www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(3): 4325-4328

www.thepharmajournal.com
Received: 18-01-2023
Accepted: 24-02-2023

Rahmat Gul
Ph.D. Scholar, Division of Agronomy, SKUAST, Jammu, Jammu and Kashmir, India

Dr. Meenakshi Gupta
Professor, Division of Agronomy, SKUAST, Jammu, Jammu and Kashmir, India

Dr. BC Sharma
Professor, Head & Dean, FOA, SKUAST, Jammu, Jammu and Kashmir, India

Dr. SarabdeepKour
Associate Professor, Department of Soil Science & Agriculture Chemistry, SKUAST, Jammu, Jammu and Kashmir, India

Dr. Rajeev Bharat
Senior Scientist, Department of Agronomy, AICRP-Rapeseed & Mustard, SKUAST, Jammu, Jammu and Kashmir, India

Shubham Jamwal
Ph.D. Scholar, Division of Agronomy, SKUAST, Jammu, Jammu and Kashmir, India

Corresponding Author:
Rahmat Gul
Ph.D. Scholar, Division of Agronomy, SKUAST, Jammu, Jammu and Kashmir, India

Influence of Zinc and Iron nutrition on growth and quality of wheat (*Triticum aestivum* L.) in Shivalik foot hills

Rahmat Gul, Meenakshi Gupta, Sarabdeep Kour, BC Sharma, Rajeev Bharat and Shubham Jamwal

Abstract
To assess the influence of zinc and iron nutrition management on wheat growth and quality the experiments were carried during *rabi* (winter) seasons of 2020-21 and 2021-22 at the Research Farm, Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha. The experiment was replicated thrice and comprised of three wheat varieties and six levels of Zn and Fe as Factor-B arranged in factorial randomized block design. The results revealed that Wheat variety WH 1105 gave the maximum plant height and dry matter accumulation, recorded at maximum tillering stage i.e. 60 days after sowing (DAS) as well as grain yield and gluten content than varieties WB 02 and HD 3086 in comparison whereas application of Rec. NPK + soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1} and foliar application of chelated $FeSO_4$ @ 1% at pre-anthesis and chelated $ZnSO_4$ @ 0.5% at grain filling stages (T_6) resulted in maximum plant height and dry matter accumulation, recorded at 60 DAS, grain yield and gluten content grain yield, straw yield and harvest index besides the gross returns, net returns and near to maximum B:C ratio than other treatments in comparison.

Keywords: Wheat, zinc, iron, bio-fortification, economics, harvest index, grain yield

Introduction

In order to maintain crop productivity, proper nutrient management is essential. Micronutrients are essential for plant growth and development, and they account for a sizable portion due to their importance in increasing crop yields (Bana *et al*., 2021) [4]. Intensive cropping with high yielding varieties is causing a marked depletion of inherent macro and micro nutrient reserves of soil (Kour *et al*., 2014) [14]. Iron and Zinc deficiencies affect more than three billion people globally and the frequency is rising at an alarming rate (WHO, 2002; Welch and Graham, 2004) [19, 18]. The main cause of human micronutrient deficiencies is poor nutritional quality of agricultural goods, especially in developing nations where products from cereal crops, including wheat and rice, represent staple diets (Welch and Graham, 2004) [18]. In addition to the low concentration and low bioavailability of micronutrients in cereal grain, milling further lowers the concentrations of Fe, Zn, and other minerals (Cakmak, 2010) [7]. To maintain an adequate level of available zinc and iron in soil solution as well as in plants and adequate zinc and iron transport to plants, agronomic bio-fortification appears to be essential. Recently, researchers have focused on "bio-fortification" as a fresh approach to addressing micronutrient deficiencies. In bio-fortification, the basic grain is improved by the use of fertilizer at appropriate crop growth stages while the crop is growing. The bio-fortification of the grains through agronomic methods is more cost-effective, sustainable, and simple to apply than genetic bio-fortification. (Frossard *et al*., 2000; Bana *et al*., 2021) [11, 4]. The soil and foliar nutrition is an important method of fertilizer application because it facilitates easy and quick nutrient utilization (Kandoliya *et al*., 2018) [13]. Depending on the application technique, Zn and Fe fertilizers can increase grain Zn and Fe concentration by up to three or four times. The most effective method for doing this was the soil + foliar application method, which increased the concentration of Zn and Fe in grain by roughly three and a half times.

Material and Method

The experiment was carried to determine the efficacy of soil and foliar application of zinc and iron on wheat yield and productivity during *rabi* (winter) season 2020-21 at the Research Farm, Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha.

The experiment comprised of three wheat varieties *viz*, V_1-WB 02 (fortified), V_2-HD-3086 (non-fortified), V_3-WH-1105 (non-fortified) in Factor-A and 6 levels of Zn and Fe as Factor-B *viz*, Rec. NPK (T_1),Rec. NPK + soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1}(T_2), Rec. NPK+ soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1} and foliar application of chelated $ZnSO_4$ @ 0.5% at both during pre-anthesis and grain filling stages (T_3), Rec. NPK + soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1} and foliar application of chelated $FeSO_4$ @ 1% both during pre-anthesis and grain filling stages (T_4), Rec. NPK + soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1} and foliar application of chelated $ZnSO_4$ @ 0.5% at pre-anthesis and chelated $FeSO_4$ @1% at grain filling stages (T_5) and Rec. NPK + soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1} and foliar application of chelated $FeSO_4$ @ 1% at pre-anthesis and chelated $ZnSO_4$ @ 0.5% at grain filling stages (T_6) arranged in factorial randomized block design with 3 replication. The soil of the experimental field was sandy clay loam in texture, slightly alkaline (7.43) in reaction, low in organic carbon (4.9), low in available nitrogen (218.85) and Zinc (0.56 mg kg^{-1}) but medium in available potassium (132.4) and available phosphorous (14.11). The soil contained sufficient levels of Fe (20.13 mg Kg^{-1}). The crop was sown in second week of November, 2021. Full doses of P and K, along with one-third of N, were applied as a basal dose at the time of sowing using inorganic sources of nutrients, such as DAP, MOP and Urea respectively. The remaining two-thirds of N were applied in two equal splits depending on the treatments at the CRI and pre-booting stages, with chelated $ZnSO_4$ applied as per the treatments. Crop growth in terms of plant height and dry matter accumulation was recorded at 60 DAS. Plant height of wheat was measured from the base of the plant at ground surface to the tip of the tallest leaf/panicle using a standard meter scale and was expressed in cm. Wheat plants from second row of one meter length were cut at the ground level, dried and weighed for recording dry matter accumulation. The grain and straw yield were calculated using the net plot area and converted to kg/ha. Gluten content of wheat flour was estimated by hydrating the flour with water and later washing the dough free of starch, sugars, water soluble proteins and other minor components. Individual data from the various characters studied in the experiment were statistically analyzed. The standard error of mean, critical difference (C.D.) at 5% level of probability and coefficient of variance were calculated using standard procedures.

Results and Discussion

The data presented in Table 1 indicates that the maximum plant height (38.08 and 38.18 cm), dry matter accumulation (130.24 and 149.80 g m^{-2}), grain yield (4519.8 and 4678.4 kg/ha) and gluten content (11.38 and 11.26%) was noticed in WH-1105, which was at par with WB 02. However, lowest plant height, dry matter accumulation, grain yield (3710.20kg /ha) and gluten content was recorded in wheat variety HD-3086. This may be attributed to greater genetic potential and efficient utilization of Zn and Fe thereby leading to production of maximum leaf area and dry matter which translated into higher yield of wheat varieties WH 1105 and WB 02. Similar findings were reported by Yilmaz *et al*., 1997 [21] who reported increased grain and straw yield, zinc content in wheat crop with soil and foliar application of Zn. Similar findings were also reported by Chaudhary *et al*. (2007) [8].

Among various levels of Zn & Fe treatment, application of Rec. NPK + soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1} and foliar application of chelated $FeSO_4$ @ 1% at pre-anthesis and chelated $ZnSO_4$ @ 0.5% at grain filling stages (T6) recorded significantly more plant height, (40.5 &40.55 cm) dry matter production, (139.8 &161.7g m^{-2}) grain yield (4340.5 &4520.90 kg /ha)and gluten content (11.28 & 11.33%) which remained statistically at par with application of Rec. NPK + soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1} and foliar application of chelated $ZnSO_4$ @ 0.5% at pre-anthesis and chelated $FeSO_4$ @1% at grain filling stages (T_5). However, the minimum plant height, dry matter production, grain yield and gluten content were found in control plots i.e. recommended NPK fertilization in the wheat crop. The interaction effect remained to be not-significant. The result indicates that the maximum plant growth and grain yield was recorded with soil application of chelated $ZnSo_4$ as well as foliar spray of chelated $ZnSo_4$ and $FeSo_4$. This can be due to the role of iron in the formation of starch and protein synthesis, as well as the preservation and formation of chlorophyll, regulate the photosynthetic and respiration activities in plants. Many of the enzymatic transformations have potential thanks to iron. A number of these enzymes are involved in the synthesis of chlorophyll, the formation of grains, and the production of dry matter, all of which contribute to final yield characteristics like the quantity of active tillers per plant. These results support those previously reported by (Ananda and Patil, 2005; Kumar *et al*., 2009; Abbas *et al*., 2016 Kour *et al*., 2014 and Gupta *et al*., 2022) [2, 15, 1, 14, 12]. Also, the role of zinc in the biosynthesis of indole acetic acid (IAA) and particularly its role in the initiation of primordia for reproductive parts and the partitioning of photosynthesis is well documented and zinc can help in production of auxin also which help in cell division and cell elongation process along with these also motivate the crop to uptake more nutrients from the soil. This finding is agreement with (Dhaliwal *et al*., 2010; Pandey *et al*., 2013; El Habbasha *et al*., 2015; and Gupta *et al*., 2022) [9, 10, 5, 10, 12].

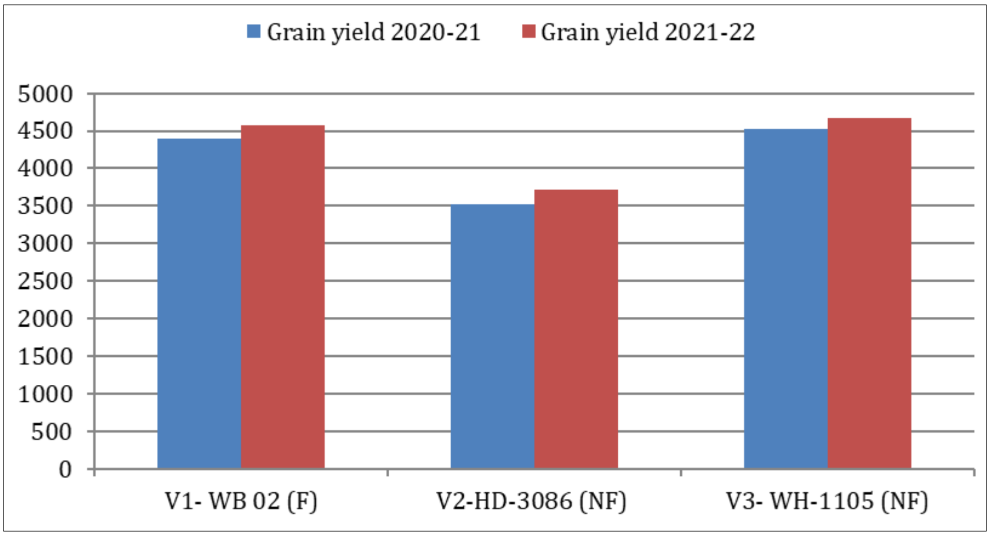

Fig 1: Effect of varieties on wheat grain yield (kg/ha) during 2020-21 & 21-22

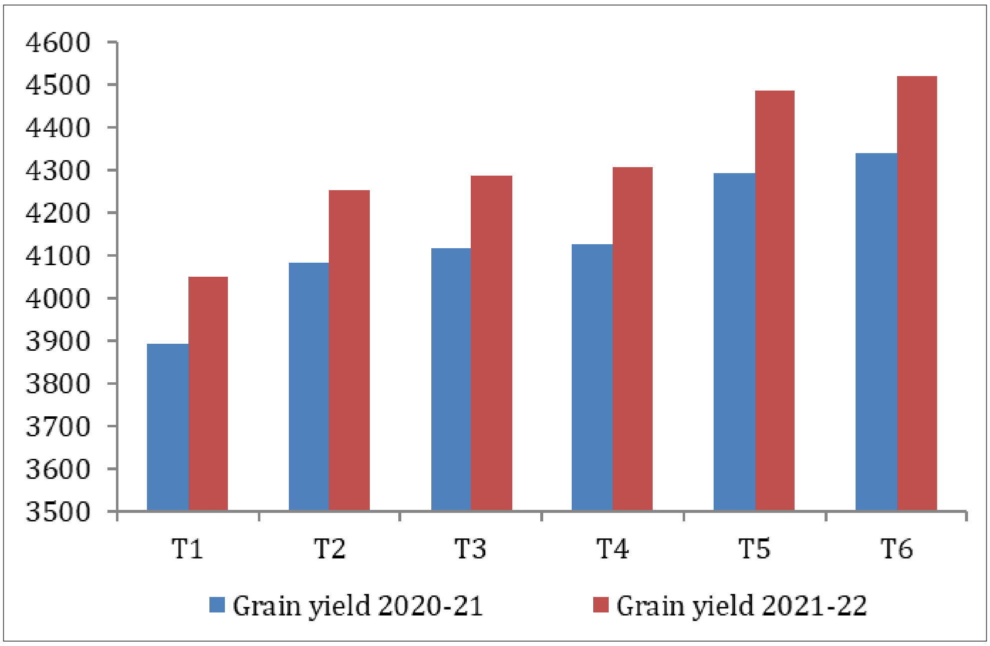

Fig 2: Effect of Zn and Fe nutrition on wheat grain yield (kg/ha) during 2020-21 & 21-22

Table 1: Effect of Zn and Fe application on grain, straw yield and harvest index of wheat

Treatments	Plant height (cm)		Dry matter accumulation (gm^{-2})		Gluten content (%)	
Varieties	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
V1- WB 02 (Fortified)	36.88	37.23	123.63	144.83	11.08	11.00
V2- HD-3086 (Non fortified)	35.07	35.42	95.48	115.96	10.21	10.52
V3- WH-1105 (Non fortified)	38.09	38.18	130.24	149.80	11.38	11.26
S.Em (±)	0.56	0.44	2.35	1.94	0.12	0.10
CD (5%)	1.61	1.28	6.75	5.57	-	NS
Zn and Fe levels						
T1: Rec. NPK	33.32	34.04	95.31	114.73	9.98	10.05
T2: Rec. NPK + SA of Ch. ZnSO4 @ 20 kg ha^{-1}	35.02	35.62	99.50	119.11	10.88	10.87
T3: Rec. NPK+ SA of Ch. ZnSO4 @ 20 kg ha-1 & FA of Ch. ZnSO4 @ 0.5% at PA & GF stages	36.12	36.54	103.69	123.83	11.02	11.12
T4: Rec. NPK+ SA of Ch. ZnSO4 @ 20 kg ha-1 & FA of Ch. FeSO4 @ 1.0% at PA & GF stages	36.93	38.15	126.78	146.87	11.00	10.94
T5: Rec. NPK+ SA of Ch. ZnSO4 @ 20 kg ha-1 & FA of Ch.4 @ 0.5% at PA & Ch. FeSO4 @1.0% at GF stages	38.65	38.77	133.61	154.89	11.18	11.25
T6: Rec. NPK+ SA of Ch. ZnSO4 @ 20 kg ha-1 & FA of Ch. FeSO4 @1.0% at PA & Ch. ZnSO4 @ 0.5% at GF stages	40.55	40.51	139.80	161.77	11.28	11.33
S.Em (±)	0.79	0.63	3.32	2.74	0.17	0.14
C D (5%)	2.28	1.81	9.55	7.87	NS	NS
AXB	NS	NS	NS	NS		

*SA-Soil application, Chel.-Chelated, FA- Foliar application, PA- Pre-anthesis, GF-Grain filling

Conclusion

Therefore, to improve grain quality and for fighting hidden hunger and nutrient malnutrition, especially in poor and developing countries where diets are dominated with wheat as staple food crops and realization of maximum growth and yield Wheat variety WH 1105 with application of Rec. NPK + soil application of chelated $ZnSO_4$ @ 20 kg ha^{-1} and foliar application of chelated $FeSO_4$ @ 1% at pre-anthesis and chelated $ZnSO_4$ @ 0.5% at grain filling stages (T_6) was found to be most remunerative for getting better crop growth, yield and quality of wheat in Shivalik region.

Acknowledgments

This research study has been done via financial support of ICAR (Afghan-Indo fellowship program) and the study has been done at the research farm and lab facilities provided by SKUAST-Jammu, Division of Agronomy, J&K-UT, India.

References

1. Abbas A, Safdar ME, Ali A, Asif M, Rehman A. Effect of foliar application of zinc at different growth stages on grain yield and quality of wheat (*Triticum aestivum* L.). J Environ. Agric. 2016;1(2):106-11.
2. Ananda N, Patil BN. Effect of micronutrients (Zn and Fe) and time of nitrogen application on growth and yield of durum wheat. Karnataka J Agric. Sci. 2005;18(3):604-608.
3. Anonymous. Annual Report. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, New Delhi; c2020-21.
4. Bana RC, AK Gupta, RS Bana, YS Shivay, SD Bamboriya, NP Thakur, R Puniya, M Gupta, S.R. Jakhar, Kailash, RS Choudhary, RS Bochalya, T Bajaya, V Kumar, P Kumar, AK Choudhary. Zinc-Coated Urea for Enhanced Zinc Biofortification, Nitrogen Use Efficiency and Yield of Basmati Rice under Typic Fluvents. Sustainability. 2021;14(1):104. https://scholar.google.com/scholar_lookup?title=Zinc-coated%20urea%20for%20enhanced%20zinc%20biofortification%2C%20nitrogen%20use%20efficiency%20and%20yield%20of%20basmati%20rice%20under%20typic%20fluvents&publication_year=2022&author=R.C.%20Bana&author=A.K.%20Gupta&author=R.S.%20Bana&author=Y.S.%20Shivay&author=S.D.%20Bamboriya&author=N.P.%20Thakur&author=R.%20Puniya&author=M.%20Gupta&author=S.R.%20Jakhar&author=Kailash&author=R.S.%20Choudhary&author=R.S.%20Bochalya&author=T.%20Bajaya&author=V.%20Kumar&author=P.%20Kumar&author=A.K.%20Choudhary https://doi.org/10.3390/su14010104
5. 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):348-352.
6. Cakmak I. Enrichment of cereal grains with zinc: Agronomic or genetic biofortification? Plant and Soil. 2007;302(1-2):1-17.
7. Cakmak I, Pfeiffer WH, McClafferty B. Biofortification of durum wheat with zinc and iron. Cereal Chem. 2010;87(1):10-20.
8. Chaudary EH, Timmer V, Javed AS, Siddique MT. Wheat response to micronutrients in rainfed areas of Punjab. Soil Environ. 2007;26(1):97-101.
9. Dhaliwal SS, Sadana US, Khurana MPS, Manchanda JS. Enrichment of rice grain with zinc and iron through fertilization. Indian J Fert. 2010;6(7):28-35.
10. El Habbasha SF, Elham Badar A, Latef EA. Effect of zinc foliar application on growth characteristics and grain yield of some wheat varieties under zinc deficient sandy soil condition. International Journal of Chem Tech Research. 2015;8(6):452-458.
11. Frossard E, Bucher M, Machler F, Mozafar A, Hurrell R. Potential for increasing the content and bioavailability of Fe, Zn and Ca in plants for human nutrition. J Sci. Food Agric. 2000;80(7):861-879.
12. Gupta Meenakshi, Attri Meenakshi, Sharma BC, Thakur NP, Kour Sarabdeep, Sharma Rohit. Efficacy of Coated Urea on Productivity and Economics of Wheat (*Triticum aestivum*). Journal of Plant Nutrition; c2022. https://doi.org/10.1080/01904167.2022.2087086
13. Kandoliya Rushang, Sakarvadiya Hl, Kunjadia B. Effect of zinc and iron application on leaf chlorophyll, carotenoid, grain yield and quality of wheat in calcareous soil of Saurashtra region; c2018.
14. Kour Sarabdeep, Arora Sanjay, Jalali VK, Bali AS, Gupta Meenakshi. Direct and residual effect of sulphur fertilization on yield, uptake and use efficiency in Mustard and succeeding Rice crop in an Inceptisol. Journal of Plant Nutrition. 2014;37(14):2291-2301.
15. Kumar R, Mehrota NK, Nautiyat BD, Kumar P, Singh PK. Effect of copper on growth, yield and concentration of Fe, Mn, Zn and Cu in wheat plants (*Triticum aestivum* L.). J Envrion. Biol. 2009;30(4):485-488.
16. Singaravel R, Imayavaramban Y, Dhanunathan K, Shanmughapriya N. Response of sesame (*Sesamum indicum*) to manganese and zinc nutrition. J Oilseeds Res. 2001;18(1):136-138.
17. Stain AJ. Global impacts of human mineral malnutrition. Plant, Soil. 2009;335(1-2):133-154.
18. Welch RM, Graham RD. Breeding for micronutrients in staple food crops from a human nutrition perspective. J Exp. Bot. 2004;55(396):353-364.
19. WHO. The world health report. Reducing Risks, Promoting Healthy Life; World Health Organization: Geneva, Switzerland; c2002. p. 1-168.
20. Wisal M, Iqbal M, Shah SM. Effect of mode of application of Zn and Fe on the yield of wheat (CV. 81). Sarhad J Agric. 1990;6(6):615-618.
21. Yilmaz A, Ekiz H, Torun B, Gultekin I, Karanlik S, Bagci SA, *et al*. Effect of different zinc application methods on grain yield and zinc concentration in wheat cultivars grown on zinc-deficient calcareous soils. J Plant Nutr. 1997;20(4-5):461-471.