.92		2	3.92		Soil band or chemigation, at flower bud swell and/or after harvest
Stone fruits							
Stone fruit [d]	USA	3.92		2	3.92		Soil band or chemigation, at flower bud swell and/or after harvest
Small fruit vine climbing							
Small fruit vine climbing [e]	USA	3.92		2	3.92		Soil band or chemigation, at flower bud swell and/or after harvest
Assorted tropical and sub-tropical fruits – edible peel							
Guava	Brazil	0.96	200				2 m within-row band (established trees, ideally at the beginning of the rainy season)
Grasses for sugar or syrup production							
Sugar cane	USA	3.92		2	3.92		Soil broadcast or band at planting and/or after harvest (at ratoon)
Sugar cane	Australia	1.92	100	1			In-furrow 30-50cm band at planting
Sugar cane	Brazil	0.96	200				In-furrow 50-cm band at planting
Tree nuts							
Tree nuts [f]	USA	3.92		2	3.92		Soil band or chemigation, at flower bud swell and/or after harvest
Seeds for beverages and sweets							
Coffee	Brazil	0.96	200				1 m within-row band (established bushes, ideally at the beginning of the rainy season)
Spices							
Pepper, black	Brazil	0.96	200				1 m within-row band (established vines, ideally at the beginning of the rainy season)

[a] Australia, USA: Application rates expressed on a treated area basis

[b] USA: **Citrus fruit**: Including Australian desert lime; Australian finger-lime; Australian round lime; Brown River finger lime; calamondin; citron; citrus hybrids; grapefruit; Japanese summer grapefruit; kumquat; lemon; lime; Mediterranean mandarin; mount white lime; New Guinea wild lime; orange, sour; orange, sweet; pummelo; Russell River lime; satsuma mandarin; sweet lime; tachibana orange; Tahiti lime; tangelo; tangerine (mandarin); tangor; trifoliate orange; uniq fruit; cultivars, varieties, and/or hybrids of these.

[c] USA: **Pome fruit**: Including apple; crabapple; loquat; mayhaw; pear; pear, oriental; quince.

[d] USA: **Stone fruit**: Including apricot; apricot, Japanese; capulin; cherry, black; cherry, Nanking; cherry, sweet; cherry, tart; Jujube, Chinese; nectarine; peach; plum; plum, American; plum, beach; plum, Canada; plum, cherry; plum, Chickasaw; plum, Damson; plum, Japanese; plum, Klamath; plum, prune; plumcot; sloe; cultivars, varieties, and/or hybrids of these.

[e] USA: **Small vine climbing**: Including Amur river grape; gooseberry; grape; kiwifruit, fuzzy; kiwifruit, hardy; maypop; schisandra berry; cultivars, varieties, and/or hybrids of these.

[f] USA: **Tree Nuts**: Including African nut-tree; almond; beechnut; Brazil nut; Brazilian pine; bunya; bur oak; butternut; cajou nut; candlenut; cashew; chestnut; chinquapin; coconut; coquito nut; dika nut; ginkgo; Guiana chestnut; hazelnut (filbert); heartnut; hickory nut; Japanese horsechestnut; Macadamia nut; Mongongo nut; monkey-pot; monkey puzzle nut; okari nut; pachira nut; peach palm nut; pecan; pili nut; pine nut; pistachio; tropical almond; walnut, black; walnut, English; yellowhorn; cultivars, varieties, and/or hybrids of these.

RESULTS OF SUPERVISED RESIDUE TRIALS ON CROPS

The Meeting reviewed new supervised field trial information for the following crops.

Crop Group	Commodity	Country/Region	Table No.
Citrus fruit	Orange, Mandarin, Lemon	USA	12
Pome fruit	Apples, Pears	Nth America	13
Stone fruit	Cherries, Peaches, Plums	USA	14
Small vine, climbing	Grapes	USA	15
Assorted tropical and subtropical fruits	Guava	Brazil	16
Grasses for sugar or syrup production	Sugar cane	Australia, Brazil, USA	17
Tree nuts	Almonds, Pecans	USA	18
Seeds for beverages & sweets	Coffee	Brazil	19
Spices	Pepper, black	Brazil	20
Misc forage and fodder crops (fodder)	Almond hulls	USA	21

The supervised trials were well documented with laboratory and field reports. Laboratory reports included procedural recoveries with spiking at residue levels similar to those occurring in samples from the supervised trials. Intervals of freezer storage between sampling and analysis were recorded for all trials and were covered by the conditions of the freezer storage stability studies.

Results from replicated field plots are presented as individual values and have not been corrected for concurrent method recoveries. When residues were not detected they are shown as ‘’ND’’ but for maximum residue level estimation a value of <LOQ (e.g. < 0.01 mg/kg) has been used.

Residues and application rates have been rounded to two significant digits. Average values have been calculated from the residue results prior to rounding and the results from trials conducted according to the maximum GAP and used for the estimation of maximum residue levels have been (underlined). Where the results of duplicate analyses are available, the highest individual value has been selected as the HR for dietary exposure estimation.

Control (untreated) plots were sampled and analysed in all trials, and if residues in these control samples exceeded the LOQ, this is reported as (c = nn mg/kg).

In the trials, where multiple analyses are conducted on a single sample, the average value is reported and where duplicate samples have been analysed, both the individual results and the average value have been reported.

Where results from separate plots with distinguishing characteristics such as different formulations, varieties or treatment schedules were reported, results are listed for each plot, and the highest value has been used in calculations of maximum residue levels and STMRs. Trials that are not considered to be independent have their location information surrounded by a heavy border (Table 13, for example).

For determining the sum of fluensulfone and the BSA metabolite (residue definition for enforcement), the concentration of BSA in each sample was multiplied by 1.53 [the ratio of the

molecular weights of fluensulfone (291.7 amu) and BSA (190.1 amu)] and the resulting product added to the concentration of fluensulfone. Residues reported as ND are assumed to be <LOQ.

For estimating residues of fluensulfone for dietary risk assessment, residues reported as ND were assumed to be zero and if residues were less than the LOQ, they were assumed to bear residues at the LOQ.

Citrus fruits

The 2017 JMPR reviewed trials on oranges, lemons, and grapefruit conducted in the USA, involving single within-row band applications of fluensulfone, applied through drip or micro-sprinkler irrigation systems or by fanjet plot sprayers about 2 months before harvest.

Samples (min. 2 kg whole fruit) were stored frozen for up to 16 months prior to analysis using method MTH-083 to measure residues of fluensulfone and metabolite BSA. Mean concurrent recovery rates for all analytes (0.01–0.1 mg/kg) were 78–103% and the LOQ was 0.01 mg/kg.

Table 12 Residues in citrus from supervised trials in the USA, involving single chemigation or banded soil applications of fluensulfone (EC formulations). [See JMPR 2017 Evaluations: Fluensulfone, Table 5, pp 1251-1253]

CITRUS FRUIT Country, Year Location (variety) Trial reference	Application				DALA	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)		Fluensulfone	BSA	Total [a]
GAP: USA	1	Chemigation	3.92		60	Pre-flower or after harvest (max 3.92 kg ai/ha per year)		
ORANGE 2014-2015 [Ref: R-31461]								
USA, 2015 Oviedo, FL (Navel) OR FL 1	1	Drip	4.00	18800	60	0.014, 0.015 [0.014]	0.018, 0.024 [0.021]	0.040, 0.052 [0.046]
USA, 2015 Oviedo, FL (Hamlin) OR FL 3	1	Drip	4.00	18800	59	0.024, <0.01 [0.017]	0.019, 0.018 [0.018]	0.053, 0.038 [0.045]
USA, 2015 Oak Hill, FL (Hamlin) OR FL 2	1	Drip	4.00	18800	58	<0.01, <0.01 [<0.01]	0.021, 0.021 [0.021]	0.042, 0.041 [0.042]
USA, 2015 Mims, FL (Navel)OR FL 4	1	Drip	4.00	18800	58	<0.01, ND [<0.01]	0.012, 0.011 [0.011]	0.028, 0.026 [0.027]
USA, 2015 Richgrove, CA (Valencia) OR-CA-3	1	Sprinkler	3.99	18900	60	ND, ND [ND]	0.016, 0.023 [0.020]	0.035, 0.046 [0.040]
	1	Sprinkler	20	18900	60	ND, ND [ND]	0.065, 0.035 [0.050]	0.11, 0.064 [0.087]

CITRUS FRUIT Country, Year Location (variety) Trial reference	Application				DALA	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)		Fluensulfone	BSA	Total [a]
USA, 2015 Oviedo, FL (Valencia) OR FL 7	1	Drip	3.99	18800	46 53 60 68 75	ND, ND [ND] ND, 0.01 [ND] ND, ND [ND] ND, ND [ND] ND, ND [ND]	<0.01, <0.01 [0.01] 0.01, 0.01 [0.01] <0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01] 0.011, 0.011 [0.011]	<0.025, <0.025 [0.025] 0.025, 0.025 [0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] 0.026, 0.027 [0.027]
USA, 2015 Orlando, FL (Valencia) OR-FL-8	1	Drip	3.99	18800	60	<0.01, ND [<0.01]	ND, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
	1	Drip	20 Process	18900	60	<0.01, <0.01 [<0.01]	0.034, 0.033 [0.034]	0.062, 0.060, [0.061]
USA, 2015 Raymondville, TX (N-33 Navel) OR-TX	1	Band spray	4.01	19100	60	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Porterville, CA (Valencia) OR-CA-1	1	Sprinkler	3.99	18900	59	ND, ND [ND]	<0.01, 0.016 [<0.013]	<0.025, 0.034 [0.030]
MANDARIN 2014-2015 [Ref: R-31461]								
USA, 2015 Porterville, CA (Murcott) OR-CA-2	1	Sprinkler	3.99	18900	60	ND, ND [ND]	0.013, 0.015 [0.014]	0.031, 0.033 [0.032]
USA, 2015 Oviedo, FL (Murcott and Minneola) OR FL 5	1	Drip	4.00	18800	60	ND, <0.01 [<0.01]	0.037, 0.045 [0.041]	0.066, 0.079 [0.072]
USA, 2015 Mims, FL (Minneola) OR FL 6	1	Drip	4.00	18800	58	ND, ND [ND]	0.029, 0.033 [0.031]	0.055, 0.061 [0.058]
LEMON 2014-2015 [Ref: R-31461]								
USA, 2015 Clermont, FL (Bearrs) LE-FL	1	Drip	4.00	18900	60	ND, ND [ND]	0.047, 0.054 [0.050]	0.081, 0.092 [0.087]
USA, 2015 Porterville, CA (Pryor) LE-CA-1	1	Sprinkler	4.00	18900	61	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Porterville, CA (Lison) LE-CA-2	1	Sprinkler	4.00	18900	60	ND, <0.01 [<0.01]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]

CITRUS FRUIT Country, Year Location (variety) Trial reference	Application				DALA	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)		Fluensulfone	BSA	Total [a]
USA, 2015 Somis, CA (Eureka) LE-CA-3	1	Sprinkler	4.00	18900	60	**0.063,** 0.035 [0.049]	0.063, 0.046 [0.054]	0.16, 0.11 [0.13]
USA, 2015 Richgrove, CA (Lisbon) LE-CA-4	1	Sprinkler	4.00	18900	60	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
GRAPEFRUIT 2014-2015 [Ref: R-31461]								
USA, 2015 Oak Hill, FL (Pink) GF-FL-1	1	Drip	4.00	18800	58	ND, <0.01 [<0.01]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Oviedo, FL (White/Flame) GF-FL-2	1	Drip	4.00	18900	60	<0.01, 0.018 [0.014]	0.042, 0.040 [0.041]	0.074, 0.080 [0.077]
USA, 2015 Mims, FL (Ray Red) GF-FL-3	1	Drip	4.00	18800	58	ND, ND [ND]	0.011, 0.01 [0.01]	0.026, 0.025 [0.026]
USA, 2015 Raymondville, TX (Rio Red) GF-TX	1	Band spray	4.01	19100	60	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Porterville, CA (Star Ruby) GF-CA-1	1	Sprinkler	4.00	18900	58	<0.01, <0.01 [<0.01]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Porterville, CA (Mellogold) GF-CA-2	1	Sprinkler	3.98	18900	46 53 60 67 73	ND, ND [ND] ND, <0.01 [ND] ND, ND [ND] ND, ND [ND] ND, ND [ND]	<0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025]

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

ND = Not detected

Pome fruit

Results from supervised trials from North America on apples and pears were provided to the Meeting. In these trials, single within-row band applications of fluensulfone were applied through drip or micro-sprinkler irrigation systems or by fanjet plot sprayers at the early flowering stage.

Samples (min. 1.7 kg whole fruit) were stored frozen for up to 10 months prior to analysis using method MTH-083 to measure residues of fluensulfone and metabolite BSA. Mean concurrent recovery rates for all analytes (0.01–0.2 mg/kg) were 75–82% and the LOQ was 0.01 mg/kg.

Table 13 Residues in pome fruit from supervised trials in North America, involving single chemigation or banded soil applications of fluensulfone (EC formulations)

POME FRUIT Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
GAP: USA	2	Chemigation	3.92		Up to flower bud swell and/or after harvest (max 3.92 kg ai/ha per year)				
APPLES									
USA, 2015 Sodus, NY (EarliGold) R-35572	1	Drip	4.16	19386	84 91 (NCH) 98 105	Apple	ND, ND [ND] ND, ND [ND] ND, ND [ND] ND, ND [ND]	<0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025]
USA, 2015 North Rose, NY (Cortland) R-35572	1	Drip	3.94	18752	99 (NCH)	Apple	ND, ND [ND]	0.011, 0.012 [0.012]	0.027, 0.028 [0.028]
USA, 2015 New Hope, NJ (Enterprise) R-35572	1	Drip	4.08	18480	165 (NCH)	Apple	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2015 Dix, IL (Jonathons) R-35572	1	Drip	3.99	18881	103 (NCH)	Apple	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Marengo, WI (Cox's Orange Pippin) R-35572	1	Sprinkler	4.11	19620	109 (NCH)	Apple	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Paradise, ID (Golden Delicious) R-35572	1	Drip	4.01	18933	113 (NCH)	Apple	ND, ND [ND]	0.11, 0.093 [0.10]	0.18, 0.015 [0.16]
USA, 2015 Porterville, CA (Granny Smith) R-35572	1	Drip	4.00	13101	113 (NCH)	Apple	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2015 Rockland, ID (McIntosh) R-35572	1	Drip	4.02	19054	123 (NCH	Apple	ND, ND [ND]	0.014, 0.015 [0.014]	0.031, 0.032 [0.031]
USA, 2015 Ephrata, WA (Red Delicious) R-35572	1	Drip	4.00	18947	141 (NCH)	Apple	ND, ND [ND]	0.012, 0.011 [0.011]	0.028, 0.027 [0.028]

POME FRUIT Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
USA, 2015 Hood River, OR (Jonagold) R-35572	1	Drip	3.99	19208	112 (NCH)	Apple	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [≤0.025]
Canada, 2015 Berwick, NS (Jonagold) R-35572	1	Drip	4.00	18489	121 (NCH)	Apple	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [≤0.025]
Canada, 2015 Melville Square, NS (Jonagold) R-35572	1	Drip	3.99	18495	122 (NCH)	Apple	ND, ND [ND]	0.018, 0.017 [0.018]	0.038, 0.036 [0.037]
Canada, 2015 Branchton, ON (Nova McIntosh) R-35572	1	Band spray	3.91	18941	113 (NCH)	Apple	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [≤0.025]
Canada, 2015 Renton, ON (Spy) R-35572	1	Sprinkler	4.00	18745	151 (NCH)	Apple	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [≤0.025]
Canada, 2015 Birr, ON (Ida reds) R-35572	1	Sprinkler	4.00	18745	158 (NCH)	Apple	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
Canada, 2015 Okanagan Falls, BC (Red Delicious) R-35572	1	Drip	4.00	18758	105 (NCH)	Apple	ND, ND [ND]	<0.01, 0.013 [0.012]	<0.025, 0.030 [0.028]
Canada, 2015 Okanagan Falls, BC (Spartan) R-35572	1	Drip	4.00	18758	160 (NCH)	Apple	ND, ND [ND]	0.011, <0.01 [0.01]	0.027, <0.025 [0.026]
PEAR									
USA, 2015 Williamson, NY (Bartlett) R-35572	1	Band spray	3.91	18725	62 (NCH)	Pear	ND, ND [ND]	0.068, 0.068 [0.068]	0.11, 0.11 [0.11]
USA, 2015 Madera, CA (Shinko) R-35572	1	Sprinkler	3.99	7515	96 (NCH)	Pear	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [≤0.025]
USA, 2015 Yettem, CA (Shinko) R-35572	1	Drip	4.00	8930	95 (NCH)	Pear	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [≤0.025]
USA, 2015 Hood River, OR (Bosc) R-35572	1	Drip	4.01	19254	113 (NCH)	Pear	ND, ND [ND]	0.011, <0.01 [0.01]	0.027, <0.025 [0.026]

POME FRUIT Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
USA, 2015 Ephrata, WA (D'Anjou) R-35572	1	Band spray	4.00	18947	114 121 (NCH) 128 135	Pear	ND, ND [ND] ND, ND [ND] ND, ND [ND] ND, ND [ND]	<0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01] <0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025]
Canada, 2015 Branchton, ON (Harrow Gold) R-35572	1	Drip	3.91	18923	95 (NCH)	Pear	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
Canada, 2015 Renton, ON (Harrow Gold) R-35572	1	Drip	4.00	18747	151 (NCH)	Pear	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
Canada, 2015 Renton, ON (Clapp) R-35572 Same site	1	Drip	4.00	18750	127 (NCH)	Pear	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
Canada, 2015 Okanagan Falls, BC (Anjus) R-35572	1	Drip	4.00	18758	88 (NCH)	Pear	ND, ND [ND]	0.10, 0.11 [0.11]	0.16, 0.18 [0.17]

NCH = near commercial harvest

ND = not detected

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

Stone fruit

Results from supervised trials from the USA on cherries, peaches and plums were provided to the Meeting. In these trials, single within-row band applications of fluensulfone were applied through drip or micro-sprinkler irrigation systems or by fanjet plot sprayers at the early flowering stage.

Samples (min. 0.5 kg, 24 fruit) were de-pitted in the field (stone weights recorded) and the flesh samples were stored frozen for up to 12 months before analysis using method MTH-083 to measure residues of fluensulfone and metabolite BSA. Mean concurrent recovery rates for all analytes (0.01–0.2 mg/kg) were 77–85% and the LOQ was 0.01 mg/kg.

Table 14 Residues in stone fruit from supervised trials in the USA, involving single chemigation soil applications of fluensulfone (EC formulations).

STONE FRUIT Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
GAP: USA	2	Chemi gation	3.92		Up to flower bud swell and/or after harvest (max 3.92 kg ai/ha per year)				

STONE FRUIT Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
CHERRY									
USA, 2015 Sodus, NY (Montmorency) R-35573	1	Drip	4.03	19609	55 (NCH)	Flesh	ND, ND [ND]	0.011, 0.012 [0.012]	0.027, 0.028 [0.028]
USA, 2015 Marengo, WI (North star) R-35573	1	Drip	4.08	19343	43 (NCH)	Flesh	ND, ND [ND]	0.027, 0.025 [0.026]	0.051, 0.048 [0.050]
USA, 2015 Plainview, CA (Tulare) R-35573	1	Drip	4.00	18940	43 (NCH)	Flesh	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Buena, WA (Lapin) R-35573	1	Sprinkler	3.95	18940	54 (NCH)	Flesh	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 The Dalles, OR (Rainier) R-35573	1	Sprinkler	4.03	18988	69 76 (NCH) 83 90	Flesh	ND, ND [ND] ND, ND [ND] ND, ND [ND] ND, ND [ND]	0.013, 0.011 [0.012] 0.011, 0.013 [0.012] 0.013, 0.014 [0.014] 0.013, 0.015 [0.014]	0.030, 0.027 [0.028] 0.027, 0.030 [0.028] 0.030, 0.031 [0.031] 0.030, 0.033 [0.031]
PEACH									
USA, 2015 Kempton, PA (Redskin) R-35573	1	Drip	4.03	30476	124 (NCH)	Flesh	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2015 Cana, NC (Honey Royale) R-35573	1	Drip	4.00	18940	141 (NCH)	Flesh	ND, ND [ND]	ND, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Athens, GA (Contender) R-35573	1	Drip	4.00	19033	107 (NCH)	Flesh	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2015 Chula, GA (Gala) R-35573	1	Drip	4.00	19317	70 77 (NCH) 84 91	Flesh	ND, ND [ND] ND, ND [ND] ND, ND [ND] ND, ND [ND]	0.025, 0.027 [0.026] 0.017, 0.017 [0.017] 0.014, 0.013 [0.014] 0.011 0.012 [0.011]	0.048, 0.051 [0.050] 0.035, 0.035 [0.035] 0.032, 0.030 [0.031] 0.027, 0.038 [0.032]
USA, 2015 Ringwood, OK (Early Girl) R-35573	1	Drip	4.03	19113	71 (NCH)	Flesh	ND, ND [ND]	0.022, 0.024 [0.023]	0.043, 0.048 [0.046]

STONE FRUIT Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No.	Type	kg ai/ treated ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
USA, 2015 Harrah, OK (John Boy) R-35573	1	Drip	3.98	19113	108 (NCH)	Flesh	ND, ND [ND]	0.042, 0.043 [0.0425]	0.075, 0.075 [0.075]
USA, 2015 Porterville, CA (Fay Elberta) R-35573	1	Drip	4.00	18940	100 (NCH)	Flesh	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Dinuba, CA (Ivory Dutchess) R-35573	1	Drip	4.00	18940	48 (NCH)	Flesh	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2015 Orange Cove, CA (Summer Flame #29) R-35573	1	Drip	4.00	18932	82 (NCH)	Flesh	ND, ND [ND]	<0.01, ND [ND]	<0.025, <0.025 [<0.025]
PLUM									
USA, 2015 Kingsburg, CA (October Sun) R-35573 PL CA-1	1	Sprinkler	3.98	18949	137 (NCH)	Flesh	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
		Sprinkler	20 Process	18949	137 (NCH)	Fruit	ND, ND [ND]	0.07	0.11
USA, 2015 Terra Bella, CA (Yummy Beaut) R-35573PL-CA-2 Harvest 29 May	1	Drip	4.00	18940	65 (NCH)	Flesh	ND, ND [ND]	0.010, 0.011 [0.011]	0.025, 0.027 [0.026]
USA, 2015 Terra Bella, CA (French Plum) R-35573PL-CA-4 Harvest 28 Jul	1	Drip	4.00	18934	117 (NCH)	Flesh	ND, ND [ND]	<0.01, 0.014 [0.012]	<0.025, 0.031 [0.028]
	1	Drip	20 Process	18934	117 (NCH)	Fruit	ND, ND [ND]	0.11	0.17
USA, 2015 Exeter, CA (Flavor Fall) R-35573 PL-CA-3	1	Drip	4.00	18940	140 (NCH)	Flesh	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2015 Oregon City, OR (Moyer) R-35573 PL-OR	1	Drip	4.00	18996	159 (NCH)	Flesh	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]

NCH = near commercial harvest

ND = not detected

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

Small fruit vine climbing

Grapes

Results from supervised trials from the USA on grapes were provided to the Meeting. In these trials, single within-row band applications of fluensulfone were applied through drip irrigation systems at the leaf emergence stage.

Samples (min. 1 kg berries) were stored frozen for up to 13 months before analysis using method MTH-083 to measure residues of fluensulfone and metabolite BSA. Mean concurrent recovery rates for all analytes (0.01–0.1 mg/kg) were 76–89% and the LOQ was 0.01 mg/kg.

Table 15 Residues in grapes from supervised trials in the USA, involving single chemigation (drip irrigation) applications of fluensulfone (EC formulations)

GRAPES Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No	Type	kg ai/ treated ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
GAP: USA	2	Chemigation	3.92		Up to flower bud swell and/or after harvest				
USA, 2014 Breinigsville, PA (Vidal Blanc 256) R-31459	1	Drip	4.02	19517	138	Berries	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
					143 (NCH)		ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
					148		ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
					153		ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2014 Dundee, NY (DeChaunac) R-31459	1	Drip	4.01	18582	113 (NCH)	Berries	ND, ND [ND]	ND	<0.025, <0.025 [<0.025]
	1	Drip	20 Process	23200	113 (NCH	Bunches	ND, ND [ND]	0.061	0.093
USA, 2014 Artois, CA (Rubired) R-31459	1	Drip	4.00	18955	93 (NCH)	Berries	ND, ND [ND]	0.34, 0.28 [0.31]	0.53, 0.44 [0.48]
USA, 2014 Kingsburg, CA (Thompson) R-31459	1	Drip	3.95	19028	64 (NCH)	Berries	ND, ND [ND]	ND, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2014 Porterville, CA (Thompson) R-31459	1	Drip	4.03	19167	65 (NCH)	Berries	ND, ND [ND]	0.011, 0.011 [0.011]	0.027, 0.027 [0.027]
USA, 2014 Dinuba, CA (Rubi Red) R-31459	1	Drip	4.01	18922	59	Berries	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
					64 (NCH)		ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
					69		ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
					74		ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2014 Kerman, CA (Thompson Seedless) R-31459	1	Drip	4.03	57930	61 (NCH)	Berries	ND, ND [ND]	ND	<0.025, <0.025 [<0.025]
		Drip	20 Process	69086	61 (NCH)	Bunches	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2014 Hillsboro, OR (Pinot Gris) R-31459	1	Drip	4.03	19047	123 (NCH)	Berries	ND, ND [ND]	0.024, 0.028 [0.026]	0.047, 0.053 [0.050]

GRAPES Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No	Type	kg ai/ treated ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
USA, 2014 Ephrata, WA (White Riesling) R-31459	1	Drip	4.05	18945	137 (NCH)	Berries	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]

NCH = near commercial harvest

ND = not detected

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

Assorted tropical and sub-tropical fruits – inedible peel

Guava

Results from supervised trials from Brazil on guava were provided to the Meeting. In these trials, single soil applications of fluensulfone (EC formulations) were applied by pressurised hand sprayers as 20 cm within-row bands under the canopy in mid-late March (end of flowering).

Samples (min. 12 whole fruit) were stored frozen for up to 6 months prior to analysis using method MTH-083 to measure residues of fluensulfone and metabolites BSA, TSA and MeS. Mean concurrent recovery rates for all analytes (0.08–0.8 mg/kg) were 102–111% and the LOQ was 0.08 mg/kg.

Table 16 Residues in guava from supervised trials in Brazil, involving a single soil-applied within-row band spray application of fluensulfone (EC 480 formulation)

GUAVA Country, Year Location (variety) Reference	Application				DALA	Residues, mg/kg				
	No	Type	kg ai/ha	Water (L/ha)		Fluensulfone	BSA	TSA	MeS	Total [a]
GAP: Brazil	1	Band	0.96		-	Ideally at the beginning of the rainy season				
Brazil, 2014 Leópolis, PR (Sassaoka) RA 002 008 14 B	1	Band	0.96	200	60 70 80 90	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Brazil, 2014 Ibaiti, PR (Sassaoka) RA 002 008 14 B	1	Band	0.96	200	60 70 80 90	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Brazil, 2014 Carlópolis, PR (Chinese) RA 002 008 14 B	1	Band	0.96	200	60 70 80 90	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Brazil, 2014 Londrina, PR (Paluma) RA 002 008 14 B	1	Band	0.96	200	60 70 80 90	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

Grasses for sugar or syrup production

Sugar cane

The 2017 JMPR reviewed a series of sugar cane trials conducted Australia, Brazil, and the USA. In these trials, single treatments of fluensulfone (EC formulations) were applied as a 500 cm band spray in the furrow at planting. Samples from all trials were placed into frozen storage immediately after harvest and stored frozen for up to 49 days (Australia), 198 days (Brazil), or 173 days (USA) prior to analysis. For all three analytes, the LOQ is 0.08 mg/kg in the Brazilian trials and 0.01 mg/kg in the Australian and US trials (US trials were analysed for fluensulfone and BSA only).

Table 17 Residues in sugar cane from supervised trials in Australia, Brazil, and the USA, involving a single in-furrow band spray of fluensulfone (EC 480 formulation) at planting [See JMPR 2017 Evaluations: Fluensulfone, Table 7, pp 1254-1257]

SUGAR CANE Location, (variety)	Application					Matrix [a]	Residues, mg/kg [mean]			
	No.	Type	kg ai/ha	Water (L/ha)	DALA		Fluensulfone	BSA	TSA	Total [b]
GAP: USA	1	Band	3.92		At planting					
Brazil 2012 (Report 002 075 11 B)										
Rio Claro, SP (IAC 110)	1	Band	0.96	200	335 364 395 425	Cane	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Piracicaba, SP (IAC 110)	1	Band	0.96	200	335 364 395 425	Cane	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Andirá, PR (BR 89)	1	Band	0.96	200	334 365 395 426	Cane	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Abatiá, PR (BR 89)	1	Band	0.96	200	334 365 395 426	Cane	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Brazil 2014 (Report RA 002 004 14 B)										
Iracemápolis, SP (RB 88)	1	Band	0.96	200	331 360 390 420	Cane	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Santa Mariana, PR (RB 88)	1	Band	0.96	200	330 360 390 420	Cane	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Cabarám, PR (RB 88)	1	Band	0.96	200	330 360 390 420	Cane	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Anápolis, GO (RB 855453)	1	Band	0.96	200	330 360 390 420	Cane	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Australia 2015 (Report ASA-13-254)										
Bellenden Ker, QLD (Q208)	1	Band	1.99	440	307	Billets Tops Trash	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.20 0.75 1.61	<0.025 <0.025 <0.025

SUGAR CANE Location, (variety)	Application					Matrix [a]	Residues, mg/kg [mean]			
	No.	Type	kg ai/ha	Water (L/ha)	DALA		Fluensulfone	BSA	TSA	Total [b]
	1	Band	3.98	440	307	Billets Tops Trash	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.52 3.38 2.70	<0.025 <0.025 <0.025
Miriwinni, QLD (Q220)	1	Band	1.99	440	307	Billets Tops Trash	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.34 1.23 0.96	<0.025 <0.025 <0.025
	1	Band	3.98	440	307	Billets Tops Trash	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.76 4.38 3.46	<0.025 <0.025 <0.025
Stapylton, QLD (Q183)	1	Band	2.03	408	372	Billets Tops Trash	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.13 0.56 0.41	<0.025 <0.025 <0.025
	1	Band	4.06	408	372	Billets Tops Trash	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.34 1.55 1.11	<0.025 <0.025 <0.025
Stotts Creek, NSW (Q244)	1	Band	2.03	408	379	Billets Tops Trash	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.23 0.84 0.77	<0.025 <0.025 <0.025
	1	Band	4.06	408	379	Billets Tops Trash	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.67 2.11 1.81	<0.025 <0.025 <0.025
USA 2015 (Report R-35574)										
Oviedo, FL (2143)	1	Band	3.88	280	267	Cane	ND, ND [ND]	0.022, 0.024 [0.023]	--	0.044, 0.047 [0.045]
Moore Haven, FL (CP1252)	1	Band	3.93	290	274	Cane	ND, ND [ND]	ND, 0.012 [<0.01]	--	<0.025, 0.028 [0.027]
Jupiter, FL (1743)	1	Band	4.02	290	235	Cane	ND, ND [ND]	<0.01, <0.01 [<0.01]	--	<0.025, <0.025 [<0.025]
Washington, LA (540)	1	Band	4.02	240	274	Cane	ND, ND [ND]	ND, ND [ND]	--	<0.025, <0.025 [<0.025]
Washington, LA (540)	1	Band	4.09	250	266 270 274 278 282	Cane	ND, ND [ND] ND, ND [ND] ND, ND [ND] ND, ND [ND] ND, ND [ND]	<0.01, <0.01 [<0.01] <0.01, ND [<0.01] ND, ND [ND] <0.01, ND [<0.01] <0.01, ND [<0.01]	--	<0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025] <0.025, <0.025 [<0.025]
Church Point, LA (540)	1	Band	4.09	250	274	Cane	ND, ND [ND]	ND, ND [ND]	--	<0.025, <0.025 [<0.025]
	1	Band	20 Process	250	280	Cane	0.075, 0.042 [0.0585]	0.122, 0.104 [0.113]	--	0.26, 0.2 [0.23]
Raymondville, TX (1210)	1	Band	4.12	290	314	Cane	ND, ND [ND]	ND, ND [ND]	--	<0.025, <0.025 [<0.025]
Kunia, HW (65-7052)	1	Band	4.18	340	365	Cane	ND, ND [ND]	ND, ND [ND]	--	<0.025, <0.025 [<0.025]

ND = not detected

Note: Application rates in the Australian and US trials are kg/treated ha

[a] Cane, billet residue data reported on a fresh-weight basis; tops, trash reported on a dry-weight basis.

[b] Sum of fluensulfone and BSA, expressed as fluensulfone.

Tree nuts

Almonds, pecans

Results from supervised trials from the USA on almonds and pecans were provided to the Meeting. In these trials, single within-row band applications of fluensulfone were applied through drip or micro-sprinkler irrigation systems at the leaf emergence stage.

Samples (min. 1 kg nutmeat and almond hulls) were stored frozen for up to 13 months before analysis using method MTH-083 to measure residues of fluensulfone and metabolite BSA. Mean concurrent recovery rates for all analytes (0.01-0.1 mg/kg in nut meat and 0.01–4.0 mg/kg in almond hulls) were 85–94% and the LOQ was 0.01 mg/kg.

Table 18 Residues in pecan and almond nutmeat from supervised trials in the USA, involving single chemigation applications of fluensulfone (EC formulations)

TREE NUTS Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No	Type	kg ai/ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
GAP: USA	2	Chemigation	3.92		At flower bud swell and/or after harvest				
ALMOND									
USA, 2014 Orland, CA-1 (Nonpareil) R-31458	1	Drip	3.96	8913	90 (NCH)	Nutmeat	<0.01, <0.01 [<0.01]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Drip	3.96	8913	60 (NCH)	Nutmeat	<0.01, <0.01 [<0.01]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2014 Terra Bella, CA-2 (Monterey) R-31458	1	Sprinkler	4.02	9078	90 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Sprinkler	4.02	9078	60 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2014 Strathmore, CA-3 (Fritzs) R-31458 Applied in July	1	Sprinkler	4.00	9078	90 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Sprinkler	4.00	9078	60 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2014 Strathmore, CA-5 (Monterey) R-31458 Applied in May	1	Sprinkler	4.00	9078	53	Nutmeat	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
					60 (NCH)		ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
					67		ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
					74		ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Sprinkler	4.00	9078	90 (NCH)	Nutmeat	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
USA, 2014 Dinuba, CA-4 (Nonpareil) R-31458	1	Sprinkler	3.96	9078	90 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Sprinkler	3.96	9078	60 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
PECAN									
USA, 2014 Chula, GA-1 (Sumner) R-31458	1	Drip	4.02	1121	90 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Drip	4.02	1121	60 (NCH)	Nutmeat	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]

TREE NUTS Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No	Type	kg ai/ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
USA, 2014 Mystic, GA-2 (Sumner) R-31458	1	Sprinkler	4.02	1121	90 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Sprinkler	4.02	1121	60 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2014 Alexandria, LA (Creek) R-31458	1	Drip	3.87	9078	90 (NCH)	Nutmeat	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]
		Drip	3.87	9078	60 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2014 Stillwater, OK-1 (Merrimac) R-31458	1	Drip	4.39	9234	90 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Drip	4.00	9234	60 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
USA, 2014 Dill City, OK-2 (Kanza) R-31458	1	Drip	4.00	9234	90 (NCH)	Nutmeat	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]
		Drip	4.00	9234	60 (NCH)	Nutmeat	ND, ND [ND]	<0.01, <0.01 [<0.01]	<0.025, <0.025 [<0.025]

NCH = near commercial harvest

ND = not detected

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

Seeds for beverages and sweets

Coffee

The 2017 JMPR reviewed a series of coffee trials conducted in Brazil, involving single treatments of fluensulfone (EC formulations), applied as 0.5–1.0 metre within-row band sprays over flowering and up to early fruit formation (BBCH 59–71).

Samples of cherries were sun-dried prior to being processed to remove the pulp. After pulp removal, the beans were placed into frozen storage for up to 12 months before analysis of fluensulfone and MeS, and up to 6 months before analysis of BSA and TSA. For all three analytes, the LOQ was 0.08 mg/kg.

The Meeting also received results from additional Brazilian trials on coffee, also involving single treatments of fluensulfone (EC formulations), applied as 1.0 metre within-row band sprays at early fruit formation stage (BBCH 70–75).

Samples of cherries (min. 1 kg) were dried in the field, machine processed to remove the pulp and stored frozen for up to 10 months before analysis using Method M1997W to measure fluensulfone, BSA and TSA residues. Mean concurrent recovery rates for TSA and BSA (0.01–0.1 mg/kg) were 93–107%, and for fluensulfone the mean recovery rate in samples fortified with 0.1 mg/kg was 104% (SD 9%, n = 6) and in samples fortified with 0.01 mg/kg the mean recovery rate was 184% (SD 11%, n = 5). The LOQ was 0.01 mg/kg.

Table 19 Residues in coffee beans from supervised trials in Brazil, involving a single soil-applied within-row band spray application of fluensulfone (EC 480 formulation)

COFFEE BEANS Country, Year Location (variety)	Application					Residues, mg/kg				
	No.	Timing, type	kg ai/ha	Water (L/ha)	DALA	Fluensulfone	BSA	TSA	MeS	Total [a]
GAP: Brazil	1		0.96		-	Ideally at the beginning of the rainy season				

COFFEE BEANS Country, Year Location (variety)	Application					Residues, mg/kg				
	No.	Timing, type	kg ai/ha	Water (L/ha)	DALA	Fluensulfone	BSA	TSA	MeS	Total [a]
Brazil, 2012 [Ref: LRN02612CF_2013i] [See JMPR 2017 Evaluations: Fluensulfone, Table 8, pp 1257-1258]										
Brazil, 2012 Ribeirão do Pinhal, PR (Obatá)	1	BBCH 71	1.92	200	150 165 180 195 210	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 0.15 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2 <0.2
Brazil, 2012 Bandeirantes, PR (Obatá)	1	BBCH 72	1.92	200	150 165 180 195 210	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 0.08 0.12 0.13 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2 <0.2
Brazil, 2012 Laranjal Paulista, SP (ICATU)	1	BBCH 70	1.92	200	150 165 180 195 210	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2 <0.2
Brazil, 2012 Iracemápolis, SP (ICATU)	1	BBCH 59	1.92	200	150 165 180 195 210	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 0.12 0.32 0.12	<0.08 <0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2 <0.2
2014 (Report RA 002 003 14 B) [See JMPR 2017 Evaluations: Fluensulfone, Table 8, pp 1257-1258]										
Brazil, 2014 Santa Mariana, PR (Caturra Amerelo)	1		0.96	200	150 165 180 195 210	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2 <0.2
Brazil, 2014 Bandeirantes, PR (Catuai Vermelho)	1		0.96	200	150 165 180 195 210	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2 <0.2
Brazil, 2014 Procópio, PR (Catuai Vermelho)	1		0.96	200	150 165 180 195 210	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2 <0.2
Brazil, 2014 Iracemápolis, SP (Catuai Vermelho)	1		0.96	200	150 165 180 195 210	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2 <0.2
Brazil, 2017. [Ref: RA 002 037 16 B]										
Brazil, 2017 Serrania/MG (Catuaí vermelho)	1	BBCH 70	0.96	200	150	<0.01	0.01	0.11	-	0.025
Brazil, 2017 Machado/MG (Arabica)	1	BBCH 70	0.96	200	150 165 180 190 210	<0.01 <0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 0.03 0.05	-	<0.025 <0.025 <0.025 <0.025 <0.025
Brazil, 2017 Caldas/MG (Catuaí vermelho)	1	BBCH 70	0.96	200	150 165 180 190 210	<0.01 <0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 <0.01 <0.01	0.04 0.03 <0.01 <0.01 <0.01	-	<0.025 <0.025 <0.025 <0.025 <0.025

COFFEE BEANS Country, Year Location (variety)	Application					Residues, mg/kg				
	No.	Timing, type	kg ai/ha	Water (L/ha)	DALA	Fluensulfone	BSA	TSA	MeS	Total [a]
Brazil, 2017 Campestre/MG (Catuaí vermelho)	1	BBCH 70	0.96	200	150 165 180 190 210	<0.01 0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 <0.01 <0.01	0.02 0.03 0.02 0.02 0.02	-	<0.025 0.025 <0.025 <0.025 <0.025
Brazil, 2017 Alfenas/MG (Catuaí vermelho)	1	BBCH 70	0.96	200	150	<0.01	<0.01	0.06	-	<0.025
Brazil, 2017 Ribeirão do Pinhal/PR (Catuaí vermelho)	1	BBCH 73	0.96	200	150 165 180 190 210	<0.01 <0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 <0.01 <0.01	-	<0.025 <0.025 <0.025 <0.025 <0.025
Brazil, 2017 Abatiá/PR (Ubatã)	1	BBCH 71	0.96	200	150 165 180 190 210	<0.01 <0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 <0.01 <0.01	-	<0.025 <0.025 <0.025 <0.025 <0.025
Brazil, 2017 Iracemápolis/SP (Catuaí vermelho)	1	BBCH 70	0.96	200	150 165 180 190 210	<0.01 <0.01 <0.01 <0.01 <0.01	<0.01 <0.01 <0.01 0.02 0.02	0.04 0.06 <0.01 0.12 0.14	-	<0.025 <0.025 <0.025 0.041 0.041
Brazil, 2017 [Ref: RA 002 044 16 B]										
Brazil,2017 Iracemápolis/ SP (Catuaí vermhelo)	1		4.80	200	150	<0.01	<0.01	0.10	-	<0.025
Brazil,2017 Machado/ MG (Catuaí vermhelo)	1		4.80	200	150	<0.01	<0.01	0.07	-	<0.025
Brazil,2017 Engenheiro/ SP (Catuaí vermelho)	1		4.80	200	150	<0.01	<0.01	0.06	-	<0.025

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

Spices

Pepper, black

The 2017 JMPR reviewed a series of black pepper trials conducted Brazil, involving single treatments of fluensulfone (EC formulations), applied as 0.5–1.0 metre within-row band sprays at early fruit formation (BBCH 70–71).

Fruits were dried to form peppercorns and placed into frozen storage prior to shipment to the analytical facility. Samples were stored frozen for up to 3 months before analysis. For all three analytes, the LOQ was 0.08 mg/kg.

Table 20 Residues in black pepper from supervised trials in Brazil, involving a single soil-applied within-row band spray application of fluensulfone (EC 480 formulation) [See JMPR 2017 Evaluations: Fluensulfone, Table 9, pp 1259]

PEPPER, BLACK	Application		DALA	Residues, mg/kg

Country, Year Location (variety) Reference	No.	Timing, type	kg ai/ha	water (L/ha)		Fluensulfone	BSA	TSA	Total [a]
GAP: Brazil	1		0.96		-	Ideally at the beginning of the rainy season			
Brazil, 2013 Jaguaré, ES (Bragantina) LRN02616PR_2013i	1	BBCH 71	0.96	100	55 60 65 70	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Brazil, 2013 Linhares, ES (Bragantina) LRN02616PR_2013i	1	BBCH 71	0.96	100	55 60 65 70	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Brazil, 2013 Aracruz, ES (Bragantina) LRN02616PR_2013i	1	BBCH 72	0.96	100	55 60 65 70	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2
Brazil, 2013 Mucuri, BA (Bragantina) LRN02616PR_2013i	1	BBCH 71	0.96	100	55 60 65 70	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.08 <0.08 <0.08 <0.08	<0.2 <0.2 <0.2 <0.2

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

Miscellaneous Fodder and Forage crops (fodder)

Almond hulls

In the supervised trials from the USA on almonds, involving single within-row band applications of fluensulfone, applied through drip or micro-sprinkler irrigation systems at the leaf emergence stage, almond hull samples were stored frozen for up to 13 months before analysis using method MTH-083 to measure residues of fluensulfone and metabolite BSA. Mean concurrent recovery rates for all analytes (0.01–4.0 mg/kg in almond hulls) were 85–94% and the LOQ was 0.01 mg/kg.

Table 21 Residues in almond hulls from supervised trials in the USA, involving single chemigation applications of fluensulfone (EC formulations)

TREE NUTS Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No	Type	kg ai/ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
GAP: USA	2	Chemi gation	3.92		At flower bud swell and/or after harvest				
ALMOND									
USA, 2014 Orland, CA-1 (Nonpareil) R-31458	1	Drip	3.96	8913	90 (NCH)	Hulls	0.012, 0.012 [0.012]	0.72, 0.64 [0.68]	1.11, 0.98 [1.05]
		Drip	3.96	8913	60 (NCH)	Hulls	0.042, 0.19 [0.12]	1.12, 1.1 [1.11]	1.76, 1.87 [1.82]
USA, 2014 Terra Bella, CA-2 (Monterey) R-31458	1	Sprinkler	4.02	9078	90 (NCH)	Hulls	<0.01, ND [<0.01]	1.51, 1.61 [1.56]	2.32, 2.47 [2.39]
		Sprinkler	4.02	9078	60 (NCH)	Hulls	ND, ND [ND]	0.81, 0.81 [0.81]	1.25, 1.25 [1.25]
USA, 2014 Strathmore, CA-3 (Fritzs) R-31458 Applied in July	1	Sprinkler	4.00	9078	90 (NCH)	Hulls	<0.01, <0.01 [<0.01]	1.59, 1.43 [1.51]	2.44, 2.2 [2.32]
		Sprinkler	4.00	9078	60 (NCH)	Hulls	ND, ND [ND]	ND, ND [ND]	<0.025, <0.025 [<0.025]

TREE NUTS Country, Year Location (variety) Reference	Application				DALA	Matrix	Residues, mg/kg [mean]		
	No	Type	kg ai/ha	Water (L/ha)			Fluensulfone	BSA	Total [a]
USA, 2014 Strathmore, CA-5 (Monterey) R-31458 Applied in May	1	Sprinkler	4.00	9078	53	Hulls	<0.01, <0.01 [<0.01]	1.27, 1.45 [1.36]	1.95, 2.23 [2.09]
					60 (NCH)		<0.01, <0.01 [<0.01]	1.07, 1.09 [1.08]	1.65, 1.67 [1.66]
					67		ND, ND [ND]	2.08, 1.84 [1.96]	3.19, 2.83 [3.01]
					74		ND, ND [ND]	1.05, 1.18 [1.12]	1.62, 1.82 [1.72]
		Sprinkler	4.00	9078	90 (NCH)	Hulls	ND, ND [ND]	0.69, 0.69 [0.69]	1.07, 1.06 [1.07]
USA, 2014 Dinuba, CA-4 (Nonpareil) R-31458	1	Sprinkler	3.96	9078	90 (NCH)	Hulls	ND, ND [ND]	0.45, 0.55 [0.50]	0.70, 0.85 [0.78]
		Sprinkler	3.96	9078	60 (NCH)	Hulls	ND, ND [ND]	0.33, 0.33 [0.33]	0.51, 0.51 [0.51]

NCH = near commercial harvest

ND = not detected

[a] Sum of fluensulfone and BSA, expressed as fluensulfone.

FATE OF RESIDUES IN STORAGE AND IN PROCESSING

Magnitude of the residue in processing

Information was provided to the 2014 JMPR on the effects of high temperature hydrolysis and of simulated commercial processing on residues of fluensulfone in tomatoes. Additional processing studies on potatoes, citrus and sugar cane were evaluated by the 2016 and 2017 JMPRs.

The current Meeting received information on the effects of processing on residues of fluensulfone in apples, plums and grapes.

As a measure of the transfer of residues into processed products, a processing factor (PF) was used, defined as:

PF = Total residue in processed product/total residue in raw agricultural commodity

If residues in the RAC were below the LOQ, no processing factor could be derived. If residues in the processed product were below the LOQ, the numeric value of the LOQ was used for the calculation but the PF was expressed as "less than" (e.g. < 0.5).

Apples

Processing studies reported by Hoi & Jones, 2016 [Ref: R-35572], were conducted in the USA to measure residues of fluensulfone and its metabolites in apple juice, wet pomace, sauce and dried fruit following exaggerated (5×) field treatment on apples.

In two of the US apple field trial sites described above, additional plots were treated with exaggerated rates of 20 kg ai/ha, as single within-row band applications, applied at the early flowering stage, through drip irrigation systems.

Bulk samples of whole apples were shipped at ambient temperature to the analytical facility for processing into juice, sauce, dried apple and wet pomace. Samples of unwashed apples were passed through a hammer mill to produce apple mash. The mash was layered into cloth sacks on a

hydraulic press and pressed to separate juice from wet pomace. While the mash was pressed, juice samples were collected. After pressing, the wet pomace stacks were broken up, combined, mixed and wet pomace samples collected. Separate samples of unwashed apples were peeled, sliced and cored before dehydration to produce dried apple slices or heated to 71 °C for 45 minutes and mashed to produce sauce.

Samples of apples and processed fractions were stored frozen for up to 10 months before analysis using method MTH-083 to measure residues of fluensulfone and metabolite BSA. Mean concurrent recovery rates for both analytes were 77–96% and the LOQ was 0.01 mg/kg.

Table 22 Residues in apples and processed apple fractions from supervised field trials in the USA, involving single chemigation applications of 20 kg ai/ha fluensulfone (EC formulations)

Matrix	Analyte	Residues, mg/kg	Processing factors	Median/ best estimate
Whole apples (RAC)	Fluensulfone	ND, ND		
	BSA	0.02, 0.03		
	Total [a]	<0.041, <0.056		
Apple juice	Fluensulfone	ND, ND		
	BSA	0.03, 0.07		
	Total	<0.056, <0.12	1.4, 2.1	1.7
Apple sauce	Fluensulfone	ND, ND		
	BSA	0.02, 0.03		
	Total	<0.041, <0.056	1.0, 1.0	1.0
Dried apple (slices)	Fluensulfone	ND, ND		
	BSA	0.15, 0.13		
	Total	<0.24, <0.21	3.7, 5.9	4.8
Pomace (wet)	Fluensulfone	ND, ND		
	BSA	0.02, 0.07		
	Total	<0.041, <0.12	1.0, 2.1	1.5

ND = not detected

[a] Total = sum of fluensulfone and BSA, expressed as fluensulfone.

Plums

Processing studies reported by Hoi & Jones, 2016 [Ref: R-35573], were conducted in the USA to measure residues of fluensulfone and its metabolites in plum juice, puree and dried plums (prunes) following exaggerated (5×) field treatment on plums.

In two of the US plum field trial sites described above, additional plots were treated with exaggerated rates of 20 kg ai/ha, as single within-row band applications, applied at the early flowering stage, through drip irrigation systems.

Bulk samples of whole plums were shipped at ambient temperature to the analytical facility for processing. Unwashed plums were sorted and placed in 52–57 °C water for 3–5 minutes to loosen extraneous material and then were rinsed with water. A portion of the washed fruit was then placed in frozen storage and a further portion was dried in a dehydrator at 74 °C for 16–24 hours and the stones manually removed before the prune samples were frozen. Plum juice was prepared from a portion of the washed plums by removing the stones and feeding the skin/flesh into a commercial juicer. For processing to plum puree, a portion of the washed plums were manually peeled and the stones removed. Flesh was cut into smaller slices and steamed for 5 minutes before blending into puree.

Samples of plums and processed fractions were stored frozen for up to 10 months before analysis using method MTH-083 to measure residues of fluensulfone and metabolite BSA. Mean concurrent recovery rates for both analytes were 75–99% and the LOQ was 0.01 mg/kg.

Table 23 Residues in plums and processed plum fractions from supervised field trials in the USA, involving single chemigation applications of 20 kg ai/ha fluensulfone (EC formulations)

Matrix	Analyte	Residues, mg/kg	Processing factor [median/best estimate]	
Whole plums (RAC)	Fluensulfone	ND, ND		
	BSA	0.07, 0.11		
	Total [a]	<0.12, <0.18		
Washed plums	Fluensulfone	ND, ND		
	BSA	0.06, 0.14		
	Total	<0.1, <0.22	0.87, 1.3	1.1
Plum juice	Fluensulfone	ND, ND		
	BSA	0.09, 0.12		
	Total	<0.15, <0.19	1.1, 1.3	1.2
Plum puree	Fluensulfone	ND, ND		
	BSA	0.06, 0.1		
	Total	<0.1, <0.16	0.87, 0.91	0.89
Dried plums (prunes)	Fluensulfone	ND, ND		
	BSA	0.19, 0.36		
	Total	<0.3, <0.56	2.6, 3.1	2.9

ND – not detected

[a] Total = sum of fluensulfone and BSA, expressed as fluensulfone.

Grapes

Processing studies reported by Jones, 2016 [Ref: R-31459], were conducted in the USA to measure residues of fluensulfone and its metabolites in grape juice, wet pomace and dried grapes (raisins) following exaggerated (5×) field treatment on grapes.

In two of the US grape field trial sites described above, additional plots were treated with exaggerated rates of 20 kg ai/ha, as single within-row band applications, applied at the early flowering stage, through drip irrigation systems.

Unwashed samples of grape bunches were collected and placed in a cooler prior to shipment to the processing facility where they were destemmed by hand and placed in a dehydrator for about 26 hours at 57 °C to produce raisins (15–18% moisture content). Samples of unwashed bunches were also passed through a crusher/de-stemmer to produce grape mash which was subsequently pressed to separate juice and wet pomace.

All samples were frozen and stored for up to 13 months before analysis for fluensulfone and BSA using Method MTH-083. Mean concurrent recovery rates for both analytes (0.01–0.2 mg/kg) were 77–97% and the LOQ was 0.01 mg/kg.

Table 24 Residues in grapes and processed grape fractions from supervised field trials in the USA, involving single chemigation applications of 20 kg ai/ha fluensulfone (EC formulations)

Matrix	Analyte[a]	Residues, mg/kg	Processing factor [median/best estimate]	
Grape bunches (RAC)	Fluensulfone	ND, ND		
	BSA	0.06, ND		
	Total [a]	<0.1, <0.025		
Grape juice	Fluensulfone	ND, ND		
	BSA	0.05, ND		
	Total	<0.087, <0.025	0.85, none	0.85
Wet pomace	Fluensulfone	ND, ND	--	--

Matrix	Analyte[a]	Residues, mg/kg	Processing factor [median/best estimate]	
	BSA	0.08, ND		
	Total	<0.13, <0.025	1.3, none	1.3
Dried grapes (raisins)	Fluensulfone	ND, <0.01		
	BSA	0.15, <0.01		
	Total	<0.24, <0.025	2.4, none	2.4
Grape stems	Fluensulfone	ND, ND		
	BSA	2.95, 0.02		
	Total	<4.5, <0.041	44, none	44

ND = not detected

[a] Total = sum of fluensulfone and BSA, expressed as fluensulfone. For estimation of maximum residue levels, residues reported as ND have been assumed to be <LOQ

RESIDUES IN ANIMAL COMMODITIES

Based on the results of livestock metabolism studies (laying hens and lactating goats), the 2016 JMPR established a fluensulfone residue definition of 'parent only', for both enforcement and dietary risk assessment in animal commodities. In animals dosed with 10 ppm fluensulfone daily for 5–7 days, parent residues were not observed in any animal commodity except poultry fat (up to 0.041 mg eq/kg) and the only fluensulfone-specific metabolite identified was TSA (only in poultry liver at up to 0.016 mg eq/kg).

Dairy Cattle Feeding Study (BSA, TSA)

In a study reported by Gieseg, 2016 [Ref: R-31484], capsules containing 1:7 mixtures of the fluensulfone metabolites BSA and TSA were administered orally to four groups of lactating Holstein-Friesian cows (3 cows/group) twice daily (after each milking) for 28 consecutive days. Dosing levels were designed to reflect 1×, 3×, 8× and 28× the anticipated livestock dietary burden. Cows were maintained on pasture for the duration of the study, with commercial dairy ration also available during milking. No feed consumption data were collected and body weights ranged from 435–588 kg, remaining relatively constant throughout the study period.

Table 25 Dairy cattle feeding study dose groups

Dose group	TSA (mg/kg bw per day)	BSA (mg/kg bw per day)
Control		–
1×	0.49	0.07
3×	1.47	0.21
8×	4.16	0.57
28×	13.85	1.89

Duplicate milk samples were collected from the morning milking at intervals during the 27-day dosing period and cows were then sacrificed and samples of muscle (loin, flank or hind-leg (round piece); fat (subcutaneous, mesenterial and peri-renal); liver and kidney were stored deep frozen at -18 °C for up to 45 days (up to 79 days for milk samples) before analysis using the LC-MS/MS method reviewed by the 2014 JMPR and validated as Method AATM-R-196, Revision 1 by Geiseg, 2016 [Ref: R-14-0759]. Mean recoveries in muscle, liver, kidney, fat and milk samples fortified with 0.01–0.1 mg/kg TSA ranged from 80–111% and for BSA (0.01–0.1 mg/kg) were 67–106% and the RSDs were <15%. The LOQ was 0.01 mg/kg for both TSA and BSA in all matrices and the limit of detection was between 0.001 and 0.003 mg/kg.

Residues of BSA were not detectable in any milk samples from the 1× and 3× dose groups and were all <0.01 mg/kg in milk samples from the higher (8×, 28×) dose groups. In tissues, BSA

residues were either not detectable or were <0.01 mg/kg in samples from all dose groups except in fat (max. 0.017 mg/kg in the 28× dose group), and in kidney samples from the 8× dose group (max. 0.021 mg/kg) and from the 28× dose group (max 0.14 mg/kg). Residue depuration was complete within 48 hours (all tissues).

Mean residues of TSA in milk over the 27-day dosing period increased from 0.011 mg/kg in the 1× dose group samples to 0.27 mg/kg in the 28× dose group samples, reaching a plateau within 2 days and declining to < 0.01 mg/kg at the end of a 48 hour depuration period. In tissues, TSA residues were either not detectable or were < 0.01 mg/kg in muscle, liver and fat samples from the 1× and 3× dose groups, with higher levels found in samples of muscle (max. 0.017 mg/kg), liver (max. 0.042 mg/kg) and fat (max. 0.18 mg/kg) from the 28× dose group. Highest residues were reported in kidney, with mean residues ranging from 0.034 mg/kg (1× dose group) to 1.1 mg/kg (28× dose group). Depuration of TSA from tissues was complete (i.e. all residues below the LOQ) within 48 hours of the final dose.

The highest residues of TSA and BSA were found in kidney. Considering the hydrophilic nature of the metabolites, that the predominant route of excretion is via urine, and that depuration was shown to be almost complete at the 48 hour time point, these residues are likely to result from urine remaining in the kidneys at sacrifice.

Table 26 Residues of BSA in milk from cows dosed with 1:7 mixtures of BSA:TSA in a 28-day feeding study

Dose Group	1× Dose Group		3× Dose Group		8× Dose Group		28× Dose Group	
Sampling time	BSA Residues (mg/kg)		BSA Residues (mg/kg)		BSA Residues (mg/kg)		BSA Residues (mg/kg)	
	Values	Mean	Values	Mean	Values	Mean	Values	Mean
Day 0 AM	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND, ND	ND
Day 2 AM					ND		ND, ND, ND	ND
Day 5 AM					ND		ND, ND, ND	ND
Day 7 AM	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, <0.01	<0.01	ND, ND, ND, <0.01	<0.01
Day 10 AM					ND		ND, ND, ND	ND
Day 14 AM	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND, <0.01	<0.01
Day 21 AM	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND, <0.01	<0.01
Day 28 AM	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND, <0.01	<0.01
Day 30 AM (depuration)							ND, ND	ND

ND = not detected

Table 27 Residues of BSA in lactating cow tissues from cows dosed with 1:7 mixtures of BSA:TSA in a 28 day feeding study

Dose Group	1× Dose Group		3× Dose Group		8× Dose Group		28× Dose Group	
	BSA Residues (mg/kg)		BSA Residues (mg/kg)		BSA Residues (mg/kg)		BSA Residues (mg/kg)	
Tissue	Values	Mean	Values	Mean	Values	Mean	Values	Mean
Muscle	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, <0.01	<0.01	ND, ND, ND, ND	ND
Liver	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND, <0.01	<0.01
Kidney	ND, ND, ND	ND	ND, <0.01, <0.01	<0.01	0.021, 0.013, 0.013	0.016	0.14, 0.09, 0.042, 0.023	0.074
Fat	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND	ND	ND, 0.017, 0.017, <0.01	0.015

ND = not detected

Table 28 Residues of TSA in milk from cows dosed with 1:7 mixtures of BSA:TSA in a 28-day feeding study

Dose Group	1× Dose Group		3× Dose Group		8× Dose Group		28× Dose Group	
Sampling time	TSA Residues (mg/kg)		TSA Residues (mg/kg)		TSA Residues (mg/kg)		TSA Residues (mg/kg)	
	Values	Mean	Values	Mean	Values	Mean	Values	Mean
Day 0 AM	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, ND	ND	<0.01, <0.01, <0.01	ND
Day 2 AM					0.092		0.25, 0.32, 0.23	0.27
Day 5 AM					0.093		0.28, 0.33, 0.28	0.3
Day 7 AM	<0.01, 0.01, 0.012	0.011	0.023, 0.028, 0.031	0.027	0.097, 0.059, 0.076	0.077	0.23, 0.32, 0.25, 0.24	0.26
Day 10 AM					0.08		0.23, 0.31, 0.25	0.26
Day 14 AM	<0.01, 0.01, 0.012	0.011	0.032, 0.024, 0.023	0.026	0.088, 0.048, 0.093	0.076	0.31, 0.42, 0.19, 0.17	0.27
Day 21 AM	<0.01, 0.01, 0.011	0.011	0.027, 0.023, 0.022	0.024	0.09, 0.049, 0.076	0.072	0.23, 0.27, 0.2, 0.25	0.24
Day 28 AM	<0.01, 0.011, 0.011	0.011	0.029, 0.028, 0.027	0.028	0.085, 0.061, 0.1	0.082	0.29, 0.3, 0.43, 0.15	0.29
Day 30 AM (depuration)							ND, ND <0.01	<0.01

ND = not detected

Table 29 Residues of TSA in lactating cow tissues from cows dosed with 1:7 mixtures of BSA:TSA in a 28-day feeding study

Dose Group	1× Dose Group		3× Dose Group		8× Dose Group		28× Dose Group	
	TSA Residues (mg/kg)		TSA Residues (mg/kg)		TSA Residues (mg/kg)		TSA Residues (mg/kg)	
Tissue	Values	Mean	Values	Mean	Values	Mean	Values	Mean
Muscle	ND, ND, ND	ND	ND, ND, ND	ND	ND, ND, <0.01	<0.01	0.017, 0.011, <0.01, <0.01	0.012
Liver	ND, ND, ND	ND	ND, ND, ND	ND	<0.01, <0.01, 0.024	0.015	0.019, 0.045, 0.068, 0.037	0.042
Kidney	0.029, 0.033, 0.039	0.034	0.061, 0.075, 0.083	0.073	0.47, 0.19, 0.19	0.28	1.1, 1.3, 1.6, 0.53	1.1
Fat	ND, ND, <0.01	<0.01	ND, ND, <0.01	<0.01	0.046, 0.017, 0.02	0.028	0.072, 0.25, 0.3, 0.1	0.18

ND = not detected

APPRAISAL

Fluensulfone is a heterocyclic fluoroalkenyl sulfone nematicide. The mode of action is through feeding inhibition and paralysis of adults and juveniles. The IUPAC name for fluensulfone is 5-chloro-1,3-thiazol-2-yl 3,4,4-trifluorobut-3-en-1-yl sulfone.

Fluensulfone was evaluated for toxicology by JMPR in 2013 and 2014.

An ADI of 0–0.01 mg/kg bw and an ARfD of 0.3 mg/kg bw were established by the 2014 JMPR. Residues were evaluated by the JMPR in 2014 and 2016. The 2016 JMPR established the following residue definitions:

For compliance with MRLs for plant commodities: Sum of fluensulfone and 3,4,4-trifluorobut-3-ene-1-sulfonic acid (BSA), expressed as fluensulfone equivalents.

- For estimation of dietary exposure for plant commodities: Fluensulfone.
- For compliance with MRLs and for estimation of dietary exposure for animal commodities: Fluensulfone.

The residue is fat-soluble.

The 2014 JMPR agreed that the exposure risks from the metabolite MeS should be assessed using the Threshold of Toxicological Concern (TTC) approach and the 2016 JMPR confirmed that the TTC approach for this metabolite remained appropriate.

Fluensulfone was scheduled at the Fiftieth Session of the CCPR for evaluation of additional uses by the 2019 JMPR. The Meeting received new supporting data and/or GAP information for citrus, pome fruit, stone fruit, grapes, guava, tree nuts, coffee, sugar cane and black pepper, additional rotational crop studies, frozen storage stability studies, processing studies and a livestock feeding study for the BSA/TSA metabolites.

Methods of analysis

The Meeting received additional validation information on the analytical methods (based on Method MTH-083) evaluated by the 2014 JMPR and used for measuring fluensulfone and metabolite BSA residues in the commodities considered by the current Meeting.

The Meeting concluded that for the commodities considered by the Meeting, the methods used in the new residue trials were sufficiently validated and are suitable to measure fluensulfone and metabolite BSA in plant commodities.

Stability of pesticide residues in stored analytical samples

The Meeting received additional information on storage stability of fluensulfone and metabolite BSA in orange, tomato, soya bean, dry beans, cereal grains and sugar cane (raw and processed).

Storage stability studies evaluated by the current and previous Meetings showed that in analytical samples stored at or below -18 °C, fluensulfone and metabolite BSA residues were stable for at least the following intervals:

High water matrices-Fruiting vegetables for 15–16 months, sugar cane for 6 months;

High acid matrices-orange for 18 months

High starch matrices-cereal grains for 10 months; Potato for 23 months; carrot for 17.5 months

High protein matrices-dry beans for 10 months

High oil matrices-peanut for 13 months

Low moisture matrices-cereal straws for 10 months

The Meeting agreed that the demonstrated storage stability in these representative plant commodities covered the residue sample storage intervals used in the field trials considered by the current Meeting.

Residues in rotational crops

Field rotational crop studies

The 2014 JMPR evaluated confined rotational crop studies (radish, lettuce and wheat as follow crops) and concluded that overall, fluensulfone can be expected to dissipate rather rapidly in the environment, with a concomitant increase in residues of BSA, TSA, and to a much lesser extent, MeS. BSA residues should then decline but TSA appears to be stable for an extended period; may accumulate in soils following repeated uses of fluensulfone.

The 2016 JMPR evaluated a field rotational cropping study involving a single bare soil application of fluensulfone (4.0 kg ai/ha) and to accommodate residues arising in rotational crops, recommended maximum residue levels for root and tuber vegetables, leafy vegetables and legume vegetables not elsewhere specified.

The current Meeting received a new field crop rotation study involving 56 field trials where rotational cereal crops were planted after a bare soil application of fluensulfone at rates of 3.6–4.2 kg ai/ha (approximating the GAP seasonal rate). The plant-back intervals were 3 months (winter wheat) and 10 months (maize, rice, sorghum and spring wheat).

Samples of forage, grain, hay and straw were stored frozen (<-10 °C) for up to 19 months before LC-MS/MS analysis (Method MTH-083) for fluensulfone and metabolite BSA. Mean procedural recoveries ranged from 72–111% and the LOQs for both analytes were 0.01 mg/kg.

Fluensulfone residues were only detected in the 3-month PBI winter wheat hay (0.02 mg/kg), but BSA residues were present up to 0.07 mg/kg in grain, 2.4 mg/kg in forage, 4.0 mg/kg in hay and up to 2.4 mg/kg in straws and stovers. Highest total residues (fluensulfone plus BSA, expressed as fluensulfone) were 0.12 mg/kg (maize grain), 3.7 mg/kg (forages) and 6.2 mg/kg (hays and straws).

The US fluensulfone label includes a requirement to observe a plant-back interval of 90 days for wheat, barley, buckwheat and oats, and 10 month plant-back interval for all other cereal grain crops.

Cereal forages

In 11 trials where wheat was grown as a rotational crop and in 20 trials where maize was grown as a rotational crop, residues of fluensulfone in forage were all < 0.01 mg/kg (n = 35).

For the purposes of estimating the livestock dietary burden, the Meeting agreed to extrapolate these data to cereal forages in general and established a median and highest residue of 0.01 mg/kg for fluensulfone in cereals forages (as received).

Cereal grains

In 15 trials where wheat was grown as a rotational crop, residues of fluensulfone in grain were all < 0.01 mg/kg (n = 15) and total residues were < 0.025 (10), 0.03 (2), 0.04 (2) and 0.07 mg/kg.

Extrapolating these data to the wheat subgroup, the Meeting estimated a maximum residue level of 0.08 mg/kg for fluensulfone (total residues) and a STMR of 0.01 mg/kg for fluensulfone (parent only) in the subgroup of wheat, similar grains, and pseudocereals without husks.

Noting that the US plant-back interval for barley and oats was the same as for wheat, the Meeting also agreed to extrapolate the wheat data to the barley sub-group and estimated a maximum residue level of 0.08 mg/kg for fluensulfone (total residues) and a STMR of 0.01 mg/kg for fluensulfone (parent only) in the subgroup of barley, similar grains, and pseudocereals with husks.

In 18 trials where maize was grown as a rotational crop, residues of fluensulfone in grain were all < 0.01 mg/kg (n = 18) and total residues were < 0.025 (17) and 0.12 mg/kg.

Extrapolating these data to the maize and sweetcorn subgroups, the Meeting estimated a maximum residue level of 0.15 mg/kg for fluensulfone (total residues), a STMR of 0.01 mg/kg for fluensulfone (parent only) in the subgroups of maize cereals and sweetcorns and a HR of 0.01 mg/kg for sweet corn (corn-on-the-cob) and baby corn.

In 11 trials where rice was grown as a rotational crop, residues of fluensulfone in grain were all < 0.01 mg/kg (n = 11) and total residues were < 0.025 (10) and 0.03 mg/kg.

Extrapolating these data to the rice subgroup, the Meeting estimated a maximum residue level of 0.04 mg/kg for fluensulfone (total residues) and a STMR of 0.01 mg/kg for fluensulfone (parent only) in the subgroup of rice cereals.

In nine trials where sorghum grain was grown as a rotational crop, residues of fluensulfone in grain were all < 0.01 mg/kg (n = 9) and total residues were < 0.025 (8) and 0.03 mg/kg.

Extrapolating these data to the sorghum grain subgroup, the Meeting estimated a maximum residue level of 0.04 mg/kg for fluensulfone (total residues) and a STMR of 0.01 mg/kg for fluensulfone (parent only) in the subgroup of sorghum grain and millet.

Cereal fodders

In 15 trials where wheat was grown as a rotational crop, residues of fluensulfone in hay were < 0.01 (14) and 0.02 mg/kg (n = 15) and total residues were < 0.025, 0.04, 0.07, 0.09, 0.19, 0.25, 0.30, 0.39, 0.41, 0.65, 3.1, 3.3, 4.0, 5.5 and 6.2 mg/kg (n = 15).

Noting that the US plant-back interval for barley and oats was the same as for wheat, the Meeting agreed to use the wheat data, after correction for an average 88% dry matter content, to estimate a maximum residue level of 15 mg/kg (dw) for fluensulfone (total residues), a median residue of 0.01 mg/kg (as received) and a highest residue of 0.02 mg/kg for fluensulfone (parent only) in hay or fodder (dry) of grasses except maize fodder and rice straw and fodder, dry.

In 15 trials where wheat was grown as a rotational crop, residues of fluensulfone in straw were < 0.01 (15) mg/kg (n = 15) and total residues were 0.03, 0.04 (3), 0.09 (2), 0.16 (2), 0.18, 0.42, 0.64, 1.4, 2.1, 2.3 and 3.7 mg/kg (n = 15).

Noting that the US plant-back interval for barley and oats was the same as for wheat, the Meeting agreed to use the wheat data, after correction for an average 88% dry matter content, to estimate a maximum residue level of 6 mg/kg (dw) for fluensulfone (total residues), a median residue of 0.01 mg/kg (as received) and a highest residue of 0.01 mg/kg for fluensulfone (parent only) in straw or fodder (dry) of cereal grains except maize fodder and rice straw and fodder, dry.

In 20 trials where maize was grown as a rotational crop, residues of fluensulfone in stover were < 0.01 (20) mg/kg (n = 20) and total residues were < 0.025 (11), 0.03, 0.04 (4), 0.09, 0.12, 0.36 and 0.39 mg/kg (n = 20).

After correction for an average 83% dry matter content, the Meeting estimated a maximum residue level of 0.6 mg/kg for fluensulfone (total residues) and a median residue of 0.01 mg/kg (as received) and a highest residue of 0.01 mg/kg (as received) for fluensulfone (parent only) in maize fodder.

In 11 trials where rice was grown as a rotational crop, residues of fluensulfone in straw were < 0.01 (11) mg/kg (n = 11) and total residues were < 0.025 (9), 0.04 and 0.04 mg/kg (n = 11).

After correction for an average 90% dry matter content, the Meeting estimated a maximum residue level of 0.06 mg/kg (dw) for fluensulfone (total residues) and a median residue of 0.01 mg/kg (as received) and a highest residue of 0.01 mg/kg (as received) for fluensulfone (parent only) in rice straw and fodder, dry.

Results of supervised residue trials on crops

Supervised trials were available for the use of fluensulfone on citrus fruit, pome fruit, stone fruit, grapes, guava, sugar cane, tree nuts, coffee and black pepper.

Product labels were available from Australia, Brazil and the USA.

When calculating total fluensulfone residues (defined as the sum of fluensulfone and the BSA metabolite, expressed as fluensulfone), the concentration of BSA in each sample was multiplied by 1.53 (the ratio of the molecular weights of fluensulfone and BSA) and the resulting product added to the concentration of fluensulfone. Residues reported as <LOQ were assumed to bear residues at the LOQ.

Citrus fruit

The critical GAP for fluensulfone on citrus in the USA is for a pre-flowering soil application of 3.92 kg ai/treated ha (broadcast, banded or by chemigation) with a PHI of 60 days.

In independent trials on citrus, conducted in the USA and matching this GAP:-

Fluensulfone residues in oranges (eight trials) were: < 0.01 (7) and 0.014 mg/kg Total residues were: < 0.025 (2), 0.027 (2), 0.030, 0.040, 0.042 and 0.046 mg/kg (n = 8).

Fluensulfone residues in mandarins (three trials) were: < 0.01 (3) mg/kg Total residues were: 0.032, 0.058 and 0.072 mg/kg (n = 3).

Fluensulfone residues in lemons (five trials) were: < 0.01 (4) and 0.049 mg/kg Total residues were: < 0.025 (3), 0.087 and 0.13 mg/kg (n = 5).

Fluensulfone residues in grapefruit (six trials) were: < 0.01 (5) and 0.014 mg/kg Total residues were: < 0.025 (4), 0.026 and 0.077 mg/kg (n = 6).

Noting that the residues arising from an early season soil application to oranges, lemons, mandarins and grapefruit trees were not statistically different (Kruskall-Wallis), the Meeting agreed to estimate a group maximum residue level based on a combined total residue data set of < 0.025 (9), 0.026, 0.027 (2), 0.03, 0.032, 0.04, 0.042, 0.046, 0.058, 0.072, 0.077, 0.087 and 0.13 mg/kg (n = 22).

For dietary intake estimation, the combined fluensulfone data set for whole fruit is: ≤ 0.01 (19), 0.014 (2) and 0.049 mg/kg and the highest individual residue was 0.063 mg/kg (in lemons).

The Meeting estimated a maximum residue level of 0.2 mg/kg for fluensulfone (total residues) and a STMR of 0.01 mg/kg and a HR of 0.063 mg/kg for fluensulfone in citrus fruit.

Pome fruit

The critical GAP for fluensulfone on pome fruit (except persimmons) is in the USA, for a pre-flowering soil application of 3.92 kg ai/treated ha (broadcast, banded or by chemigation).

In independent trials on pome fruit, conducted in Canada and the USA and matching this GAP, fluensulfone residues in apples (16 trials) and pears (eight trials) were all < 0.01 mg/kg. Fluensulfone residues were also < 0.01 mg/kg in two exaggerated-rate (5×) trials on apples.

In these trials, total residues were:

Apples: < 0.025 (10), 0.028 (3), 0.031, 0.037 and 0.16 mg/kg (n = 16) Pears: < 0.025 (5), 0.026, 0.11 and 0.17 mg/kg (n = 8).

Noting that the residues arising from an early season soil application to apple and pear trees were not statistically different (Kruskall-Wallis), the Meeting agreed to estimate a group maximum residue level based on a combined total residue data set of < 0.025 (15), 0.026, 0.028 (3), 0.031, 0.037, 0.11, 0.16 and 0.17 mg/kg (n = 24).

The Meeting estimated a maximum residue level of 0.2 mg/kg for fluensulfone (total residues) and a STMR of 0 mg/kg and a HR of 0 mg/kg for fluensulfone in pome fruit (except persimmon, Japanese).

Stone fruit

The critical GAP for fluensulfone on stone fruit is in the USA, for a pre-flowering soil application of 3.92 kg ai/treated ha (broadcast, banded or by chemigation).

In independent trials on stone fruit, conducted in the USA and matching this GAP, fluensulfone residues in the flesh of cherries (five trials) and peaches (nine trials), plums (five trials) were all < 0.01 mg/kg (n = 19). Fluensulfone residues were also < 0.01 mg/kg in two exaggerated-rate (5×) trials on plums.

While residues were not measured in whole fruit, the 2017 Meeting concluded that in general, the contribution of the pit to the weight of the whole fruit is approximately 10% and that the flesh residues could be used to estimate maximum residue levels for stone fruit.

In these trials, total residues in flesh were:

Cherries: < 0.025 (2), 0.028, 0.031 and 0.050 mg/kg (n = 5)

Peaches: < 0.025 (6), 0.035, 0.046 and 0.075 mg/kg (n = 9)

Plums: < 0.025 (3), 0.026 and 0.028 mg/kg (n = 5).

Noting that the residues arising from an early season soil application to cherry, peach and plum trees were not statistically different (Kruskall-Wallis), the Meeting agreed to estimate a group maximum residue level based on a combined total residue data set of < 0.025 (11), 0.026, 0.028, 0.028, 0.031, 0.035, 0.046, 0.050 and 0.075 mg/kg (n = 19).

The Meeting estimated a maximum residue level of 0.09 mg/kg for fluensulfone (total residues) and a STMR of 0 mg/kg and a HR of 0 mg/kg for fluensulfone (parent only) in stone fruit.

Small fruit vine climbing

Grapes

The critical GAP for fluensulfone on small fruit vine climbing crops is in the USA, for a pre-flowering soil application of 3.92 kg ai/treated ha (broadcast, banded or by chemigation).

In independent trials on grapes, conducted in the USA and matching this GAP, fluensulfone residues in berries were all < 0.01 mg/kg (n = 9). Fluensulfone residues were also < 0.01 mg/kg in two exaggerated-rate (5×) trials on grapes.

In these trials, total residues were: < 0.025 (6), 0.027, 0.050 and 0.48 mg/kg (n = 9).

Noting that grapes is a representative commodity for the small fruit vine climbing sub-group, and that the US GAP includes all commodities in this sub-group, the Meeting estimated a maximum residue level of 0.7 mg/kg for fluensulfone (total residues) and a STMR of 0 mg/kg and a HR of 0 mg/kg for fluensulfone (parent only) in the small fruit vine climbing sub-group.

Guava

The critical GAP for fluensulfone on guava is in Brazil, for a banded within-row soil treatment of 0.96 kg ai/ha, at the beginning of the rainy season, when trees are growing new roots. No PHI is specified.

In four Brazilian trials where single banded soil applications of 0.96 kg ai/ha were applied during mid-late March (about the end of flowering), fluensulfone residues in fruit sampled at intervals from 60–90 DAT were all < 0.08 mg/kg and total residues were all < 0.2 mg/kg (n = 4).

The Meeting concluded that since the validated LOQ of 0.08 mg/kg was higher than the level that can be achieved using current analytical techniques (0.01 mg/kg), maximum residue levels for guava could not be recommended.

Sugar cane

The critical GAP for fluensulfone on sugar cane is in the USA, for a soil broadcast or band application of 3.92 kg ai/treated ha at planting.

In independent trials on sugar cane, conducted in Australia (four trials) and the USA (seven trials) and matching this GAP, fluensulfone residues in the canes/billets were all < 0.01 mg/kg.

In these trials, total residues were: < 0.025 (9), 0.027 and 0.045 mg/kg (n = 11).

The Meeting estimated a maximum residue level of 0.06 mg/kg for fluensulfone (total residues) and a STMR of 0.01 mg/kg and a HR of 0.01 mg/kg for fluensulfone (parent only) in sugar cane.

Tree nuts

The critical GAP for fluensulfone on tree nuts is in the USA, for a pre-flowering soil application of 3.92 kg ai/treated ha (broadcast, banded or by chemigation).

Almonds

In five independent trials on almonds conducted in Canada and the USA and matching this GAP, fluensulfone residues in nutmeat were all < 0.01 mg/kg (n = 5).

In these trials, total residues in nutmeat were: < 0.025 (5) mg/kg (n = 5).

Pecans

In five independent trials on pecans conducted in Canada and the USA and matching this GAP, fluensulfone residues in nutmeat were all < 0.01 mg/kg (n = 5).

In these trials, total residues in nutmeat were all < 0.025 mg/kg (n = 5).

Noting that the residues arising from an early season soil application to almond and pecan trees were relatively consistent the Meeting agreed to estimate a group maximum residue level.

The Meeting estimated a maximum residue level of 0.025 (*) mg/kg for fluensulfone (total residues) and a STMR of 0.01 mg/kg and a HR of 0.01 mg/kg for fluensulfone (parent only) in tree nuts.

Coffee beans

The critical GAP for fluensulfone on coffee is in Brazil, for a banded within-row soil treatment of 0.96 kg ai/ha, at the beginning of the rainy season, when bushes are growing new roots. No PHI is specified.

In eight Brazilian trials where single banded soil applications of 0.96 kg ai/ha were applied mid-late February (over flowering and up to early fruit formation), fluensulfone residues in fruit sampled at intervals from 150–210 DAT were all < 0.08 mg/kg and total residues were all < 0.2 mg/kg (n = 8).

In a further set of Brazilian trials conducted in 2017, where single banded soil applications of 0.96 kg ai/ha (eight trials) were applied early-mid February (early fruit formation), fluensulfone residues in fruit sampled at intervals from 150–210 DAT were: < 0.01 (7) and 0.01 mg/kg. Fluensulfone residues were also < 0.01 mg/kg in three exaggerated-rate (5×) trials on coffee. Total residues in the eight (1× rate) trials were: < 0.025 (5), 0.025 (2) and 0.041 mg/kg (n = 8).

Based on the results of the 2017 trials, the Meeting estimated a maximum residue level of 0.05 mg/kg for fluensulfone (total residues) and a STMR of 0 mg/kg for fluensulfone (parent only) in coffee bean.

Pepper, black

The critical GAP for fluensulfone on black pepper is in Brazil, with a banded within-row soil treatment of 0.96 kg ai/ha, at the beginning of the rainy season, when vines are growing new roots. No PHI is specified.

In four Brazilian trials where single banded soil applications of 0.96 kg ai/ha were applied during early fruit formation (mid-July), fluensulfone residues in fruit sampled at intervals from 55–70 DAT were all < 0.08 mg/kg and total residues were all < 0.2 mg/kg (n = 4).

The Meeting agreed that the number of trials was not sufficient to recommend a maximum residue level for fluensulfone in pepper, black, white, pink, green.

Residues in animal feeds

Almond hulls

In five independent trials on almonds conducted in Canada and the USA and matching the US GAP, fluensulfone residues in almond hulls were all < 0.01 mg/kg (n = 5) and total residues were: 0.78, 1.8, 2.3, 2.4 and 3.0 mg/kg.

The Meeting estimated a maximum residue level of 7 mg/kg (dw) for fluensulfone (total residues) and a median residue of 0.01 mg/kg (as received) for fluensulfone (parent only) in almond hulls.

Fate of residues during processing

The Meeting received new information on the fate of fluensulfone residues during processing in apples, plums and grapes. Processing studies on citrus and sugar cane were evaluated by the 2017 JMPR.

For dietary risk assessment, in the citrus processing studies, fluensulfone residues were present in orange oil, but not detected in whole fruit. Processing factors could therefore not be calculated. However, since residues concentrated in oil, the Meeting agreed to use proportionality to estimate dietary exposure to fluensulfone in citrus oils.

In the processing studies involving an application rate of 8.1 kg ai/ha, the highest fluensulfone residue in orange oil was 0.7 mg/kg. When scaled to the GAP application rate (3.92 kg ai/ha), the Meeting estimated a STMR-P of 0.34 mg/kg for fluensulfone in citrus oil.

For estimating maximum residue levels, processing factors for total residues (sum of fluensulfone + BSA, expressed as fluensulfone) in the commodities considered at this Meeting are summarized below.

Table 1 Fluensulfone (total residue) processing factors for maximum residue level estimation

Raw commodity [MRL]	Processed commodity	Individual processing factors	Mean or best estimate processing factor	RAC MRL × PF (mg/kg)	MRL (mg/kg)
Orange fruit [0.2 mg/kg]	Pulp (dry)	5.1, 6.3	5.7	1.1	1.5
	Oil	12, 0.72	6.3	1.3	1.5
Apple [0.2 mg/kg]	Juice (raw)	1.4, 2.1	1.7	0.35	0.4
	Sauce	1.0, 1.0	1.0	0.2	Not required
	Dried	3.7, 5.9	4.8	1	1
Plum [0.09 mg/kg]	Dried (prunes)	2.6, 3.1	2.9	0.26	0.3
	Juice	1.1, 1.3	1.2	0.11	Not required
Grape [0.7 mg/kg]	Dried (raisins)	2.4	2.4	1.7	2
Sugar cane [0.06 mg/kg]	Molasses	7.4	7.4	0.5	0.5

Using the estimated maximum residue levels for the raw commodities and applying the calculated mean processing factors, the Meeting estimated maximum residue levels of 1.5 mg/kg for citrus oil (extrapolated from orange oil) and citrus pulp, dry; 0.4 mg/kg for apple juice; 1.0 mg/kg for apples, dried; 0.3 mg/kg for prunes, 2 mg/kg for dried grapes and 0.5 mg/kg for sugar cane molasses.

For livestock dietary burden calculation, no processing factor could be calculated for citrus pulp, dry, since there were no measurable residues of fluensulfone in the whole fruit in the processing studies. However, by scaling the fluensulfone residues (0.02 mg/kg) in citrus pulp, dry from fruit treated with 8.1 kg ai/ha to the GAP application rate of 3.92 kg ai/ha, the Meeting estimated an median residue of 0.01 mg/kg for citrus pulp, dry.

Farm animal dietary burden

The highest maximum dietary burdens in beef cattle and dairy cattle calculated by the 2016 JMPR, based on the commodities considered by that Meeting, were 2.1 and 1.0 ppm respectively (about 5× less than the 10 ppm dose used in the goat metabolism study).

The Meeting estimated that the additional feed commodities considered by the current Meeting (cereal grains and forages, citrus dried pulp, almond hulls and hays of cereals except maize and rice) would not contribute more than 0.04 ppm to these maximum and mean dietary burdens, and agreed there was no need to revise the previous maximum residue level recommendations for mammalian commodities.

For poultry, the highest maximum dietary burden for broiler and layer poultry estimated by the 2016 JMPR was 0.51 ppm. The additional dietary burden from fluensulfone residues in the new feed commodities (cereal grains and forages) is not more than 0.015 ppm. The Meeting agreed that a revision of the previously estimated maximum residue level recommendations for poultry commodities was unnecessary.

RECOMMENDATIONS

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

Definition of the residue for compliance with the MRL (plant commodities): the sum of fluensulfone and 3,4,4-trifluorobut-3-ene-1-sulfonic acid (BSA), expressed as fluensulfone equivalents.

Definition of the residue for compliance with the MRL (animal commodities): *fluensulfone*

Definition of the residue for dietary risk assessment (plant and animal commodities): *fluensulfone*

The residue is fat-soluble.

Table 2 Residue levels suitable for establishing maximum residue limits and for IEDI and IESTI assessments for fluensulfone

CCN	Commodity	Recommended maximum residue level (mg/kg)		STMR or STMR-P mg/kg	HR or HR-P mg/kg
		New	Previous		
FC 0001	Citrus fruit	0.2		0.01	0.063
FP 0009	Pome fruit (except Persimmon, Japanese)	0.2		0	0
FS 0012	Stone fruit	0.09		0	0
FB 2008	Small fruit vine climbing, subgroup of	0.7		0	0
GS 0659	Sugar cane	0.06		0.01	0.01
TN 0085	Tree nuts	0.025 (*)		0.01	0.01
SB 0716	Coffee bean	0.05		0	
GC 2086	Wheat, similar grains, and pseudocereals without husks	0.08		0.01	
GC 2087	Barley, similar grains, and pseudocereals with husks	0.08		0.01	

CCN	Commodity	Recommended maximum residue level (mg/kg)		STMR or STMR-P mg/kg	HR or HR-P mg/kg
		New	Previous		
GC 2091	Maize cereals	0.15		0.01	
GC 2090	Sweet corns	0.15		0.01	0.01 (corn-on-the-cob, baby corn)
GC 2088	Rice cereals	0.04		0.01	
GC 2089	Sorghum grain and millet	0.04		0.01	
AS 0162	Hay or fodder (dry) of grasses except maize fodder and rice straw and fodder, dry	15 dw		0.01 ar [median]	0.02 ar [highest]
AS 0645	Maize fodder	0.6 dw		0.01 ar [median]	0.01 ar [highest]
AS 0649	Rice straw and fodder, dry	0.06 dw		0.01 ar [median]	0.01 ar [highest]
AS 0081	Straw or fodder (dry) of cereal grains except maize fodder and rice straw and fodder, dry	6 dw		0.01 ar [median]	0.01 ar [highest]
AM 0660	Almond hulls	7 dw		0.01 ar [median]	
AB 0001	Citrus pulp, dry	1.5		0.01 [median]	
OR 0001	Citrus oil, edible	1.5		0.34	
JF 0226	Apple juice	0.4		0	
DF 0226	Apples, dried	1		0	0
DF 0014	Prunes	0.3		0	0
DF 5259	Dried grapes	2		0	0
DM 659	Sugar cane molasses	0.5		0	0
	Cereal forages			0.01 (ar) [median]	0.01 (ar) [highest]

(ar) – as received; (dw) – dry weight

DIETARY RISK ASSESSMENT

Long-term dietary exposure

The ADI for Fluensulfone is 0–0.01 mg/kg bw. The International Estimated Daily Intakes (IEDIs) for fluensulfone were estimated for the 17 GEMS/Food Consumption Cluster Diets using the STMR or STMR-P values estimated by the JMPR. The results are shown in Annex 3 of the 2019 JMPR Report.

The IEDIs ranged from 1–3% of the maximum ADI. The Meeting concluded that long-term dietary exposure to residues of fluensulfone from uses considered by the JMPR is unlikely to present a public health concern.

Acute dietary exposure

The ARfD for fluensulfone is 0.3 mg/kg bw. The International Estimate of Short Term Intakes (IESTIs) for fluensulfone were calculated for the food commodities and their processed commodities for which HRs/HR-Ps or STMRs/STMR-Ps were estimated by the present Meeting and for which consumption data were available. The results are shown in Annex 4 of the 2019 JMPR Report.

The IESTIs varied from 0–1% of the ARfD for children and 0–1% of the ARfD for the general population. The Meeting concluded that acute dietary exposure to residues of fluensulfone from uses considered by the present Meeting is unlikely to present a public health concern.

Threshold of toxicological concern (TTC) consideration for metabolites

MeS (2-Methylsulfonylthiazole)

The 2016 JMPR applied the TTC approach to assess the metabolite MeS. Based on the uses considered by the 2014 and 2016 Meetings, the estimated dietary exposure of 0.07 µg/kg bw per day was below the TTC for Cramer Class III compounds of 1.5 µg/kg bw per day. The 2016 Meeting concluded that dietary exposure to MeS was unlikely to present a public health concern for the crops considered by that Meeting.

For the food commodities considered at the current Meeting (citrus fruit, pome fruit, small fruit vine climbing, sugar cane, tree nuts, coffee and cereal grains), residues of MeS were not measured in the field trials. However, MeS is predominantly a minor soil degradate (with a half-life of about 30 days) and was not found in the plant metabolism studies (tomato, lettuce, potato), nor in the rotational crop metabolism studies. In field trials where MeS residues were measured, residues above the LOQ were only found in peppers, cucumber and summer squash. For permanent crops, the Meeting considered that any uptake of MeS from soil would be insignificant. Based on the rotational crop metabolism studies (including wheat as a rotational crop), where MeS was not found, significant residues of MeS are not expected in sugar cane and cereal grains.

The Meeting recalculated its estimation of dietary exposure to residues of MeS resulting in a revised exposure estimate of 0.077 µg/kg bw per day, below the TTC for Cramer Class III compounds of 1.5 µg/kg bw per day. The Meeting concluded that dietary exposure to MeS in the commodities considered by the JMPR is unlikely to present a public health concern. Should further uses be considered in the future, these conclusions may need to be re-evaluated.

REFERENCES

Reference	Author(s)	Year	Title
00207511 B	do Valle Borges de Siqueira, V.L	2013	Determination of Fluensulfone and its Metabolites in Sugar Cane Stalks, after MIL FI 0437/09 Application. Plantec Laboratories' Report No. 00207511 B. ADAMA Ref: LRN02607CN_2013i. GLP; Unpublished. 12 Mar 2013
ASA-13-254	Keats, A.	2016	To determine fluensulfone residues in sugarcane following one application of MCW2 480 EC. Report No. ASA-13-254. ADAMA Ref: R-37404. 11 Nov 2016
LRN02611CT_2013i	do Valle Borges de Siqueira, V.L	2013	Determination of Fluensulfone and its metabolites in citrus fruits, after application of MIL FI 0437/09, . Plantec Laboratories. Report No. 002 041 11 B. ADAMA Ref: LRN02611CT_2013i. GLP; Unpublished. 16 Dec 2013
LRN02612CF_2013i	Orlandini de Palma, T.	2013	Determination of Fluensulfone and its Metabolites in Coffee Grain, after Application of MIL FI 0437/09. Plantec Laboratories. Report No. 002 040 11 B. ADAMA Ref: LRN02612CF_2013i. GLP; Unpublished. 16 Dec 2013
LRN02616PR_2013i	do Valle Borges de Siqueira, V.L	2013	Determination of Fluensulfone and its Metabolites in Black Peppercorn after Application of MIL FI 0437/09. Plantec Laboratories. Report No. RA 002 079 13 B. ADAMA Ref: LRN02616PR_2013i. GLP; Unpublished. 17 Dec 2013
R-14-0759	Gieseg, M.	2016	Determination of Fluensulfone Metabolite Residues (TSA and BSA) in Edible Commodities (Tissue and Milk) of Lactating Dairy Cattle following twice Daily Oral Administration over 28 consecutive days-Development and Validation of a Method of Analysis for the Determination of Fluensulfone Metabolites TSA and BSA Residues in Bovine Tissues and Milk. Study No ADFB3074. Eurofins Agroscience Testing Pty Ltd.
R-31415	Jones, G L	2016	Magnitude of Residues of MCW-2 and BSA in Rotational Cereal Grains (Crop Groups 15 and 16) Under Field Conditions.Report No. AA130712. ADAMA Ref. R-31415. GLP, Unpublished. 11 Nov 2016
R-31458	Jones, G L	2016	Magnitude of the Residue of MCW-2 in Tree nut crops (Almonds and Pecans). Report No. AA140711. ADAMA Ref. R-31458. GLP, Unpublished. 11 Nov 2016

Reference	Author(s)	Year	Title
R-31459	Jones, G L	2016	Magnitude of the Residue of MCW-2 in Vine Crops (Grape and Kiwifruit) and Processed Commodities of Grape. Report No. AA140712. ADAMA Ref. R-31459. GLP, Unpublished. 23 Nov 2016
R-31461	Kelley, K	2017	Magnitude of the Residue of MCW-2 in Citrus (Orange, Lemon and Grapefruit) and Citrus Processed Commodities. American Agricultural Services, Inc. Report No. AA140716. ADAMA Ref. R-31461. GLP, Unpublished. 22 August 2017
R-31484	Gieseg, M.	2016	Determination of Fluensulfone Metabolite Residues (TSA and BSA) in Edible Commodities (Tissue and Milk) of Lactating Dairy Cattle following twice Daily Oral Administration over 28 consecutive days.; Veterinary Health Research New Zealand Ltd.; Unpublished report No. ADFB3074; ADAMA study no. R-31484
R-35572	Hoi, S W Jones, G L	2016	Magnitude of the Residue of MCW-2 in Pome Fruit Crops (Apples and Pears). Report No. AA150710. ADAMA Ref. R-35572. GLP, Unpublished . 30 Nov 2016
R-35573	Hoi, S W Jones, G L	2016	Magnitude of the Residue of MCW-2 in Stone Fruit (Cherry, Peach and Plum). Report No. AA150709. ADAMA Ref. R-35573. GLP, Unpublished . 11 Nov 2016
R-35574	Jones, G L	2016	Magnitude of the Residue of MCW-2 in Sugar Cane and Sugar Cane Processed Commodities, American Agricultural Services, Inc. Report No. AA150702. ADAMA Ref. R-35574. GLP, Unpublished. 01 December 2016
R-35606	Casimirio, C M	2015	Analytical and validation methodology: Fluensulfone residue determination and its metabolites in guava fruits. Report No. PLMV RA 002 044/2016. ADAMA Ref. R-35606. GLP, Unpublished. 02 September 2015
RÀ 002 003 14 B	Morena Casimiro, C.	2015	Determination of Fluensulfone and its Metabolites, in Coffee Beans, after Application of MIL FI 0437/09. Plantec Laboratórios. Report No. RÀ 002 003 14 B. ADAMA Ref: LRN02730CF_2015. GLP; Unpublished. 12 Feb 2015
RA 002 004 14 B	Morena Casimiro, C.	2015	Determination of Fluensulfone Residue and its Metabolites, in Stalk Sugar cane (Plant), after MIL FI 0437/09 application . PLANTEC Laboratórios. Report No. RA 002 00414 B. ADAMA Ref: LRN02724CN_2015. GLP; Unpublished. 10 Sep 2015
RA 002 007 14 B	Morena Casimiro, C.	2015	Determination of Fluensulfone Residue and its Metabolites, in Citrus Fruits, after MIL FI 0437/09 Application. Plantec Laboratórios. Report No. RA 002 007 14 B. ADAMA Ref: LRN02716CT_2015. GLP; Unpublished. 03 July 2015. Addendum 1 (15 December 2016)
RA 002 008 14 B	Casimirio, C M	2015	Determination of fluensulfone residue and its metabolites, in guava fruits, after MIL FI 0437/09 application. Report No. RA 002 008 14 B. GLP, Unpublished. 02 Sep 2015
RA 002 037 16 B	do Valle Borges de Siqueira, V L	2018	Determination of Fluensulfone and Metabolites M-3625 and M-3627 Residue, on Coffee Grains, after MIL FI 0437/09 Application. Report No. RA 002 037 16 B. ADAMA Ref: not assigned. GLP, Unpublished. 02 October 2018
RA 002 037/2018	do Valle Borges de Siqueira, V L	2018	Determination of Fluensulfone and Metabolites M-3625 and M-3627 Residue, on Coffee Grains, after MIL FI 0437/09 Application. Report No. RA 002 037 16 B. ADAMA Ref: not assigned. GLP, Unpublished. 02 October 2018
RA 002 044 16 B	Siqueira, V	2018	Determination of fluensulfone and metabolites M-3625 and M-3627 residues, on coffee grains, after application of MIL FI 0437/09. Report No. RA 002 044 16 B. ADAMA Ref. not assigned. GLP, Unpublished . 24 August 2018
RES-00091	Brown, S	2018	Stability of residues of fluensulfone and metabolites in crops stored frozen for up to 35 months (interim report). Report No. RES-00091. ADAMA Ref. not yet assigned. GLP, Unpublished. 5 December 2018