Novel fertilizer strategy to biofortify zinc concentration in wheat grains

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SOILS: WHERE FOOD BEGINS

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Introduction

- Wheat provides a fifth of humanity's food. Zinc deficiency in soils does not only reduce crop productivity, but it also leads to low-Zn food causing human malnutrition

- Increasing wheat grain Zn concentration is a grand challenge

- Agronomic biofortification of Zn in wheat grains is much faster than biofortification through breeding programs

- Increasing Zn content in food crops is a global challenge with implications for both crop production and human health (Bouis and Saltzman, 2017)

Aim & Objective

- **Aim**: Agronomic biofortification of wheat grains with zinc (Zn) through foliar as well as basal Zn fertilizer applications have been proposed as an agronomic strategy to increase grain Zn concentration, which can serve as a **nutritional intervention** in regions with low dietary Zn intake.

- **Objective:** To bio-fortify wheat grain with Zn through Zn fertilization.

Methodology

25 field experiments were conducted during *rabi* seasons 2014-15 and 2015-16 at farmer's field across Punjab(6), Uttar Pradesh(7), Haryana(6) and Himachal Pradesh(6) states of Northern India with the following treatments:

- **Control :** Recommended N, P, K
- **Basal/soil Zn application:** (25-50 kg $ZnSO_4$. $7H_2O$ ha^{-1}) + Recommended N, P, K
- **Foliar Zn application:** (spray 0.5% Zn SO_4. $7H_2O$)+ Recommended N, P, K

  (Foliar Zn applications realized 2 times: first at anthesis stage and the second one at early milk stage (after 90-95 days and 110-115 days of sowing of crop).
- The soil characteristics were analyzed using standard procedure before conducting the experiments.

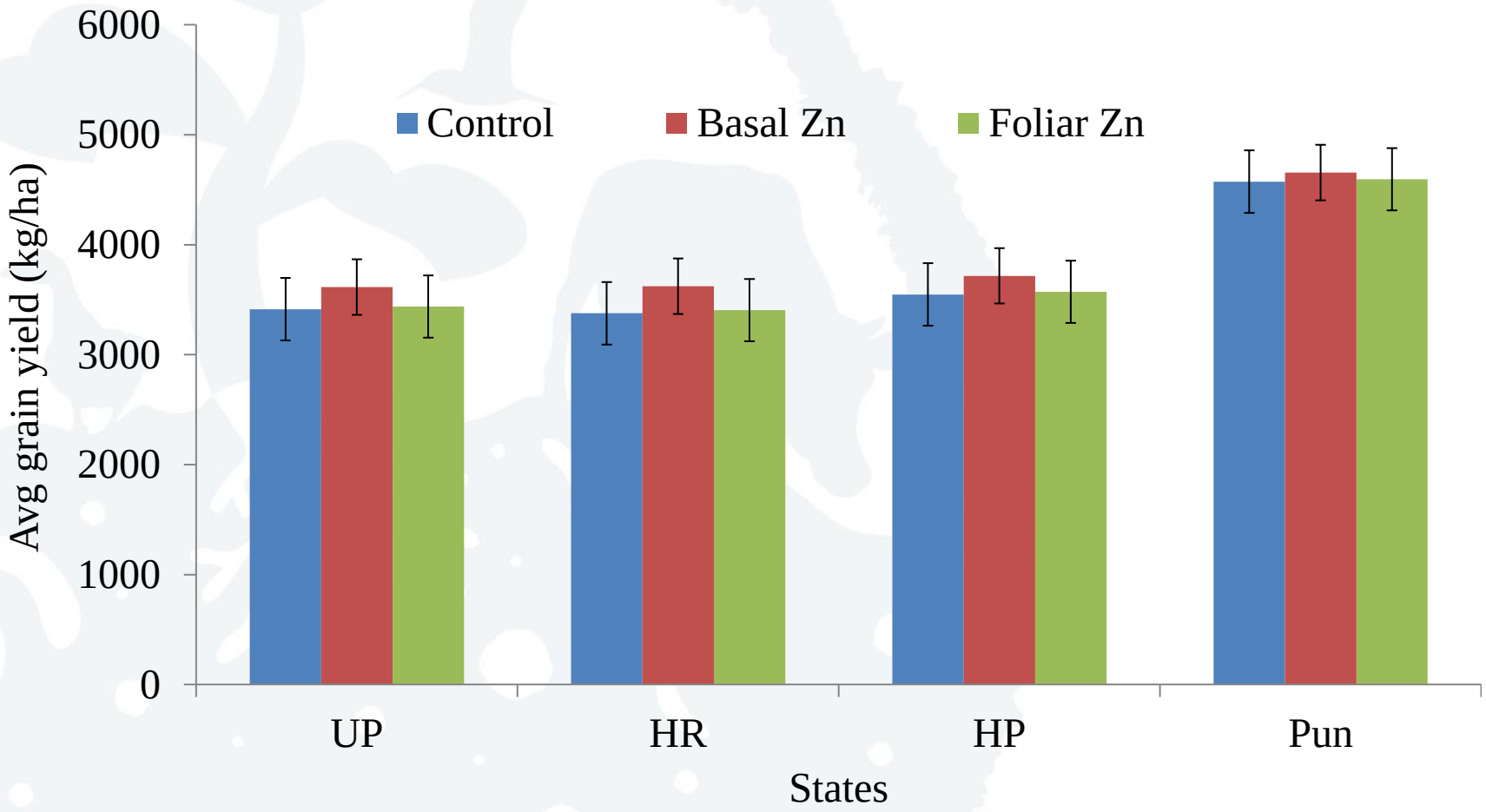
Summary of soil fertility status of selected fields

n = 25	pH	EC	O.C	Av. P	Av. K	DTPA -Zn	Cu	Mn	Fe
		(dS/ m)	(%)	(kg/ha)		(mg/kg or ppm)			
Min.	7.06	0.17	0.37	6	144	**0.13**	1.08	0.8	2.72
Max.	8.7	0.81	0.97	40.7	438	**2.29**	16.38	6.34	28.64
Mean		**0.34**	**0.58**	**18.4**	**276**	**0.81**	**4.43**	**2.04**	**11.49**

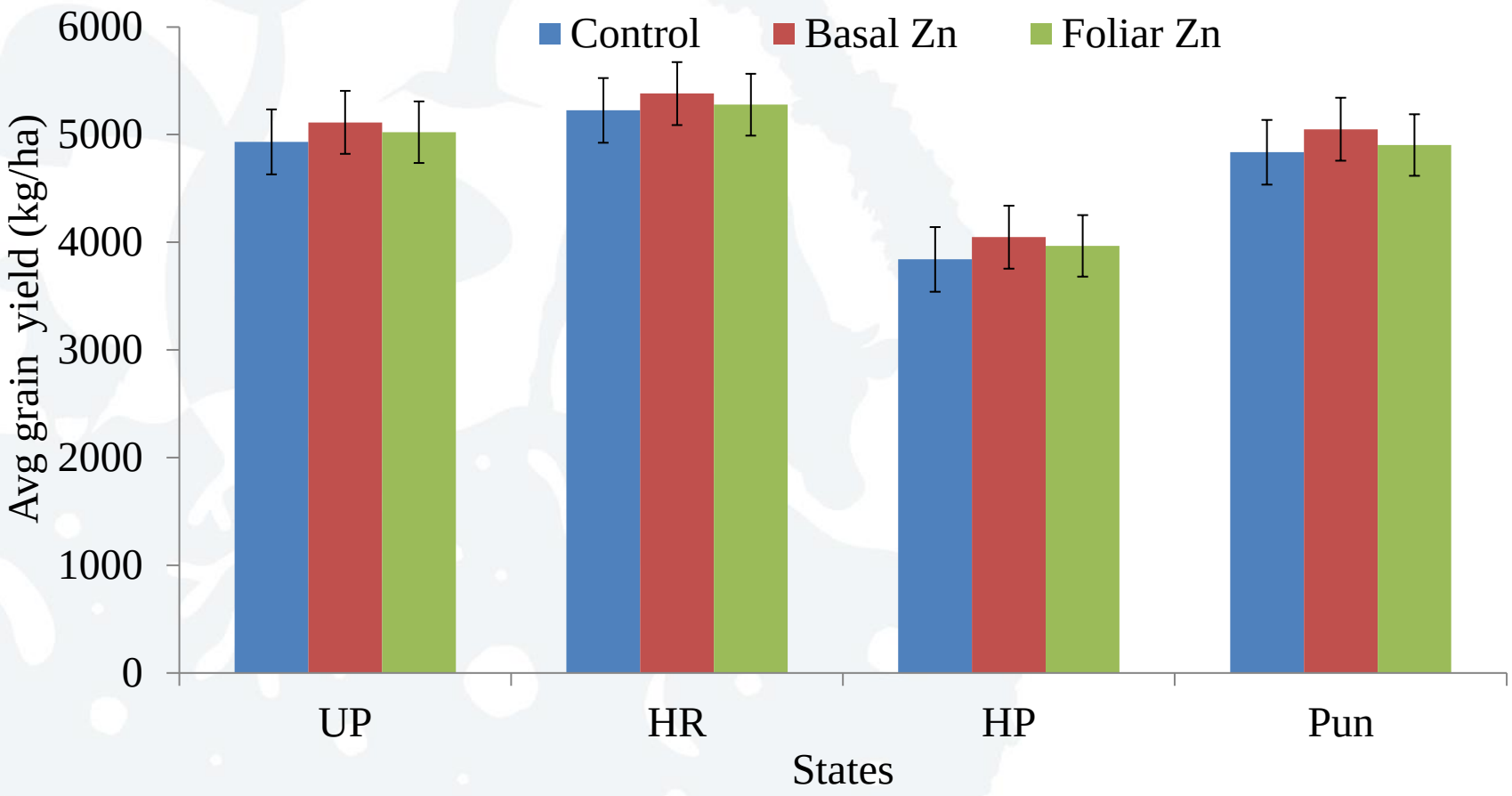
Effect of Zinc application methods on wheat grain yield (state wise analysis of pooled data; n=7 (UP), 6 (HR), 6 (HP), 6 (PB)

Particular	2014-15				2015-16				
	UP	HR	HP	Punjab	UP	HR	HP	Punjab	Mean
Control	3413	3377	3547	4573	4932	5225	3841	4836	**4218**
Soil Zn	3614	3623	3717	4657	5113	5382	4048	5049	**4400**
Foliar Zn	3437	3405	3572	4595	5022	5278	3967	4903	**4272**
General Mean	**3488**	**3468**	**3612**	**4608**	**5022**	**5295**	**3952**	**4929**	
CV(%)	18.45	29.65	9.48	4.07	6.16	2.37	1.62	2.56	
SE(d)	198.57	342.81	114.08	62.48	95.56	41.84	21.38	42.14	
LSD at 5%	NS	NS	NS	NS	NS	83.99	42.92	84.60	

State-wise wheat grain yield (2014-15)



State-wise wheat grain yield (2015-16)



Field view of foliar application of Zn (grain filling stage) and harvesting of wheat

Effect of Zn application methods on wheat grain Zn conc. (state wise analysis of pooled data; n= 7 (UP), 6 (HR), 6 (HP), 6 (PB)

Particular	2014-15				2015-16				Mean
	UP	HR	HP	Punjab	UP	HR	HP	Punjab	
Control	19.33	18.57	18.41	20.76	18.27	15.63	16.04	24.84	**18.98**
Soil Zn	19.76	18.64	18.94	20.91	20.03	17.19	17.11	26.57	**19.89**
Foliar Zn	33.16	31.90	32.21	36.68	38.45	35.11	36.97	37.20	**35.21**
General Mean	**24.08**	**23.04**	**23.19**	**26.12**	**25.58**	**22.64**	**23.37**	**29.54**	
CV(%)	16.8	4.44	9.62	12.12	8.81	5.85	5.84	7.34	
SE(d)	1.25	0.34	0.74	1.06	0.70	0.44	0.46	0.72	
LSD at 5%	2.50	0.68	1.49	2.12	1.39	0.89	0.91	1.45	

Summary of Grain Zn concentration

- The results showed that **grain Zn concentration** increased from 0.1% to 6.3% (during 2014-15) and 3.2% to 10.3% (during 2015-16) by **soil Zn application** as compared to control.

- However, increase in grain Zn concentration by **foliar Zn application** was more pronounced which ranged from **48% to 94%** (during 2014-15) and **32% to 139%** (during 2015-16) over the value of respective control.

Effect of Zn application methods on Zn use efficiencies in biofortification of wheat crop (pooled triplicate data of all 25 sites or 75 unit of each treatment).

Particular	Zn Agronomic Efficiency	Zn Use Efficiencies (%)	Utilization Efficiency
Soil Zn	3.7	0.058	11.14
Foliar Zn	18.33	7.94	57.1

Conclusion

- **Foliar Zn fertilizer application significantly increased Zn concentration in wheat grains by nearly two-fold.**
- Positive impact of foliar Zn application occurred consistently over a wide range of environment and local agricultural management practices.
- This agriculture intervention strengthens the links between **agriculture research** and **nutrition**.

Acknowledgement

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Thank you !
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Key References

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