ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2019; 5(9): 174-177
www.allresearchjournal.com
Received: 19-07-2019
Accepted: 23-08-2019

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Effect of zinc application on growth characters and yield of wheat (*Triticum aestivum* L.)

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Abstract
A pot culture study entitled "Agronomic fortification of wheat as influenced by graded levels of zinc" was conducted during *rabi* 2017-2018 at Department of Soil Science and Agricultural Chemistry. Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola. The significantly highest yield and growth characters were observed in the treatment of soil application of RDF + $ZnSO_4$ @ 30 kg ha^{-1}. It is concluded that the soil application of $ZnSO_4$ @ 30 Kg ha^{-1} + RDF (80:40:40 kg ha^{-1} N, P_2O_5, K_2O) at the time of sowing recorded highest wheat grain and straw yield, growth characters.

Keywords: Agronomic fortification, wheat, zinc, yield

Introduction
In India, wheat is most important food crop after rice in terms of area and production. Wheat (*Triticum aestivum* L. emend. Fiori and Paol) is an important staple food crop for billions people of the world and among cereals. It is estimated that area under wheat in world was 223 million hectare, with annual production of 736.3 million metric tonnes. India contributes gross area of 30.4 million hectare with annual production of 92.08 million metric tonnes and productivity is 3.1 tonnes ha^{-1}. Maharashtra contributes 12.72 Lakh ha area with the annual production of 22.14 Lakh tonnes and productivity is 1740 kg ha^{-1} during year 2017-18.
In plants, zinc plays a vital role as a catalytical, structural and regulatory co-factor of many enzyme reactions. Zinc is necessary for the metabolism of carbohydrates, protein synthesis, the biosynthesis of growth hormones, in particular of indole acetic acid and the maintenance of the integrity of cell membranes. Plants suffering from acute zinc deficiency exhibit stunted growth, chlorosis of leaves, shortened internodes and petioles, and clustering of small malformed leaves at the top of the plant (Classic rosette symptom of dicotyledons). The deficiency symptoms first appears on young leaves as zinc is an immobile nutrient in plants. Zinc deficient leaves remains small with extended necrotic spots and interveinal chlorosis on the upper leaf surfaces.
In humans zinc is a component of a large number of enzymes (>300) and participates in various metabolic processes such as synthesis and degradation of carbohydrates, proteins, and nucleic acids. Zinc plays a vital role in the functioning of the nervous, reproductive, and immune systems and is important in the physical growth and cognitive development of children. Numerous health problems such as retarded growth, skeletal abnormalities, delayed wound healing increased abortion risk and diarrhoea are formed due to zinc deficiency. Approximately one-third of the world's population is suffering from zinc deficiency. The situation is even more adverse in developing countries where more than half of the children and pregnant women are suffering from iron and zinc deficiencies. This situation is largely attributed to the high consumption of cereal based foods viz., wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.) and maize (*Zea mays* L.), in these countries.
Cereals are the major source of zinc for the world's population, especially for the poor people living in rural areas. However, zinc contents of cereal-based foods are quite inadequate to meet human demands. The problem is especially acute for wheat consumers, as wheat (*Triticum aestivum* L.).

Materials and Methods
A pot culture experiment was conducted during rabi season of 2017-18 at Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola. The soil for filling the pots where

collected from long term fertilizer experiment unit, Dr. PDKV, Akola which was deficient in zinc. The experimental soil which was collected from LTFE unit was slightly alkaline in reaction, medium in organic carbon, moderately calcareous in nature, low in available N, medium in available P, very high in available K, marginal in available S, and sufficient in micronutrients but deficient in zinc. The certified seed of wheat (AKAW-4627) were sown in Rabi season by drilling method at rate of 150 kg ha^{-1} (20 seeds per pot). Basal dose of nitrogen, phosphorous and potassium was applied through urea, single super phosphate and murate of potash. For T_1 treatment only RDF was applied, T_2 treatment RDF + $ZnSO_4$ was applied @ 10 kg ha^{-1},T_3 treatment RDF + $ZnSO_4$ was applied @ 20 kg ha^{-1},T_4 treatment RDF + $ZnSO_4$ was applied @ 30 kg ha^{-1}, T_5 treatment RDF + $ZnSO_4$ was applied @ 40 kg ha^{-1}. Foliar treatments were applied according to the treatments such as T_6 treatment was applied through $ZnSO_4$ two foliar sprays @ 0.5% first at pre-flowering and second at milk stage. T_7 treatment was applied through $ZnSO_4$ two foliar sprays of @ 1.0% first at pre flowering and second at milk stage. Double quantities of fertilizers (Urea, SSP, MOP) were applied in the pot culture experiment as the nutrients would become less available to the plants.

Results and Discussion

The results obtained from the present investigation have been presented under following heads.

Growth characters and yield

A. plant height

Plant height reflects the vegetative growth behaviour of crop plants to environment and to applied inputs. Plant tends to grow to a certain height in each growth stage. A glance of data would indicate that height of plant increased with advancement of crop age. It was observed that, the mean plant height increased progressively and reached its maximum at harvest. Zinc application on wheat significantly increased the plant height 30, 60 DAS and at harvest as compared to recommended dose of fertilizer (RDF) 80:40:40 kg ha^{-1} (T_1). Significantly higher plant height was observed in RDF + $ZnSO_4$ @ 30 kg ha^{-1} (T_4) in 30 DAS, 60 DAS and harvest observations (17.70, 35.86, 50.99 cm) respectively. The RDF + $ZnSO_4$ two foliar sprays @ (1.0%) first at pre flowering and second at milk stage (T_7) and RDF + $ZnSO_4$ two foliar sprays @ (0.5%) First at pre flowering and second at milk stage (T6) with varying concentration did not affect the plant height significantly because the application time was at pre flowering and milk stage. At this stage, vegetative growth period of wheat was near about completed so it did not affected in plant height significantly. But soil application influenced the plant growth and was significantly higher over other treatments. Also it was seen that plant height was increased the at 30 DAS, 60 DAS and harvest stage observation respectively on RDF + $ZnSO_4$ @ 30 kg ha^{-1} (T_4) than RDF (T_1) treatment. The increase in plant height of wheat due to zinc through soil application corroborate with the findings of Ranjbar and Bahamian (2007) [11] who reported that plant height of wheat increased with application of zinc. Khan *et. al.* (2007) [7] also suggested that there was an increased in plant height due to zinc application. The increase in plant height under zinc treatments might be due to its effect in the metabolism of growing plants, which may effectively explain the response of zinc application.

Table 1: Effect of zinc application on plant height of wheat

Treatments		At 30 DAS (cm)	At 60 DAS (cm)	At harvest (cm)
T_1	Recommended dose of fertilizer (RDF) 80:40:40 NPK kg ha^{-1}	14.62	32.98	46.39
T_2	RDF + $ZnSO_4$ @ 10 kg ha^{-1}	16.20	34.65	49.52
T_3	RDF + $ZnSO_4$ @ 20 kg ha^{-1}	16.50	34.95	49.61
T_4	RDF + $ZnSO_4$ @ 30 kg ha^{-1}	17.70	35.86	50.99
T_5	RDF + $ZnSO_4$ @ 40 kg ha^{-1}	16.65	34.99	49.70
T_6	RDF + $ZnSO_4$ Two foliar sprays @ (0.5%) First at pre flowering and second at milk stage	14.65	34.70	49.58
T_7	RDF + $ZnSO_4$ Two foliar sprays @ (1.0%) First at pre flowering and second at milk stage	14.68	34.75	49.60
	SE (m)±	1.154	1.202	1.220
	CD at 5%	3.502	3.648	3.701

B. Dry matter accumulation

Maximum dry matter accumulation (5.35 g $plant^{-1}$) was observed in RDF + $ZnSO_4$ @ 30 kg ha^{-1} (T_4). But this value were found to be statistically at par with treatments such as RDF + $ZnSO_4$ two foliar sprays @ (1.0%) first at pre flowering and second at milk stage (T_7), RDF + $ZnSO_4$ two foliar sprays @ (0.5%) first at pre flowering and second at milk stage (T_6), RDF + $ZnSO_4$ @ 40 kg ha^{-1} (T_5). The lower dry matter accumulation (4.93 g $plant^{-1}$) was found in the RDF 80:40:40 NPK kg ha^{-1} (T_1) treatment. The apparent and significantly higher dry matter accumulation in wheat plant was obtained with soil application of RDF + $ZnSO_4$ (T_4) compared to the values obtained in other treatments in this study, might be due to better nourishment derived from the soil as a result of balanced fertilization which improved soil nutrient status. Which may be due to the zinc addition in combination with RDF as soil application provided distribution of zinc within wheat plant through xylem and translocate in phloem, which increases vegetative tissue formation resulted in the improved photosynthetic activity, which shows boosted growth of plant parts and increment in dry matter. These results were in support with the results of Chandrakumar *et al.* (2002) [1], Dewal and pareek *et al.* (2004) [2]. Yin *et al.* (2016) [14] also suggested that there is an increase in biomass of paddy plant through the soil application as compared to foliar application.

C. Number of tillers

Tillers are the grain bearing part and it possesses the leaves. The application of zinc either as soil or foliar application through $ZnSO_4$ was found to be non significant. But the maximum number of tillers (8.93 tillers $plant^{-1}$) was found in the soil application of zinc as RDF + $ZnSO_4$ @ 30 kg ha^{-1} (T_4) and lowest number of tillers (6 tillers $plant^{-1}$) was seen in recommended dose of fertilizer (RDF) 80:40:40 NPK kg ha^{-1} (T_1) treatment. Over all plant growth is directly

reflected in production of tillers in wheat plant. Therefore, counting of tillers provides adequate basis for measuring the treatment differences owing to various micronutrient treatments. The application of zinc with RDF might have increased the use efficiency of added nutrient and supplied it continuously to the plant throughout the crop growth period and promoted various physiological activities in plant which is considered to be indispensable for proper growth and development. Zinc also helped in formation of growth hormones and auxin metabolism which helped the plant for increase in tillers. These findings are in accordance with Dewal and Pareek (2004) [2] and Dhaliwal *et al*. (2012) [3]. Khan M. U. (2002) [8] also concluded that application of zinc increased the number of tillers significantly over control treatment.

D. Number of seeds

The numbers of seed (51.33 seeds plant^{-1}) were significantly superior in RDF + $ZnSO_4$ @ 30 kg ha^{-1} (T_4) than other treatment which was higher over recommended dose of fertilizer (RDF) 80:40:40 NPK kg ha^{-1} (T_1) treatment which shows that application of zinc increased its reproductive potential. The lowest number of seeds (42.74 seeds plant^{-1}) was found in the RDF (T_1) treatment. The favourable response of zinc application on number of seeds has also been reported by Habib (2009) [4] in wheat and reported that there is an increase in number of seeds per earhead with application of zinc. Yassen *et al.* (2010) [13] also reported the increase in grains per earhead with increase in zinc doses in wheat.

Table 2: Effect of zinc application on dry matter accumulation, number of tillers and number of seeds of wheat

Treatments		Number of tillers plant^{-1}	Dry matter accumulation (g plant^{-1})	Number of seeds plant^{-1}
T_1	Recommended dose of fertilizer (RDF) 80:40:40 NPK kg ha^{-1}	6	4.93	42.74
T_2	RDF + $ZnSO_4$ @ 10 kg ha^{-1}	7.10	5.05	45.90
T_3	RDF + $ZnSO_4$ @ 20 kg ha^{-1}	7.50	5.19	48.43
T_4	RDF + $ZnSO_4$ @ 30 kg ha^{-1}	8.93	5.35	51.33
T_5	RDF + $ZnSO_4$ @ 40 kg ha^{-1}	7.80	5.27	50.10
T_6	RDF + $ZnSO_4$ Two foliar sprays @ (0.5%) First at pre flowering and second at milk stage	8.03	5.31	50.50
T_7	RDF + $ZnSO_4$ Two foliar sprays @ (1.0%) First at pre flowering and second at milk stage	8.46	5.33	51.10
	SE (m)±	1.154	0.012	0.755
	CD at 5%	NS	0.036	2.292

E. Yield

The significantly higher seed yield (9.80 g pot^{-1}) of wheat was observed in the treatment of soil application RDF + $ZnSO_4$ @ 30 kg ha^{-1} (T_4) and it was at par with treatment RDF + $ZnSO_4$ two foliar sprays @ (1.0%) first at pre flowering and second at milk stage (T_7), RDF + $ZnSO_4$ two foliar sprays @ (0.5%) first at pre flowering and second at milk stage (T_6), RDF + $ZnSO_4$ @ 40 kg ha^{-1}(T_5), RDF + $ZnSO_4$ @ 20 kg ha^{-1} (T_3). The lowest seed yield of wheat (8.40 g pot^{-1}) was recorded in RDF (T_1). The soil application zinc as $ZnSO_4$ @ 30 kg ha^{-1} (T_4) increased the seed yield over RDF (T_1) 80:40:40 kg ha^{-1} and it was significantly higher over other treatments. Foliar application of zinc as RDF + $ZnSO_4$ two foliar sprays @ (1.0%) first at pre flowering and second at milk stage (T_7) and RDF + $ZnSO_4$ two foliar sprays @ (0.5%) first at pre flowering and second at milk stage (T_6) increased the seed yield over RDF respectively. The RDF + $ZnSO_4$ @ 40 kg ha^{-1} (T_5) and RDF + $ZnSO_4$ @ 20 kg ha^{-1} (T_3) also increased over RDF respectively. The RDF 80:40:40 NPK kg ha^{-1} (T_1) treatment decreased the seed yield over RDF + $ZnSO_4$ @ 10 kg ha^{-1} (T_2) because of the deficient nutrient content in soil. Similar result are in close agreement with the findings reported by Keram *et al*. (2013) [6] who reported that increased in grain size and number of grain per earhead has positive correlation with grain yield.

The significantly higher wheat straw yield (11.93 g pot^{-1}) was also observed with soil application of RDF + $ZnSO_4$ @ 30 kg ha^{-1} (T_4) and it was found to be at par with RDF + $ZnSO_4$ two foliar sprays @ (1.0%) first at pre flowering and second at milk stage (T_7), RDF + $ZnSO_4$ two foliar sprays @ (0.5%) first at pre flowering and second at milk stage (T_6), RDF + $ZnSO_4$ @ 40 kg ha^{-1} (T_5). The lowest straw yield of wheat (10.40 g pot^{-1}) was recorded in RDF 80:40:40 NPK kg ha^{-1} (T_1) treatment.

The straw yield was increased might be due to involvement of zinc in variety of physiochemical and biochemical processes. Similar result quoted by Haslett *et al*. (2001) [5], Mohammad *et al*. (2009) [1], Yassen *et al*. (2010) [13] and Shivay *et al*. (2013) [12] reported that the increased straw yield over the RDF. Our results are in line with Ram *et al.* (2012) [10] which showed that the soil application of Zn had economic and long term effects on enhanced crop production on Zn deficient soils. Zinc is a constituent of number of enzymes as carbonic anhydrogenase and also help for formation of growth hormones such as auxin, promote starch formation and seed maturation. This could be the reason for increased grain and straw yield of wheat.

Table 3: Effect of zinc application on yield of wheat

Treatments		Yield (g pot^{-1})	
		Grain	Straw
T_1	Recommended dose of fertilizer (RDF) 80:40:40 NPK kg ha^{-1}	8.40	10.40
T_2	RDF + $ZnSO_4$ @ 10 kg ha^{-1}	9.25	11.00
T_3	RDF + $ZnSO_4$ @ 20 kg ha^{-1}	9.45	11.50
T_4	RDF + $ZnSO_4$ @ 30 kg ha^{-1}	9.80	11.93
T_5	RDF + $ZnSO_4$ @ 40 kg ha^{-1}	9.60	11.75
T_6	RDF + $ZnSO_4$ Two foliar sprays @ (0.5%) First at pre flowering and second at milk stage	9.73	11.87

T_7	RDF + $ZnSO_4$ Two foliar sprays @ (1.0%) First at pre flowering and second at milk stage	9.75	11.90
	SE (m)±	0.069	0.067
	CD at 5%	0.209	0.204

Conclusion

From the present investigation it is concluded that the application of $ZnSO_4$ @ 30 kg ha^{-1} along with recommended dose of fertilizer significantly influenced the Plant height, dry matter accumulation, Number of seeds per plant, Yield significantly increased.

Acknowledgment

The authors are thank full to teachers and staff of Department of Soil Science and Agricultural Chemistry for providing facilities for the research work.

References

1. Chandrakumar K, Helepyati AS, Desai BK, Pujari BT. Grain yield dry matter production and its partitioning in wheat var. DWR-195 as influenced by organics, macro, micronutrients and methods of application. Karnataka Journal of Agricultural Science. 2002; 17(1):10-16.
2. Dewal GS, Pareek RG. Effect of phosphorus, sulphur and zinc on growth, yield and nutrient uptake of wheat. Indian J Agron. 2004; 49(3):160-162.
3. Dhaliwal SS, Sadana US, Khurana MP, Sidhu SS. Enrichment of wheat grains with Zn through ferti-fortification. Indian J Fert. 2012; 8(7):48-55.
4. Habib M. Effect of foliar application of Zn and Fe on wheat yield and quality. African journal of biotechnology. 2009; 8(24):6795-6798.
5. Haslett BS, Reid RJ, Rangel Z. Zinc mobility in wheat: Uptake and distribution of zinc applied to leaves or roots. Annals of Botany. 2001; 87:379-386.
6. Keram KS, Sharma BL, Sharma GD, Thakur RK. Impact of zinc application on its translocation into various plant parts of wheat and its effect on chemical composition and quality of grain. Scientific Research and Essays., 2013; 8(45):2218-2226.
7. Khan MU, Qasim M, Khan I. Effect of Zn fertilizer on rice grown in different soils of Dera Ismail Khan. Sarhad J. Agric. 2007; 23(4):72-75.
8. Khan MU. Yield and quality of rice (*Oryza sativa* L.) as affected by different levels and methods of zinc application., Ph. D Thesis, Gomal University, Dera Ismail Khan, Pakistan, 2002.
9. Mohammad R, Pahlavan-Rad, Mohammad, Pessarakli. Response of wheat plants to zinc, iron and manganese applications, uptake and concentration of zinc, iron and manganese in wheat grains. Communication in Soil Science and Plant Analysis. 2009; 40(7, 8):1322-1332.
10. Ram A, Pannu RK, Prasad D. Effect of management practices on growth, yield and quality of late sown wheat. Indian J. Agron. 2012; 57:92-95.
11. Ranjbar GA, Bahmaniar MA. Foliar application of Zn fertilizer on yield and growth of bread wheat (*Triticum aestivum* L.) cultivars. Asian Journal of Plant Sciences. 2007; 6(6):1000-1005.
12. Shivay YS, Prasad R, Pal M. Zinc fortification of Oat grains through zinc fertilization. Agric. Res., 2013; 2(4):375-381.
13. Yassen A, Abou EA, El-Nour A, Shedeed S. Response of wheat to foliar spray with urea and micronutrients. J Ame. Sci. 2010; 6(9):14-22.
14. Yin H, Gao XP, Stomph T, Li L, Zhang FS, Zou CQ. Zinc concentration in rice (*Oryza sativa* L.) grains and allocation in plants as affected by different zinc fertilization strategies. Commu. Soil Sci. and Plant Ana. 2016; 47(6):761-768.