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Effect of inorganic and biological source of Zinc on growth and yield of Wheat (*Triticum aestivum* L.)

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Abstract
The present field experiment was conducted at pot house of department of faculty of Agricultural sciences & allied industries of Rama University Kanpur under the Central Plain zone of Uttar Pradesh, during Rabi season. A study was conducted to assess fertilizer effect on wheat yield and soil fertility with the following treatments; T_1-Control,T_2–RDF (120:60:40 kg per ha),T_3-RDF+5 kg $ZnSO_4$ per ha,T_4-RDF+10 kg $ZnSO_4$ per ha,T_5-RDF+Seed treatment (ZSB),T_6-RDF+$ZnSO_4$ per ha + seed treatment (ZSB),T_7-RDF + 10 kg $ZnSO_4$ per ha + seed treatment PSB).Treatments differed significantly in influencing soil fertility and grain and straw yields of wheat crop. The study indicated that addition of 100% $ZnSo_4$+ZSB+Seed treatment + RDF recorded significantly higher value of growth and yield attributes in terms of plant height (cm), dry matter accumulation (g m-2),number of effective tillers (m-2) and yield attributes character grains spike-1, 1000-grain weight (g), harvest index (%), grain yield (38.40 q ha-1) straw yield (63.3 q ha-1).The content of organic carbon increase with the combined application of organic and inorganic with biofertilizer. Integration of 100% NPK + FYM + $ZnSo_4$ + Mn + Fe was found more productivity and remunerative with the higher residual soil fertility status after wheat crop. The highest bioavailable Zn was calculated for foliar (30%) and soil application (28%).

Keywords: Inorganic, biological zinc, growth, yield, wheat

Introduction
Wheat is grown in greater quantities than all other food crops (220.6 million hectares, 2014). Wheat is traded globally and is higher than all cereal crops. In 2017, world production of wheat stood at 771.5 million tonnes, with 2019 production forecast at 766.8 million tonnes, making wheat the second most grown grain after maize. World production of wheat and all other cereal crops ha striped since1960 and is expected to increase further by the middle of the 21st century. Global demand for wheat is increasing due to the unique visco elastic and adhesive properties of gluten proteins, which facilitate production. Processed foods, the consumption of which is increasing as a result of the worldwide industrialization process and westernization of the diet.

Wheat is primarily a very important source of carbohydrates. It is considered a major source of vegetable protein in the human diet, with a protein content of about 13.5%, which is relatively high for all grown cereals, but in protein quality to supply some essential amino acids. something less. When consumed as a whole grain, wheat is a good source of many nutrients and dietary fiber in our bodies.

Soil micronutrient deficiencies in soil are one of the many factors that limit or reduce wheat yields (Nayyar *et al*., 2001; Kataki *et al*., 2001a). Intensive mining of minerals by crops has resulted in greater loss of micronutrient reserves from the soil due to micronutrient deficiencies. It is estimated that 65-210 g Zn, 231-1220 g Fe, 140-331 g Mn and 35-50 g Cu are extracted from wheat crop for 2 tonnes of wheat grain. Reduction in Zn, Fe, Mn and Cu, respectively (Narwal *et al*., 2010). Whereas Punjab state has 22,12,11 and 2% reduction in Zn, Fe, Mn and Cu (Benbi *et al*.,2011).

Micronutrient malnutrition is a health problem affecting more than 3.1 billion people worldwide (Kakamak *et al*., 2010). Among them are the drawbacks of Zn and Fe: aremost popular. About 45% of children under 5 years of age in India are zinc deficient (Kapil and Jain, 2011). Zn and Fe deficiencies cause serious human health complications such as stunting, infection, impaired brain function, poor mental development and anemia (Fraga, 2005).

New reports suggest that improving nitrogen status as a policy of biofortification can increase Zn and Fe concentrations in whole grains and endosperms of wheat. Experiments on wheat showed that increasing soil or foliar applications of N at critical growth stages were highly effective in further improving rooting. Shoot and grain accumulation of Zn and Fe (Aciksoz *et al*., 2011; Kutman *et al*., 2011).

Inadequate work has been done to study the role of N in relation to soil/foliar application of micronutrients and their effects on wheat quality and productivity at critical phenological stages during pre- and post-war period, under conditions of Uttar Pradesh. There is a need to fully study the effect of improved and N nutrition on the transport of Zn, Fe, Cu and Mn in grain during ontogenesis of new wheat varieties.

Materials and Methods

The present study namely "Effect of Inorganic and Biological Source of Zinc on Growth and Yield of Wheat" carried out in Rabi Season of 2021-22 at Agriculture Research Farm, Rama University, Mandhana, Kanpur Nagar Uttar Pradesh, India. A study was conducted to assess fertilizer effect on wheat yield and soil fertility with the following treatments; T_1-Control, T_2–RDF (120:60:40 kg per ha), T_3-RDF+5 kg $ZnSO_4$ per ha, T_4-RDF+10 kg $ZnSO_4$ per ha, T_5-RDF+Seed treatment (ZSB), T_6-RDF+$ZnSO_4$ per ha + seed treatment (ZSB), T_7-RDF + 10 kg $ZnSO_4$ per ha + seed treatment PSB).

Statistical measure, i.e., mean, standard error of mean, coefficient of variation and range for each quantitative character were computed for the study of phenotypic variability. The analysis of variance for RBD, were done by following methodology advocated by Panse and Sukhatme (1967)

Results and Discussion

Table -1 showed that in 30 DAS treatment 7 shows the highest value of plant height (6.83) Followed by Treatment 4 (6.42), Treatment 5 (6.39), Treatment 6 (6.18) minimum value is shown in treatment 1 (Control) (5.60). In 60DAS treatment 7 shows the highest value of plant height (43.43) Followed by Treatment 4 (43.00), Treatment 5 (41.30), Treatment 2 (37.50) minimum value is shown in treatment 1 (Control) (32.00). In 90DAS treatment 7 shows the highest value of plant height (84.83) Followed by Treatment 4 (84.76), Treatment 5 (80.40), Treatment 2 (76.83) minimum value is shown in treatment 1 (Control) (69.00). AT HARVEST90DAS treatment 7 shows the highest value of plant height (85.38) Followed by Treatment 4 (85.09), Treatment 5 (82.62), Treatment 6 (78.51) minimum value is shown in treatment 1 (Control) (71.11).

Table 1: Plant height (cm) wheat as influenced by different sources of organic and inorganic zinc

Treatment	30DAS	60DAS	90DAS	At Harvest
T1	5.60	32.00	69.00	71.11
T2	5.37	37.50	76.83	78.40
T3	6.16	32.46	69.43	71.25
T4	6.42	43.00	84.76	85.09
T5	6.39	41.30	80.40	82.62
T6	6.18	36.80	76.76	78.51
T7	6.83	43.43	84.83	85.38
C.D. at 5%	1.23	3.25	4.96	4.96

Table 2 shows that in 30DAS treatment 7 shows the highest value of Leaf area index (1.59) Followed by Treatment 5, treatment 3 (1.58), Treatment 4, treatment 2 (1.57), Treatment 6 (1.56) minimum value is shown in treatment 1 (Control) (1.55).

Table 2: Leaf Area Index wheat as influenced by different sources of organic and inorganic zinc

Treatment	30DAS	60DAS	90DAS
T1	1.55	1.77	1.87
T2	1.57	2.10	2.07
T3	1.58	1.90	1.93
T4	1.57	2.37	2.26
T5	1.58	2.13	2.18
T6	1.56	2.05	2.06
T7	1.59	2.46	2.29
C.D. at 5%	0.02	0.25	0.85

In 60DAS treatment 7 shows the highest value of Leaf area index (2.46) Followed by Treatment 4 (2.37), Treatment 5 (2.13), Treatment 2 (2.10) minimum value is shown in treatment 1 (Control) (1.77). In 90DAS treatment 7 shows the highest value of Leaf area index (2.29) Followed by Treatment 4 (2.26), Treatment 5 (2.18), Treatment 2 (2.07) minimum value is shown in treatment 1 (Control) (1.87).

Table 3: Dry weight (g m-2) wheat as influenced by different sources of organic and inorganic zinc

Treatment	30DAS	60DAS	90DAS	At Harvest
T1	46.00	91.25	160.32	171.51
T2	49.74	95.58	168.70	179.85
T3	46.74	112.85	192.73	208.86
T4	54.45	124.71	208.69	224.61
T5	53.45	115.38	200.68	217.32
T6	52.13	106.94	189.90	207.93
T7	54.58	125.29	211.61	226.41
C.D. at 5%	4.25	12.52	35.72	37.02

Table 3 shows that in 30DAS treatment 7 shows the highest value of Dry weight (54.58) Followed by Treatment 4 (54.45), Treatment 5 (53.45), Treatment 6 (52.13) minimum value is shown in treatment 1 (Control) (46.00). In 60 DAS treatment 7 shows the highest value of Dry weight (125.29) Followed by Treatment 4 (124.71), Treatment 5 (115.38), Treatment 3 (112.85) minimum value is shown in treatment 1 (Control) (91.25). In 90DAS treatment 7 shows the highest value of Dry weight (211.61) Followed by Treatment 4 (208.69), Treatment 5 (200.68), Treatment 3 (192.73) minimum value is shown in treatment 1 (Control) (160.32). AT HARVEST 90DAS treatment 7 shows the Dry weightof plant height (226.41) Followed by Treatment 4 (224.61), Treatment 5 (217.32), Treatment 3 (208.86) minimum value is shown in treatment 1 (Control) (171.51).

Table 4: Yield attributes and yields of wheat as influenced by different sources of organic and inorganic zinc

Treatment	Effective tiller (m^{-2})	Spikelet spike^{-1}	1000-grains weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Protein content in grain (%)
T1	68.9	14.6	28.25	2217	4872	0.25	9.37
T2	82.6	15.4	29.38	2290	5690	0.26	10.00
T3	82.4	15.4	35.02	3133	5065	0.35	12.8
T4	73.8	15.1	39.05	3516	6243	0.37	13.74
T5	75.8	14.9	36.86	3217	6036	0.35	12.81
T6	75.5	15.1	34.03	2916	5722	0.34	12.08
T7	86.3	16.0	39.54	3800	6336	0.38	14.05
C.D. at 5%	4.65	1.52	4.02	14.65	17.60	0.002	11.02

The maximum value of effective tiller shown is treatment 7 (86.3), Followed by treatment 2 (82.6), treatment 3 (82.4), treatment 5 (75.8), treatment 6 (75.5), minimum value is recorded in treatment 1 (68.9). The maximum value of Spikelet spike-1shown is treatment 7 (16.0), Followed by treatment 2, treatment 3 (15.4), treatment 4, treatment 6 (15.1), treatment 5 (14.9), minimum value is recorded in treatment 1 (14.6). The maximum value of 1000-Grans weight shown is treatment 7 (39.54), Followed by treatment 4, (39.05), treatment 5 (36.86), treatment 3, (35.02), minimum value is recorded in treatment 1 (28.25). Maximum value of effective tiller shown is treatment 7 (3800), Followed by treatment 4, (3516), treatment 5 (3217), treatment 3, (3133), minimum value is recorded in treatment 1 (2217).

Table 5: Nutrient uptake by grain and straw of wheat wheat as influenced by different sources of organic and inorganic zinc

Treatment	Nitrogen (kg/ ha)		Phosphorus (kg /ha)		Potassium (kg/ ha)		Zinc (g /ha)	
	Straw	Grains	Straw	Grains	Straw	Grains	Straw	Grains
T1	41.90	13.47	7.14	2.79	8.36	47.63	60.89	48.88
T2	70.48	22.78	22.78	12.53	5.99	84.99	118.01	91.04
T3	81.07	33.33	16.75	10.31	18.81	95.99	146.11	123.29
T4	74.54	28.72	13.94	7.74	16.72	88.23	129.33	98.97
T5	84.98	33.78	18.12	11.27	20.33	101.20	160.09	132.17
T6	73.40	29.57	14.99	8.73	17.13	90.28	136.64	104.86
T7	67.43	12.68	12.68	6.98	14.01	82.80	115.26	86.24
C.D. at 5%	3.34	1.45	0.75	0.41	0.87	5.00	7.16	5.61

The maximum value of Straw yield (t ha-1)shown is treatment 7 (6336), Followed by treatment 4, (6243), treatment 5 (6036), treatment 6, (5722), minimum value is recorded in treatment 1 (4872).The maximum value of harvest index (%) shown is treatment 7 (0.38), followed by treatment 4 (0.37), treatment 5 (0.35), treatment 6, (0.34), minimum value is recorded in treatment 1 (0.25).The maximum value of protein content in grain (%) shown is treatment 7 (14.05), followed by treatment 4 (13.74), treatment 5 (12.81), treatment 6, (12.08), minimum value is recorded in treatment 1 (9.37).

Table 6: Effect of different sources of organic and inorganic zinc on economics of wheat

Treatment	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
T1	8000	28850	20850	2.61
T2	7000	18192	11192	1.60
T3	10500	19104	8604	0.82
T4	9200	33631	24431	2.65
T5	8650	30957	22307	2.58
T6	8100	28250	20100	2,48
T7	12700	36101	23401	1.84

Conclusion

Based on one years of experiment it may be inferred that application of treatments T7 (10Kg Znso4/ha + Seed treatment ZSB) gave the highest grain yield value of wheat crop showed good potential for sustainable production and proved to be quite remunerative in alluvial tract of Uttar Pradesh.

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