E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(9): 347-353
Received: 24-07-2024
Accepted: 28-08-2024

Vipin Kumar Yadav
Ph.D. Scholar, Department of Agronomy, Shri Durga Ji Post Graduate Collage Chandeshwar, Azamgarh, Utter Pradesh, India

Phool Chandra Singh
Professor, Department of Agronomy, Shri Durga Ji Post Graduate Collage Chandeshwar, Azamgarh, Utter Pradesh, India

Jitender Yadav
Ph.D. Scholar, Department of Agronomy, Shri Durga Ji Post Graduate Collage Chandeshwar, Azamgarh, Utter Pradesh, India

Amar Singh Gaur
Assistant Professor, Department of Agriculture, Jananayak Chandrashekher University Ballia, Utter Pradesh, India

Corresponding Author:
Vipin Kumar Yadav
Ph.D. Scholar, Department of Agronomy, Shri Durga Ji Post Graduate Collage Chandeshwar, Azamgarh, Utter Pradesh, India

Effects of different source zinc and application methods on growth and yield of wheat (*Triticum aestivum* L.) under timely sowing crop

Vipin Kumar Yadav, Phool Chandra Singh, Jitender Yadav and Amar Singh Gaur

DOI: https://doi.org/10.33545/2618060X.2024.v7.i9Se.1503

Abstract
Wheat (*Triticum aestivum* L.) has been described as the "kin of cereals" and one of the most important staple food crops cultivated in at least 43 countries. This study, was conducted field experiment during *rabi* season of 2021-22 and 2022-23 at Shri Durga ji Post-graduate College Chandeshwar Azamgarh Uttar Pradesh, India. Investigating different micro nutrient management approaches with cost effective and plant need based micro fertilizer recommendations. These approaches provide principles and tools for supplying different dose of Zinc for crop nutrients to achieve higher yield. These methods not only aim to modify micro nutrient dose but also apply at optimal rate and time to achieve higher yield and nutrient efficiency by the crop. The wheat growing area Zn deficiency one of the major problems of wheat area. The experiment consisted five treatment and nutrient management options as applied in sources Zn in different treatments. T_1 -Control: seed soaking with distilled water (6 hours) and drying for 24 hours at NTP in shade +No. Zn addition T_2- Seed soaking with 4% solution of ZnSo4 (6 hours) and drying for 24 hours at NTP in shade, T_3 Seed soaking with 8% solution of ZnSo4 (6 hours) and drying for 24 hours at NTP in shade T_4- 26 kg of ZnSo4/ ha. As basal before sowing and T_5 28 kg of ZnSo4/ ha. As basal before sowing. These treatments were replicated four time in a randomized block design in different plots. The results of the experiment indicate that significantly higher values of growth parameters (plant populations, plant height, fresh shoot weight, dry shoot weight, No. of leaves, No. of tillers,). Significantly higher plant height and No. of leaves and No. of Tiller of wheat was recorded is 60 and 90 DAS but 30 DAS were non-significantly effect with treatment T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing) over rest of the treatments except T_4 (26 kg of $ZnSO_4$/ ha. As basal before sowing). Application of T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing) recorded maximum No. of leaves, No. of tillers which was significantly higher over rest of the treatments except T_4 (26 kg of $ZnSO_4$/ ha. As basal before sowing) during both the years experimentations. Fresh shoot and Dry shoot accumulation at 30 DAS was not significantly influenced by micro different nutrient management options with applications Zn. Which, application of T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing) recorded maximum fresh shoot and dry shoot weight at 60 and 90 DAS which was superior over rest of the treatments except T_4 (26 kg of $ZnSO_4$/ ha. As basal before sowing) on pooled basis and yield attributes (No. of productive tillers, length of spick No. of grain spick, grain yield, straw yield, biological yield, harvest index and test weight) of wheat were recorded significantly Superior performance of growth and yield attributes resulted in T_5 28 kg of ZnSo4/ ha. As basal before sowing significant enhancement in grain, straw and biological yield. The wheat is maximum recorded 40.63, 41.86 and 41.25 grain yield and 58.59,59.88 and 59.24 straw yield and biological yield 99.22,101.74 and 100.48 q ha^{-1} higher with both year, of the experimentations respectively.

Keywords: Wheat (*Triticum aestivum* L.), king of cereals, staple food crop

Introduction
Wheat (*Triticum aestivum* L.) has been the most important staple food crop cultivated in at least 43 countries. About 35 percent of the world's population directly or indirectly depends upon wheat for food and about 20 percent of the world's protein supply comes from wheat alone. It significantly contributed towards the green revolution's success and greatly helped transform our country from a situation of “ship to mouth” to self-sufficiency. It is cultivated in almost all the states of India, but its extensive cultivation is confined to Uttar Pradesh, Punjab, Haryana,

Madhya Pradesh Rajasthan and Gujarat.

The cultivation of wheat and nutrient management approaches are cost-effective and plant-need-based fertilizer recommendations. These approaches provide principles and tools for supplying crop nutrients to achieve higher yields. These approaches not only aim to modify fertilizer dose but also apply nutrients at optimal rate and time to achieve higher yield and nutrient use efficiency by the crop. Nutrient Expert is a decision support tool for nutrient management in wheat based on organic and inorganic nutrient management with the use of zinc as a micro nutrient. It was developed by the International Plant Nutrition Institute (IPNI) and CIMMYT, Mexico. It provides nutrient recommendations for an individual farmers' field both in presence or absence of soil testing data. It also 4R principle works on the - right method, right amount, right dose, and right time. This will help to increase yield as well as profit by target enabled strategy for fertilizer management. The crop growing area of wheat ranks first in the area and production at global level, and India is the second largest wheat producer in the world followed by China. Which is total area of world is 224.49 Mha. and production is 7.92 with a productivity of 34.34 is India, estimated to be around 31.76 Mha and production is 108.75 Mt with a productivity is 34.32 q. ha. Recently, several wheat varieties have been developed, significantly boosting food grain production and minimizing malnutrition and starvation. However, the bioavailability of micronutrients (Zn, Cu, Mn, Fe, etc.) in wheat cultivars is generally quite low. Zn and Fe concentrations in present cultivated wheat were found to be lower than in wild wheat (Cakmak *et al*., 2004) [1]. Old wheat cultivars were claimed to be rich in comparison to modern cultivars. It might be due to more efficient micronutrient absorbance and their translocation to grain than today's semi-dwarf, high-yielding varieties that were introduced after the mid-1960s. The range of Zn availability in wheat varieties in India varies from 20-30 mg kg^{-1} (PAU, 2011). Zn deficiency affects, on average, one third of world's population, ranging from 4 to 73 percent in different countries (Hotz and Brown, 2004) [26].

The provision of wheat grains with higher micronutrient levels is a challenging task for wheat production because the production approach is a long-term process and may be affected by very low chemical solubility of Zn and Fe in soil due to high pH and low organic matter (Cakmak, 2008) [1] but one that would complement the use of supplemental fertilizers (Agronomic manipulation) particularly on soils inherently low in these nutrients. There are several examples demonstrating that applying Zn fertilizers to cereal crops improves not only productivity but also grain Zn concentration. Plants are capable of absorbing soluble compounds and gases through leaves. The application of foliar spray implies that the micro-nutrient will be absorbed from the point of application (leaves) to the point of utilization (growing tissue).

The application of micronutrients for different methods as specific and critical growth stages of wheat may contribute towards mineral enrichment of grain and yield enhancement by improving their availability. The most effective method for increasing grain zinc concentration is the soil + foliar application method which may result in an about 3-fold increase in grain Zn concentration (Cakmak *et al*., 2010b) [3]. Applying Zn during the grain development stage contributes to increased grain Zn concentration (Zhang *et al.*, 2010) [8]. Recently, it has been reported that grain concentration of Zn can be increased by enhancing the N supply. Zn and N applications have a synergistic effect on grain Zn concentration of wheat (Kutman *et al*., 2010; Shi *et al*., 2010) [9, 10].

Materials and Methods

The research experiment was conducted at Sri Durga Ji P.G. College in Chandeswar, Azamgarh, U.P., which are primarily agricultural, practices focusing on cereals pulses, oil seeds, sugar cane, and fruits like mango and guava area. Azamgarh is geographically located 26°27' North latitude, and 83°11' East longitude. It is bordered by Mau, Gorakhpur, Ghazipur, Jaunpur, Sultanpur, and Ambedkar Nagar. The region experiences a hot climate year-round, with temperatures ranging from 46°F to 103°F and approximately 932.1 millimeters of precipitation annually. Azamgarh has limited industrial development, with notable industries including sugar milling, Banarasi sari production, and black pottery. The experimental crop in Azamgarh was uniformly fertilized with 100-120 kg of nitrogen (N), 60-80 kg of phosphorus (P), and 40-60 kg of potassium (K) and 20-25 kg of zinc (Zn) per hectare, using urea, diammonium phosphate, and muriate of potash and Zinc sulphate respectively. At sowing, the entire dose of P and K along with one-third of N was applied, with the remaining Nitrogen and Zinc dose top-dressed after the first irrigation. Fertilizers were spread right before seeding to promote effective uptake. Sowing involved the HD-2967 wheat variety, planted at 100 kg per hectare with a row spacing of 20 ×10 cm, and manually completed on November 15 for the 2021–22 season and November 16 for the 2022–23 season. Treatments varied between plots, addressing for different method of zinc application. Irrigation was scheduled at critical growth stages, from 20 to 25 days after sowing (DAS), ensuring no water stress occurred. Nutrient (Zn) management was adapted per plot based on specific treatment plans. Harvesting involved manual cutting with serrate edge sickles once 85% of the panicles had matured spikelets. Post-harvest, grains were sun-dried for 4-5 days, then threshed using both tractor-drawn equipment and manual labour. The biological yield was determined by weighing the produce post-threshing, and the grain yield was recorded after adjusting for a 14% moisture content.

Results and Discussion

The two-year wheat cultivation experiments highlighted the importance of nutrient management especially for the application of Zinc on optimizing wheat growth and productivity.

Plant populations

The data related to plant papulations of wheat measure per square meter varied from 18.33-22.33, 18.35-21.26 in treatment T_1 was minimum and T_5 is maximum respectively during 2021-22, 2022-23. Numerically variation were abserved in plant papulation among the treatments but statistically significant differences were not found. The representing the plant population of wheat did as follow the same pattern as described for first year and second year.

Plant height

Plant height of wheat was recorded at 30, 60 and 90 which ranges from 25.75-27.81, 26.25-29.11 cm during 2021-22, 2022-23 respectively. Minimum and maximum plant height was obtained in treatment T_1 (control) and T_5 (28 kg of ZnSo4/ ha. As basal before sowing) 30 DAS. Numerically fluctuation in plant height among the treatments was seen but effect of treatment did not reach up to the level of significance. Plant height wheat at 60 DAS was varied from 41.51.-49.14, 43.74.-50.37 cm in respectively. Minimum and maximum plant height was obtained in treatment T_1 (control) and T_5 (28 kg of ZnSo4/

ha. As basal before sowing) at 60 DAS. Numerically fluctuation in plant height among the treatments was seen as well as effect of treatment reach up to the level of significance. Plant height at 90 DAS of wheat varied from 76.89- 86.21, 78.95-87.42and 77.65- 86.81 cm during the study periods and in pools data respectively. Minimum and maximum plant height was recorded in treatment T_1 (control) and T_5 (28 kg of ZnSo4/ ha. As basal before sowing). Plant height at 90 DAS follows the same pattern of variations as described for 60 DAS. Over all the review of data revealed that treatment T_5 was highly significant over all the treatment during the investigation. El Habbasha *et al.* (2015) [12] found that foliar application of zinc significantly increases the plant height of wheat. The higher plant height of wheat crop with treatment T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing) might be due to the positive interaction effect of nitrogen and zinc nutrients which enhances the uptake of each other and increase the plant height of wheat. Prasad *et al.* (2016) [11] also reported that zinc positively impacts with nitrogen in the soil.

Dry shoot weight/per plant at 60 and 90 DAS

It is evident different nutrient management options were treated (zinc application) with Seed soaking with 4% solution of $ZnSO_4$ (6 hours) and drying for 24 hours at NTP in shade and a different dose of $ZnSO_4$/ ha. As basal before sowing recorded significant variations in dry matter accumulations (per plant) at 60 DAS during both the year and on a pooled basis. Application of treatment T_5 (28 kg of ZnSo4/ ha. As basal before sowing) and T_1 (control) recorded maximum and minimum values of 243.88-257.30, 244.46-255.72 and 244.17-257.59 dry matter accumulation which was significantly superior over rest of the treatments except T_4 (26 kg of ZnSo4/ ha. As basal before sowing application) during both year and on pooled basis data. Data further revealed that on T_5 significantly higher over the rest of treatment but it was statistically at par with T_4.

The data recorded significant variations in dry matter accumulations at 90 DAS during both the years. Application of treatment T_5 and T_1 (28 kg of ZnSo4/ ha. As basal before sowing) recorded maximum and minimum values 752.20-767.13, 752.87- 767.80 is dry shoot accumulation, which was significantly superior over rest of the treatments except T4 (26 kg of ZnSo4/ ha. As basal before sowing application) during both the years and on pooled basis. Data also reveal that on, T_5 recorded significantly higher dry matter accumulation all the treatment Expect to T_4. The difference in dry shoot accumulation due to different nutrient management treatments might be due to the difference in their no. of leaves and no. of tillers production capacity as number of tiller in different scientist reported that increasing levels of nitrogen increases the dry matter accumulation (Chaturvedi, 2006; Tong *et al.*, 2007; Wang *et al.*, 2010 and Lifeng *et al.*, 2011) [13, 5, 14, 16], and tiller numbers (Mattas *et al.*, 2011) in wheat. Ranjbar and Bahmaniar (2007) [17] reported that soil and application of zinc significantly influenced the growth paramerts of wheat

Fresh shoot weight at 30, 60 and 90 DAS

It is evident as basal before sowing 30 DAS fresh weight recorded is not up to the level of significant variations in fresh weight varied from (per plant) 4.29-4.97, 5.07-5.75 and 4.68-5.36 varied during both year and on. Application of T_5 (28 kg of ZnSo4/ ha. As basal before sowing) at 60 DAS recorded maximum and minimum dry matter accumulation was 11.75-18.03, 13.29-18.77 and 13.05-18.56 significantly superior over rest of the treatments except T_4 (26 kg of ZnSo4/ ha. Data further revealed, T_5 recorded over T_1, T_2 T_3, fig. 4.2 it was statistically at par with T_4.

Fresh shoot weight at data presented 90 DAS was recorded significant variations in fresh weight are maximum and the minimum was 85.20-94.48, 86.54-98.07 and 85.87-97.40 at T_5 and T_1 during both the years and on pooled basis. Application of T_5 (28 kg of ZnSo4/ ha. As basal before sowing) recorded maximum fresh weight, which was significantly superior over rest of the treatments except T_4 (26 kg of ZnSo4/ ha. As basal before sowing application) during both the years and on pooled basis.

It is furnished of fresh and dry shoot weight accumulation from par plant at 30, 60 and 90 DAS and no. of leaves per par plant at 30, 60 and 90 DAS, were obtained with treatment T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing). However, treatments T_4 (26 kg of $ZnSO_4$/ ha. As basal before sowing) gave similar values of all these parameters.

Further, there was non-significant variations obtained in dry shoot accumulation from at 30 DAS, fresh and dry weight as well as the no. of leaves per plant due to different nutrient management with options with application of nitrogen and Zn in various dose of treatments. The difference in dry shoot accumulation its might be due to the effect to be no. of leaves and no. of tillers production capacity as number of tiller in different scientist reported and reviled that increasing levels of nitrogen and zinc application, increases the dry matter accumulation higher fresh and dry weight, tillar and number of spick obtained wheat (Chaturvedi, 2006; Tong *et al.*, 2007; Wang *et al.*, 2010 and Lifeng *et al.*, 2011) [13, 5, 15, 16], and tiller numbers (Mattas *et al.*, 2011) in wheat. Ranjbar and Bahmaniar (2007) [17] and Nadim *et al.* (2012) [18].

No. of Leaves per plant at 30, 60 and 90 DAS

An interpretation of data indicates that variation in leaf area index at among different Nutrient management operations and An interpretation of data in Table 1 reveals that different nutrient management options with Zn application recorded non-significant variations in 30, DAS but 60 and 90 DAS significant during both the years. Application of T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing) recorded maximum and minimum 19.37-27.50 and 20.34-28.47 was 60 DAS is significantly superior over rest of the treatments except T_4 (26 kg of $ZnSO_4$/ ha. As basal before sowing) during both the years. Treatment T_5 recorded significantly higher recorded over (Fig. 4.4). But however, it was statistically at par with treatment T_4. A perusal of data reveals that different nutrient management options with different dose of $ZnSO_4$/ ha. As basal before sowing recorded significant variations is No. of Leaves per plant at 90 DAS. The maximum and minimum value range from 32.27-44. 83, 33.02-45.40 and 33.93-45.11 at 90 DAS during both the years and on pooled basis. Application of T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing) recorded significantly superior over T_1 T_2 T_3 and T_4 during both the years.

The no. of leaves and no. of tillers production capacity as number of tiller in different scientist reported that increasing levels of nitrogen increases the dry matter accumulation (Erdal, U., Turan, M. A., & Taban, S. (2003) [22] and tiller numbers (Mattas *et al.*, 2011) in wheat. Mosanna, *et al.* (2015) [27]. Reported that soil and application of zinc significantly influenced the growth paramerts of wheat. Abdoli, *et al.* (2014) [23]. Revealed that higher no of leaves and number of spick obtained with zinc application in wheat

Spick length

The nutrient management and method of Zn application data recorded significant variations in average ear length during both the years of experimentation and on a pooled basis. Application T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing) recorded maximum ear length which was significantly superior over T_1 T_2 T_3 and T_4 during both the years and on. Treatment T_5 recorded significantly higher spick length over T_1 T_2 T_3 but T_4 was at par with each other except to Treatment T_5. The spick length capacity as number of tiller in different scientist reported that increasing levels of nitrogen increases the dry matter accumulation Bharti *et al*. (2013) [24], and tiller numbers (Mattas *et al*., 2011) in wheat. Hotz, *et al*. (2004) [26] reported that soil and application of zinc significantly influenced the growth paramerts of wheat. Revealed that higher fresh and dry weight, tiller and number of spick obtained with zinc application in wheat.

Grain yield wheat

An examination of data reveals that different nutrient management treatments with different method of $ZnSO_4$ ha^{-1} soil application recorded significant variations in grain yield during both the years of experimentation and on pooled basis. The maximum and minimum grain yield was registered 38.35- 40.63 39.38-41.46 with treatment T_5 (28 kg of $ZnSO_4$/ ha. As basal before sowing) and control during both the years. T_5 recorded significantly higher grain yield over T_1 T_2 T_3 but T_4 was at par T_5 A cursory look on data presented and reveals that treatment T_2 (Seed soaking with 4% salution of $ZnSO_4$ (6 houres) and drying for 24 houres at NTP in shade), T_3 (Seed soaking with 8% salution of $ZnSO_4$ (6 houres) and drying for 24 houres at NTP in shade) and T_4 (26 kg of $ZnSO_4$/ ha. As basal before sowing) recorded significantly higher grain yield over T_1 (Control: seed soaking with distilled water (6 houres) and drying for 24 houres at NTP in shade +No. Zn addition) Further, treatment T_4 and T_5 found at par each other of grain yield during both the years.

The differences in effective tillers, grains spick $^{-1}$and average spick length in general attributed because with the higher nitrogen and zinc (both soil and soaking) application tillers produced more productive panicles which led to higher numbers of effective tillers. Further, better nutrition with higher nitrogen and zinc (both soil and soaking) application increases the length of spick and as the number of grain ear^{-1} is associated with ear length, it also increases with increasing spick length. Similar findings also reported by Jan *et al.* (2013). Ahmadi and David (2016) also reported that the number of grains spick and test weight in wheat was significantly influenced by nitrogen with zinc management. Grain yield is the function of different yield attributes *viz.* numbers of effective tillers, grains $ears^{-1}$, average ear length and test weight. An ultimate increase in these components *i.e.* numbers of tillers, grains spick - ^{1}, average ear length and test weight increased the grain yield. These results corroborate the findings of Jan *et al.* (2013).

Table 1: Effect of INM and Zn applications methods on plant population, plant height and dry matter of wheat

Treatment	Plant population / M^2		Plant height (cm)						Dry matter accumulation (g)					
			30 DAS		60DAS		90DAS		30 DAS		60DAS		90DAS	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
T_1-Control: Seed soaking with distilled water	11.0	18.95	25.75	26.25	42.51	43.74	76.89	78.95	46.27	47.72	243.88	244.46	752.20	752.87
T_2-Seed soaking with 4% salution of $ZnSO_4$	19.00	19.93	26.46	27.76	45.98	47.21	82.22	83.43	52.33	52.39	250.32	252.32	759.80	760.47
T_3-Seed soaking with 8% salution of $ZnSO_4$	19.52	20.26	27.08	28.38	46.62	47.85	83.22	84.43	52.47	53.15	252.52	253.10	762.47	761.49
T_4-26 kg of $ZnSO_4$ / ha. As basal before sowing	19.00	20.44	27.57	28.87	47.84	49.07	84.32	85.21	52.80	53.48	254.96	255.54	764.83	765.50
T_5-28 kg of $ZnSO_4$/ ha. As basal before sowing	20.33	21.26	27.81	29.11	49.14	50.37	86.21	87.42	54.07	54.75	257.30	255.72	767.13	767.80
SEM	0.395	0.438	0.630	0.61	0.883	0.883	1.26	1.13	1.56	1.56	2.21	1.52	2.23	0.2
C.D. (0.05)	NS	NS	NS	NS	2.712	2.716	2.65	2.35	NS	NS	7.21	4.98	7.58	7.2
C.V.	3.65	3.76	4.05	3.37	3.11	3.03	4.11	3.707	5.23	5.15	1.52	1.05	0.51	0.5

Table 2: Effect of INM and Zn applications methods on spick, length fresh weight and No. of leaves par plant of wheat

Treatment	Spike length (cm)		Fresh shoot weight/plant at (g.)						No. of leaves per plant					
			30 DAS		60DAS		90DAS		30 DAS		60DAS		90DAS	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
T_1-Control: seed soaking with distilled water	12.59	14.04	4.29	5.07	11.75	13.29	85.20	86.54	8.46	9.81	19.37	20.34	32.27	34.02
T_2-Seed soaking with 4% salution of $ZnSO_4$	15.63	17.08	4.57	5.35	14.32	15.51	89.73	91.07	9.03	10.38	21.83	23.58	38.12	39.77
T_3-Seed soaking with 8% salution of $ZnSO_4$	16.65	18.10	4.62	5.51	15.63	16.12	91.60	92.94	9.07	10.42	23.70	25.50	41.57	42.14
T_4-26 kg of $ZnSO_4$ / ha. As basal before sowing	17.05	18.50	4.70	5.61	16.30	16.79	93.77	95.11	10.17	11.52	25.77	26.74	42.40	42.97
T_5-28 kg of $ZnSO_4$/ ha. As basal before sowing	18.21	19.66	4.97	5.75	18.03	18.77	94.48	98.07	10.33	11.68	27.50	28.47	44.83	45.40
SEM	1.045	1.045	0.51	0.17	0.776	0.798	1.73	1.93	0.517	0.517	1.49	1.52	1.65	1.001
C.D. (0.05)	3.4	3.4	NS	NS	2.53	2.64	3.31	3.62	NS	NS	4.86	4.98	5.18	3.26
C.V.	11.4	10.36	5.93	5.64	8.84	8.59	5.66	6.31	9.51	8.32	10.94	10.62	7.38	4.24

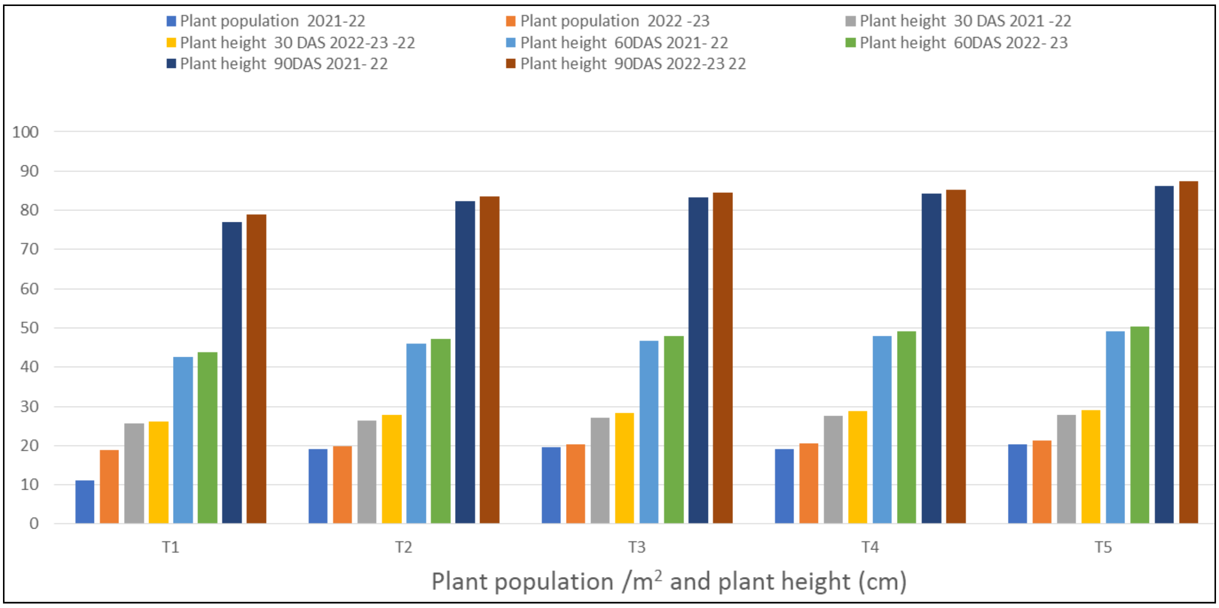

Fig 1: Effect of INM and Zn applications methods on plant population, plant height and dry matter of wheat

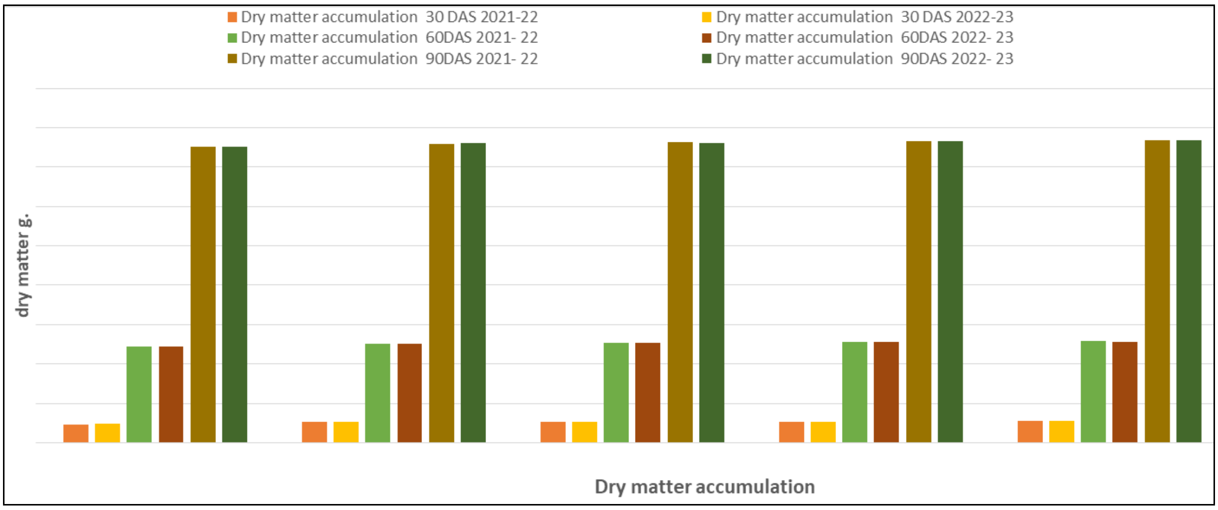

Fig 2: Effect of INM and Zn applications methods on dry matter accumulation of wheat

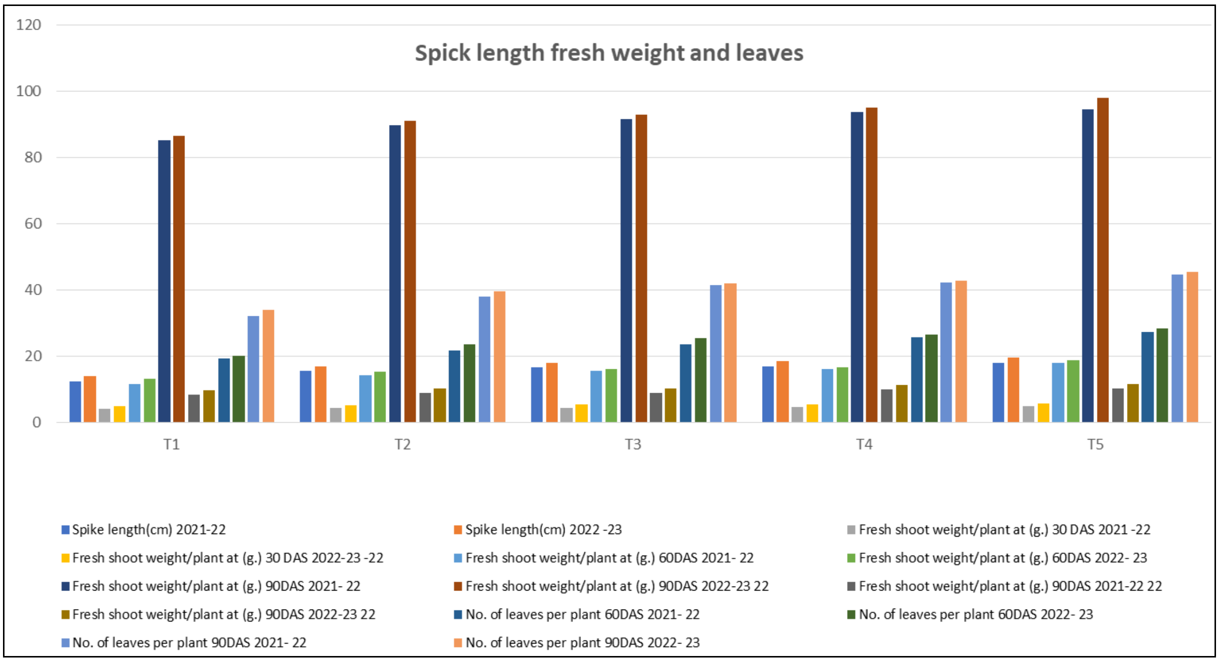

Fig 3: Effect of INM and Zn applications methods on spick, length fresh weight and No. of leaves par plant of wheat

Conclusion

The obtained result it's on the basis of observation that among different doses of Zn with application of wheat varieties, HD-2967 and among different nutrient management options with methodology of Zn application on growth and yield with treatment 28 kg of ZnSo4/ ha. As basal before sowing soil application and recorded highest grain yield, net return and B: C ratio. Further, Nitrogen phosphorus, potassium and zinc concentrations in wheat grain and straw increased by soil application (at milking and dough stage) of zinc along with higher nitrogen phosphorus and potassium application. Therefore, zinc of wheat variety HD-2967 can be obtained with 28 kg of ZnSo4/ ha. As basal before sowing under the wheat crops, the treatment is also further required to the validation of the trail.

References

1. Cakmak I. Enrichment of cereal grains with zinc: agronomic or genetic biofortification? Plant Soil. 2008;302(1-2):11-17.
2. Cakmak I. Biofortification of cereals with Zn and Fe through fertilization strategy. In: 19th World Congress of Soil Science, Soil solution for a changing world. Brisbane, Australia; c2010. p. 4-6. Published DVD.
3. Cakmak I, Kalayci M, Kaya Y, Torun AA, Aydin N, Wang Y, Arisoy Z, Erdem HAMIDE, Yazici A, Gokmen O, Ozturk L. Biofortification and localization of zinc in wheat grain. J Agric Food Chem. 2010;58(16):9092-9102.
4. Cakmak I, Torun A, Millet E, Feldman M, Fahima T, Korol A, Nevo E, Braun HJ, Ozkan H. Triticum dicoccoides: an important genetic resource for increasing zinc and iron concentration in modern cultivated wheat. Soil Sci Plant Nutr. 2004;50(7):1047-54.
5. Tong Y, Zhao Y, Zhao H, Fan H. Effect of nitrogen rates on uptake and transformation and yield of winter wheat. Plant Nutr Fertil Sci. 2007;13(1):64-9.
6. Khaleque MA, Paul NK, Meisner CA. Yield and N use efficiency of wheat as influenced by bed planting and nitrogen application. Bangladesh J Agric Res. 2008;33(3):439-48.
7. Cakmak I, Torun B, Erenoglu B, Ozturk L, Marscher H, Kalayci M, Ekiz H, Yilmaz A. Morphological and physiological differences in the response of cereals to zinc deficiency. Euphytica. 1998;100(1-3):349-57.
8. Zhang Y, Shi R, Rezaul KMD, Zhang F, Zou C. Iron and zinc concentrations in grain and flour of winter wheat as affected by foliar application. J Agric Food Chem. 2010;58(23):12268-74.
9. Kutman UB, Yildiz B, Oturk I, Cakmak I. Improved nitrogen status enhances zinc and iron concentrations both in the whole grain and the endosperm fraction of wheat. J Cereal Sci. 2011;53(1):118-25.
10. Shi R, Jhang Y, Chan X, Sun Q, Zhang F, Romheld V, Zou C. Influence of long-term nitrogen fertilization on micronutrient density in grains of winter wheat (*Triticum aestivum* L.). J Cereal Sci. 2010;51(1):165-70.
11. Prasad R, Shivay YS, Kumar D. Interactions of zinc with other nutrients in soils and plants - a review. Indian J Fertilisers. 2016;12(5):16-26.
12. El Habbasha SF, Elham A, Badar, Latef EA. Effect of zinc foliar application on growth characteristics and grain yield of some wheat varieties under zinc deficient sandy soil condition. Int J Chem Tech Res. 2015;8(6):452-8.
13. Chaturvedi I. Effect of different nitrogen levels on growth, yield and nutrient uptake of wheat (*Triticum aestivum* L.). Int J Agric Sci. 2006;2(2):372-4.
14. Wang G, Gutuerrez M, Ottman M, Thorp K. Durum wheat yield prediction at flowering stage for late N management. Forage Grain Report. College of Agriculture and Life Sciences, University of Arizona; 2010. p. 38-47.
15. Wang S, Li M, Liu K, Tian X, Li S, Chen Y, Jia Z. Effects of Zn, macronutrients and their interactions through foliar applications on winter wheat grain nutritional quality. PLoS One. 2017;12(7):1-15.
16. Lifeng W, Fuckang Z, ZinJun L, HanMi Z. Effect of irrigation and nitrogen fertilizer on growth and yield of spring wheat in Hexi oasis of Gansu (China). J Northwest A&F Univ - Nat Sci. 2011;39(7):55-63.
17. Ranjbar GA, Bahmaniar MA. Effects of soil and foliar application of Zn fertilizer on yield and growth characteristics of bread wheat cultivars. Asian J Plant Sci. 2007;6(6):1000-5.
18. Nadim MA, Awan IU, Baloch MS, Khan EA, Naveed K, Khan MA. Response of wheat (*Triticum aestivum* L.) to different micronutrients and their application methods. J Anim Plant Sci. 2012;22(1):113-9.
19. Jan A, Wasim M, Amanullah J. Interactive effects of zinc and nitrogen application on wheat growth and grain yield. J Plant Nutr. 2013;36(1):1506-20.
20. Ahmadi SA, David AA. Effect of nitrogen and zinc on yield of wheat (*Triticum aestivum* L.). Int J Multidisciplinary Res Dev. 2016;3(5):291-3.
21. Abbas KA, Jarallah H, Al-Amedy. Effect of N and Zn use efficiency on yield and both nutrients uptake by wheat. J Agric Vet Sci. 2017;10(3):81-8.
22. Erdal U, Turan MA, Taban S. Effect of zinc application on growth and nutrient contents of corn grown in soils with different characters. Ankara Univ J Agric Sci. 2003;9:334-9.
23. Abdoli M, Esfandiari E, Mousavi SB, Sadeghzadeh B. Effects of foliar application of zinc sulfate at different phenological stages on yield formation and grain zinc content of bread wheat (cv. Kohdasht). Azarian J Agric. 2014;1(1):11-7.
24. Bharti K, Pandey N, Shankhdhar D, Srivastava PC, Shankhdhar SC. Improving nutritional quality of wheat through soil and foliar zinc application. Plant Soil Environ. 2013;59(8):348-52.
25. Hotz C, Braun KH. Assessment of the risk of zinc deficiency in populations and options for its control. Food Nutr Bull. 2004;25(2):194-204.
26. Li M, Yang XW, Tian XH, Wang SX, Chen YL. Effect of nitrogen fertilizer and foliar zinc application at different growth stages on zinc translocation and utilization efficiency in winter wheat. Cereal Res Commun. 2014;42(1):81-90. doi:10.1556/CRC.2013.0042.
27. Mosanna R, Khalilvand-Behrozyar E. Effect of zinc nano-chelate foliar and soil application and different growth stages on physiological performance of maize (*Zea mays* L.). Biol Forum Int J. 2015;7(1):1327-30.
28. Movahhedy-Dehnavy M, Modarres-Sanavy SAM, Mokhtassi-Bidgoli A. Foliar application of zinc and manganese improves seed yield and quality of safflower (*Carthamus tinctorius* L.) grown under water deficit stress. Ind Crops Prod. 2009;30:82-92. DOI: 10.1016/j.indcrop.2009.02.004.
29. Faujdar SR, Mahendra S. Effect of FYM, biofertilizers and zinc on yield of maize and their residual effect on wheat. J

Crops Soil. 2013;23(1):41-52.
30. Hossain SMA, Kamal AMA, Islam MR, Mannan MA. Effects of different levels of chemical and organic fertilizers on growth, yield and protein content of wheat. J Bio Sci. 2002;2:304-6