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Effect of zinc fertilization on wheat yield under sandy loam soil

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Abstract
A field experiment was conducted during *Rabi* season of 2012-13 to 2016-17 to study effect of zinc fertilization on effect of zinc fertilization on yield attributes and yield of wheat under sandy loam soil at Dry Farming Research Staion, JAU, Jam Khambhaliya of North Saurashtra Agroclimatic Zone of Gujarat. The experiment comprising of ten different treatments of basal and foliar application of zinc laid out in Randomized Block Design with four replications. Significantly higher plant height, number of grains per spike, 1000 grain weight, grain & straw yield of wheat were obtained with soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at heading & milking stages (T_6). Significantly higher content of zinc in wheat grain was recorded under treatment T_3 (soil application of $ZnSO_4$ 20 kg ha^{-1} + foliar spray at crown root initiation & heading stages). While, significantly higher zinc content in straw was recorded with application of treatment T_8 (soil application of $ZnSO_4$@20 kg ha^{-1} + foliar spray at milking & dough stages). The significantly higher zinc uptake (475.0 g ha^{-1} was recorded under treatment T_6. The highest total income (Rs. 79074 ha^{-1}) and net realization (Rs. 46578 ha^{-1}) and B: C ratio (2.4) were obtained with soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of ZnSO4 @ 0.5 % at heading & milking stages (T_6).

Keywords: Wheat, zinc fertilization, yield, content, uptake

Introduction
Wheat (*Triticum aestivum* L.) is the staple food and second most important food crop after rice in the country, which contributes nearly one-third of the total food grains production. It is consumed mostly in the form of bread as "Chapatti". Wheat straw is used for feeding cattle. Wheat contains more protein than other cereal and has a relatively high content of niacin and thiamine. It is basically concerned in providing the characteristics substance "Gluten" which is very essential for bakers.

Now a days due to intensive agriculture, soils and also feed found deficient in micronutrients particularly zinc. Deficiencies directly or indirectly resulted in poor crop yield and also cause serious health problems in human beings and in livestock also. Application of Zn containing fertilizers through various agronomic approaches *viz.* soil application, foliar application, seed treatment and use of biofertilizers may increase micronutrient concentration in grain, depending on soil type, crop and other factors. Among all the measures, one possible way to increase the uptake of metals by plant is the addition of inorganic salts to soil or their supplementation through foliar application i.e. ferti-fortification.

One of the cheapest sources of supplementation is application of some of the inorganic salts which contain Zn in it, for example, $ZnSO_4$. The uptake of Zn could be further enhanced, if the supplementation is made at proper growth stages either as basal, foliar or in combination of both the modes. However, information on this aspect especially for wheat with respect to Zn ferti-fortification for important wheat varieties under cultivation in region is not available. Keeping this in view, a field experiment was planned to study the effect of zinc fertilization on wheat yield on sandy loam soil.

Material and Methods
The experiment was carried out during Rabi seasons of 2012-13 to 2016-17 at Dry Farming Research Station, Junagadh Agricultural University, Jamkhambhalia of North Saurashtra Agro-climatic Zone. The The soil characteristics at 0-15 cm depth had pH 8.10, electrical conductivity (EC) 0.20 m.mhos, organic carbon (OC) 0.35%, available P_2O_5 28.6 kg/ha and available K_2O 336 kg/ha and available S 14.8 mg/kg. The experiment included total 10 treatments viz. T_1 – Control RDF (120-60-00 NPK kg ha^{-1}) only, T_2 – $ZnSO_4$ 25 kg ha^{-1} soil application as basal, T_3 – $ZnSO_4$ 20 kg ha^{-1} soil application as basal + $ZnSO_4$ 0.5 % FS at

CRI + Heading Stage, T_4 – $ZnSO_4$ 20 kg ha^{-1} soil application as basal + $ZnSO_4$ 0.5 % FS at CRI + Milking Stage, T_5 - $ZnSO_4$ 20 kg ha^{-1} soil application as basal + $ZnSO_4$ 0.5 % FS at CRI + Dough Stage, T_6 – $ZnSO_4$ 20 kg ha^{-1} soil application as basal + $ZnSO_4$ 0.5 % FS at Heading Stage + Milking stage, T_7 – $ZnSO_4$ 20 kg ha^{-1} soil application as basal + $ZnSO_4$ 0.5 % FS at Heading stage+ Dough Stage, T_8 – $ZnSO_4$ 20 kg ha^{-1} soil application as basal + $ZnSO_4$ 0.5 % FS at Milking stage + DS, T_9 – $ZnSO_4$ 15 kg ha^{-1} soil application as basal + $ZnSO_4$ 0.5 % FS at Heading stage + Milking Stage + Dough Stage and T_{10} - $ZnSO_4$ 0.5 % FS at CRI + Heading stage + Milking Stage + Dough Stage each replicated thrice in random block design with the plot size of (a) Gross: 5.0 X 2.7 m (12 rows) (b) Net: 4.0 X 2.25 m (10 rows). The spacing and seed rate were 22.5 cm and 120 kg ha^{-1}, respectively. The fertilizer was given as per treatments. The experiment was not sown during the year 2015-16 due scarcity of water due to drought.

Results and Discussion

Biometric parameter

The pooled data given in table 1.1 revealed the significantly higher plant height (93.3 cm) & number of grains per spike (34.8) were recorded under treatment T_6 (soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of ZnSO4 @ 0.5 % at heading & milking stages). The treatment T_6 & T_9 recorded significantly higher 1000 grain weight (46.5 gm) but it was statistically at par with (T_3, T_4, T_5, T_7, T_8, and T_{10}.). These results are in agreement with those of Khan *et al.* (2010) [3] and Muhammad *et al*. (2017) [4].

Grain & Straw yield

The pooled result presented in table 1.1 showed the soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at heading & milking stages (T_6) produced significantly higher grain yield (4333 kg ha^{-1}) over treatments T_1, T_2, T_3,T_7, T_8, T_9 and T_{10}, while it was at par with treatments T_5 (soil application $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at crown root initiation & dough stages) and T_4 (soil application of $ZnSO_4$ @ 20 kg ha^{-1} SA + foliar spray of $ZnSO_4$ @ 0.5 % at crown root initiation & milking stages). The Soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at heading & milking stages (T_6) produced higher grain yield by 28.5 per cent as compared to T_1 (RDF 120-60-50 kg NPK/ha). The minimum grain yield (3096 kg ha^{-1}) was recorded under control plot (T_1) (RDF only). The similar findins were also obtained by Khan *et al.* (2010) [3], Sabir *et al.* (2015) [5], Dahshouri *et al.* (2017) [1] and Muhammad *et al*. (2017) [4].

The result given in table 1.1 indicated that the significantly higher straw yield of wheat (6509 kg ha^{-1}) was recorded under treatment T_6 (soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at heading & milking stages) over treatments T_1, T_2, T_3,T_7, T_8, T_9 andT_{10}, while it was at par with treatments T_5 (soil application $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at crown root initiation & dough stages) and T_4 (soil application of $ZnSO_4$ @ 20 kg ha^{-1} SA + foliar spray of $ZnSO_4$ @ 0.5 % at crown root initiation & milking stages). The treatment T_1 (application of RDF only) recorded minimum straw yield of wheat (4920 kg ha^{-1}). This result is in accordance with the finding of Khan *et al*. (2010) [3], Sabir *et al* (2015) [5] and Dahshouri *et al.* (2017) [1] Muhammad *et al*. (2017) [4].

Content and uptake of Zinc

The results in table 1.1 revealed that the significantly higher content of zinc (26.6 ppm) in grain was recorded under treatment T_3 (soil application of $ZnSO_4$ 20 kg ha^{-1} + foliar spray at crown root initiation & heading stages) over treatments T_1, T_2, T_4, T_8 and T_{10}. While, it was remained at par with treatments T_5, T_6, T_7 and T_9. In case of straw significantly higher zinc content (57.9 ppm) was recorded under treatment T_8 (soil application of $ZnSO_4$@20 kg ha^{-1} + foliar spray at milking & dough stages). The significantly higher zinc uptake (475.0 g ha^{-1} was recorded under treatment T_6 (soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at heading & milking stages), which was at par with treatment T_5. Similar results were reported by Dogra *et al*. (2014) [2], Sabir *et al.* (2015) [5], Muhammad *et al*. (2017) [4] and Dahshouri *et al.* (2017) [1].

Economics

The data pertaining to economics of various treatments (Table 1.1) in wheat crop revealed that highest net realization (Rs. 46578 ha^{-1}) and B: C ratio (2.4) were obtained with soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at heading & milking stages (T_6) followed by T_5 (soil application of $ZnSO_4$ @ 20 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.5 % at heading & dough stages). These results are in agreement with those of Sabir *et al.* (2015) [5].

Table 1: Biometric observations, grain & straw yield, economics and Zn content and uptake of wheat affected by different treatments

T. No.	Treatments	Plant Height (cm)	No. of grains/ spike	1000 grain wt. (gm)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net return Rs./ha	B:C ratio	Zn content, (ppm)		Zn Uptake (gm/ha)
									Grain	Straw	
T_1	Control RDF	86.0	29.4	43.4	3096	4920	25458	1.90	20.0	49.8	304.2
T_2	$ZnSO_4$25 kg ha^{-1} SA	88.1	31.5	44.7	3619	5349	34008	2.06	23.0	48.1	342.7
T_3	$ZnSO_4$ 20 kg ha^{-1} SA+ $ZnSO_4$ 0.5 % FS at CRI + HS	90.6	32.4	45.5	3807	5698	36977	2.14	26.6	53.9	408.8
T_4	$ZnSO_4$ 20 kg ha^{-1} SA + $ZnSO_4$ 0.5 % FS at CRI + MS	91.0	33.3	46.0	3887	5787	38426	2.18	23.7	53.5	402.8
T_5	$ZnSO_4$ 20 kg ha^{-1} SA + $ZnSO_4$ 0.5 % FS at CRI + DS	93.1	34.4	46.4	4012	6309	40874	2.26	25.6	57.4	464.7
T_6	$ZnSO_4$ 20 kg ha^{-1} SA + $ZnSO_4$ 0.5 % FS at HS + MS	93.3	34.8	46.5	4333	6509	46578	2.37	25.3	56.0	475.0
T_7	$ZnSO_4$ 20 kg ha^{-1} SA + $ZnSO_4$ 0.5 % FS at HS + DS	87.1	33.0	45.9	3691	5568	34887	2.07	26.0	53.9	398.0
T_8	$ZnSO_4$ 20 kg ha^{-1} SA + $ZnSO_4$ 0.5 % FS at MS + DS	85.0	32.1	45.7	3694	5488	34901	2.07	24.1	57.9	408.0
T_9	$ZnSO_4$ 15 kg ha^{-1} SA + $ZnSO_4$ 0.5 % FS at H + MS + DS	88.6	32.7	46.5	3731	5634	35460	2.09	25.1	51.7	386.3
T_{10}	$ZnSO_4$ 0.5 %FS at CRI + HS + MS + DS	88.5	32.5	45.4	3580	5293	32830	2.01	24.6	53.1	373.1
	S.Em.±	1.6	0.8	0.6	161	245.1			0.6	1.6	16.8
	C.D. at 5 %	4.4	2.4	1.7	478	728.3			1.7	4.4	49.9
	C.V. %	6.0	8.9	4.6	9.9	9.3			8.5	10.1	11.1

Conclusion

The farmers of North Saurashtra Agro-climatic Zone (AES-10) growing wheat are recommended to apply ZnSO4 @ 20kg ha-1 as basal along with two foliar sprays of ZnSO4 @ 0.5 % (50 g/10 lit. water) at heading and milking stages with recommended dose of fertilizer (120-60-60 NPK kg/ha) for obtaining higher yield and net realization.

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