Journal of Advances in Biology & Biotechnology

Volume 27, Issue 8, Page 324-334, 2024; Article no.JABB.119408
ISSN: 2394-1081

Analysis of the Consequences of a Mixture of Micronutrients on the Parameters Associated with Wheat Growth and Yield

Harmandeep Singh [a++], Ravinder Kaur [b#*], Anjana Nautiyal [c†], Aditi Verma [d‡] and Swati Dudhpuri [e^]

[a] *Agricultural Services, Nestle India Ltd., Moga, India.*
[b] *School of Agriculture, Dev Bhoomi Uttarakhand University, India.*
[c] *Department of Agriculture (Agronomy), SGRR University, India.*
[d] *Department of Agriculture, Centre for Agriculture Farmers and Development (NGO), India.*
[e] *Department of Agriculture, Dolphine Institute of Biomedical and Natural Sciences, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jabb/2024/v27i81145

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/119408

Original Research Article

Received: 14/05/2024
Accepted: 16/07/2024
Published: 20/07/2024

[++] *Officer;*
[#] *Assistant Professor;*
[†] *Ph.D Schlor;*
[‡] *Assistant Trainer;*
[^] *Alumini;*
**Corresponding author: E-mail: rajjik007@gmail.com;*

Cite as: *Singh, Harmandeep, Ravinder Kaur, Anjana Nautiyal, Aditi Verma, and Swati Dudhpuri. 2024. "Analysis of the Consequences of a Mixture of Micronutrients on the Parameters Associated With Wheat Growth and Yield". Journal of Advances in Biology & Biotechnology 27 (8):324-34. https://doi.org/10.9734/jabb/2024/v27i81145.*

ABSTRACT

The field experiments were conducted at the agriculture farm of BFIT Crop Research Centre, Dehradun, Uttarakhand, during 2021–22 on the title- "Analysis of the consequences of a mixture of micronutrients on the parameters associated with wheat growth and yield". A RBD (Randomized Block Design) of plot with eight treatments and three replications was used in this study. The experimental treatments included: T_1 - Control (without fertilizer or any other growth activity), T_2 - RDF (NPK) only, T_3 - RDF (NPK) + Local Formulation(LF) Grade V 10kg/ha mixture of micronutrient on Soil Application (SA) only, T_4 - RDF (NPK) + Local Formulation (LF) GradeV 10kg/ha mixture of micronutrient on Soil Application (SA) + 0.25% FS of micronutrient mixture @ tillering stage only,T_5 - RDF(NPK) + Local Formulation (LF) Grade V 15kg/ha mixture of micronutrient on Soil Application (SA) only,T_6 - RDF(NPK) + Local Formulation (LF) Grade V 15kg/ha mixture of micronutrient on Soil Application (SA) + 0.25 % FS @ tillering stages only, T_7 - RDF (NPK) + Local Formulation(LF) GradeV 25kg/ha mixture of micronutrient on Soil Application (SA) only, T_8 - RDF (NPK) + Local Formulation (LF) Grade V 25kg/ha mixture of micronutrient 0.25% Foliar Spray (FS) of micronutrient mixture @ tillering stage only. Significant 0.5% increases in spike length, spikelets/spike, spike/m^2, number of tillers/m2, number of grains/spike, 1000-grain weight, grain, straw, and biological yields (ton)/fed were noted in the study's results. Additionally, the harvest index was found to be significantly higher in T_8 only. The highest grain yield was achieved by T_8 while lower yield of growth attributes / parameters was found in the control plot.

Keywords: Micronutrients; growth; yield; fertilizers; NPK.

1. INTRODUCTION

Triticum aestivum L or wheat, is a significant cereal crop that provides food for approximately one-third of the global population. With a global production of 713 million tons in 2018, wheat ranked third in terms of grain production, behind rice (745 million tons) and maize (1,016 million tons) [1]. Wheat is the food crop which covers about 14% of the global crop area and has the largest share in global food trade [2]. Thanks to its diverse agro-ecological conditions, India has emerged as the world's second-largest wheat producer, ensuring food and nutrition security for a significant portion of its populace through consistent supply and output, particularly in recent times [3,4]. The crop has been grown on about 30 million hectares (14% of the world's total area) in order to reach the highest-ever output of 99.70 million tonnes of wheat (13.64% of world production), with a record average productivity of 3371 kg/ha. It is perceived that micronutrients play a pivotal role in the yield improvement [5]. Wheat is a highly nutritious grain. 13.2% protein, 2.5% fat, 78.1% starch, 2.1% mineral matter, 72 g of carbohydrates, and 0.4 g of sugar are found in 100 g of whole-grain wheat flour [6].

The plains and hills of Uttarakhand state, which have different agro-climatic endowments, offer different agricultural environments, with commercial agriculture being undertaken in the lowlands. The majority of hill farmers engage in subsistence farming. In the plains, single crops are typically cultivated throughout a particular season, whereas mixed cropping is used in the hills. the productivity of wheat in the plains is 30.45 quintals/hectare, whereas it is 13.2 quintals/hectare in the hills. According to the Uttarakhand State Planning Commission [7] rice production is 12.36 quintals per hectare in the hills and 27.49 quintals per hectare in the plains. These results could be attributed to micronutrient participation in several physiological and biochemical processes that lead to increased generation of dry matter [8]. Beginning at tillering, multiple foliar sprays of a micronutrient mixture increased the production of grains, straw, and biological components.

Micronutrients also improve the enzymatic system of plants and increase leaf area, grain output, and plant productivity. Micronutrients are chemicals with specific and important physiological roles in plant metabolism, according to Marschner [9] Due to calcareous soils, high pH, low organic matter content, salt stress, prolonged droughts, high bicarbonate concentration in irrigation water, and inconsistent NPK fertilizer application, many Asian countries experience widespread micronutrient shortages [10]. All higher plants are known to need zinc, iron, manganese, copper, and boron as vital crop nutrients. Additionally, it has been established that these elements are necessary for respiration, photosynthesis, N-fixation, and other biological processes [11]. Therefore, using zinc fertilizer is a viable short-term strategy to increase zinc concentrations in seeds and can also help to lessen health issues associated with zinc deficiencies in underdeveloped countries [12,3,4]. Zn is a further crucial mineral nutrient for humans; its absence can impair immune system performance, physical development, cognitive ability, DNA damage, and the onset of cancer in young individuals [13,14,15].

In the real world, boron is essential for the formation of pollen tubes, flower male fertility, floral organ development, and plant consumption of carbohydrates [16]. As a result of boron shortage, poor anther and pollen development occurs during the grain setting stage [17] and the resulting grain is often starch-free [18]. Significant reductions in grain output can occur even in the absence of obvious indicators during vegetative growth, and low boron levels in the field may have a bigger effect on sexual reproduction. The sterility resulting from low wheat boron availability in boron-deficient soils is a significant concern [19].

Chaudry et al*.* [20] stated that micronutrients (Zn, Fe, B) significantly increased the wheat yield over control when applied single or in combination with each other while Mandal et al*.* [21] observed significant positive interaction between fertilizer treatments and physiological stages of wheat growth.

Despite being crucial for photosynthetic activity, little is known about Mn homeostasis in plants. On the other hand, Mn deficiency can pose a substantial nutritional threat to plants in high pH and high partial pressure of O^2 soils, where Mn bioavailability can fall well below the level required for normal plant growth [22]. In these situations, it is often associated with other problems with soil fertility related to acidity, such as aluminum toxicity and deficiencies in calcium (Ca), magnesium (Mg), and molybdenum (Mo) [23].

The main component of those changes is the transport process. Many eukaryotic creatures have previously had their Mn transporters discovered at the molecular level [24]. Copper (Cu) is necessary for plant growth. It contributes to a number of enzymatic functions and is essential for the synthesis of chlorophyll, among other things.

The current circumstances highlight the necessity for research to determine whether a micronutrient deficiency is the root cause of wheat's low grain formation, yield, and nutrient content. The goal of the current study is to evaluate how micronutrients affect wheat growth and yield. We did our research in BFIT Technical campus Dehradun (Uttrakhand). For research we have selected PBW 292(Late sown) variety of wheat. This variety have a good agronomic characteristics like height of variety 95-100 cm, ripening period 120-125 days & sowing time 2nd week of November to last week of December.

The aforementioned plan of action served as the inspiration for this research project, which has the following objectives.

Objectives: To study the effect of micronutrient mixture on growth parameters and yield attributes parameters/characters of wheat crop.

2. MATERIALS AND METHODS

The present research investigation was setup in a Randomized Block Design (RBD) having eight treatment combinations which is replicated thrice, randomly allocated in each replication. The Wheat variety PBW-292 was grown during the experimental years 2020 -21. The seed treatment was done manually before sowing of crop with the help of Bavistin (Carbadizem 50% WP) to prevent the prevential fungal diseases and chloropyriphos 20% EC used for seed protect for Rodents and Termites. The seed rate 125 kg per hac was used for sowing PBW 292 (Late sown variety). The micronutrient mixture solution (Fe, Mn, Zn, Cu and B) used in this experiment for foliar application. The mixture were prepared by using a content of micronutrient and made 1 liter solution. The micronutrient mixture application on T_3, T_4, T_5, T_6, T_7 and T_8 was used Soil Application (SA) for different doses and the mixture applied once before sowing according to the treatment as per recommendation kg/hac.

The germination count was record after 8 days of sowing. Plant height was calculated and recorded when it reached at maturity. Plant height was recorded @ CRI, tillering and at harvesting time. The number of plant per m^2 and number of tillers per m^2 was recorded @ CRI, Tillering and at Harvesting time. The length of all the spikes was measure in centimeters with the help of scale in randomly selected plants. Then, the average was calculated for further procedure.

The grains quantity in numbers of each spike from randomly selected. Plants were counted to find out the average of the crop on its maturity. Leaf area index of wheat from each plot was measured by dividing leaf area of a plant to be sampled ground area covered by single plant as given by Shivam et al., [25]. The data related to leaf area index was recorded at 30, 60, and at harvesting.

Leaf area index = Leaf area per plant (cm2) / Ground area per plant (cm2)

The quantity of one thousand grains was collected from each plot through each replication. The grains were collected from each plot on randomly selected basis. . It was weighed to record the test weight. Biological yield was weighed and calculated in kilograms on the basis of biological yield per plot by all the foliage and grains received from each plot. Harvest index was computed as ratio economic yield to total biological yield and expressed in percentage. The harvest index was calculated by using the following formula.

Harvest index **(%)** = Grain yield (kg ha-1) / Biological yield (kg ha-1)

The produce of each net plot was threshed separately, cleaned and the grain yield was recorded in kg per net plot and then converted into kg ha^{-1}. Straw yield was obtained by subtracting the grain yield of each net plot from their respective total dry matter yield the computed in term of kg ha^{-1} and converted into the hactare. Leaf area index (m^2) was measured by using this formula:

Leaf area index (LAI)=Total leaf area / Ground area

3. CULTURAL OPERATION

The experimental field was thoroughly prepared by tractor driven cultivator followed by harrowing and planking for leveling the soil on 25/12/2021. The seed treatment was done manually before sowing of crop with the help of Bavistin (Carbadizem50% WP) to prevent the prevential fungal diseases and chloropyriphos 20% EC used for seed protect for Rodents and Termites.The seed rate 125 kg per hac was used for sowing PBW 292 (Late sown variety) on 28/12/21. The crop was sowing in line sowing method in the plot. The optimum doses of phosphorus (60kg P_2O_5 ha^{-1}) and 25% of nitrogen (20 kg nitrogen ha^{-1}) in the form of urea and diamonium phosphate were applied in plots. Remaining nitrogenous fertilizer was applied three spilt doses at wheat growing stages on 28/12/21. The first irrigation was given after 25 DAS at CRI (Crown Root initiation) stages. Total five irrigations were applied during the crop growth period as and when required by crop depending upon soil moisture situations. Thinning was done 30 days after sowing in each plot mainly for the purpose of maintaining uniform plant population. Attempts were made to keep the experimental field weed free throughout the crop season. Two hand weeding were carried out during the entire crop growth period. The micronutrient mixture solution (Fe, Mn, Zn, Cu and B) used in this experiment for foliar spraying. The mixture were prepared by using a content of micronutrient and made 1 liter solution. The micronutrient mixture application on T_3, T_4, T_5, T_6, T_7, T_8, was used as soil application for different doses and the mixture applied once before sowing according to the treatment as per recommendation kg/ha. The chloropyrifos 20%EC was applied along with irrigation water as when required to control the infestation of termite and rodents. Wheat was harvested when the leaves and stems turn yellow and become finally dry.

Harvesting was carried out manually with the use of a sickle. The threshing was done manually individually field plot. The data were recorded individually plot in the field.

3.1 Experimental Design, Treatments and Layout

The present research investigation was setup in a Randomized Block Design (RBD) having eight treatment combinations which is replicated thrice, randomly allocated in each replication. The Wheat variety PBW-292 was grown during the experimental years 2020 -2021.

The experiment was done using RBD and the statistical analysis of the data was carried out using or applying Two-factor ANOVA Test. It was determined by applied two factor ANOVA Test of significance were recorded on the basis of CD difference at 5%.

4. RESULTS AND DISCUSSION

4.1 Effect of Micronutrients Mixture on the Growth on wheat

Table 3 shows that the tallest plant (89.87 cm) was obtained from the treatment T8 = RDF

(NPK) + 25 kg/ha mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only, while the shortest plant (49.63 cm) was obtained from the treatment (control). The different levels of micronutrients had no significant effect on the growth of the mustard crop. It was also discovered that a mixture of trace nutrients and (NPK) build up plant growth in this instance. Narimani et al*.* [10] corroborate the current findings, showing that all micronutrients improved these features when compared to the control group. The results showed that micronutrients and RDF (NPK) had a major impact on tiller output. In T_8 treatment application of RDF (NPK)+25kg/hac mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only produced the maximum number of tillers (386.17.) which was statistically at par with T_7 383.50. The minimum number of tillers (285.17 m^{-2}) was recorded in T_1 (control) treatment. A similar result has been found in past experiment that when Cu was applied, Kumar et al*.* [26] saw an increase in the number of tillers, whereas Manal et al*.* [27] saw a rise in the number of tillers when Mn was applied. The data on spike length revealed significant increase with applied RDF(NPK) & Micronutrient mixture foliar application. Maximum spike length of 14.3 cm was produced by T_8 plot (RDF (NPK) + 25kg/hac mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only). While minimum spike length 9.4 was recorded in T_1 (control).The spike length data were repersented in below table and graphically. The micronutrient combination of Cu+ Fe+ Mn+ Zn produced the highest values of spike length and number of grains spike-1, according to Mekkei and El-Haggan Eman's [28] observations. Maximum number of grains (39.25) was produced by T_8 (RDF (NPK) + 25kg/hac mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only) which was statistically at par with T_6 and T_7 with 37.17, and 36.92 grains spike^{-1}respectively. In the T_1 (control) plot, the minimum number of grains (29.83) was recorded. Boron was crucial for grain setting and a larger grain count in wheat because it is involved in the transfer of food resources in plants.

Table 1. Experiment details

	Experimental Design and layout	
	Crop	**Wheat**
1.	Variety	PBW 292 (single)
2.	Year and Season	2021, Winter
3.	Design	Randomized Block Design (RBD)
	a) Treatments	8
	b) Replications	3
	c) Total no of plots	24
4.	Plot Size	2×1m^2
5.	Fertilizer (N:P:K)	80:40:40
6.	Date of Sowing	28/12/2022
7.	Date of Harvesting	26/04/2022

Fig. 1. Details of micronutrient mixture local formulation grade V

Table 2. Treatments details

T_1	Control (without fertilizer or any other growth activity)
T_2	RDF(NPK) only
T_3	RDF(NPK) + LF GradeV 10kg/hac mixture of micronutrient on SA only.
T_4	RDF(NPK) + LF GradeV 10kg/hac mixture of micronutrient on SA + 0.25% FS of micronutrient mixture @ tillering stage only
T_5	RDF(NPK) + LF GradeV 15kg/hac mixture of micronutrient on SA only.
T_6	RDF(NPK) + LF GradeV 15kg/hac mixtureofmicronutrienton SA + 0.25 % FS @ tillering stages only.
T_7	RDF (NPK) + LF GradeV 25kg/hac mixture of micronutrient on SA only.
T_8	RDF (NPK) + LF GradeV 25kg/hac mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only.

Table 3. List of nutrients and their composition

Nutrient	Composition (%)
Zinc(Zn)	5.0%(min)
Iron(Fe)	2.0%(min)
Manganese(Mn)	0.5%(min)
Copper(Cu)	0.2%(min)
Boron(B)	0.5%(min)

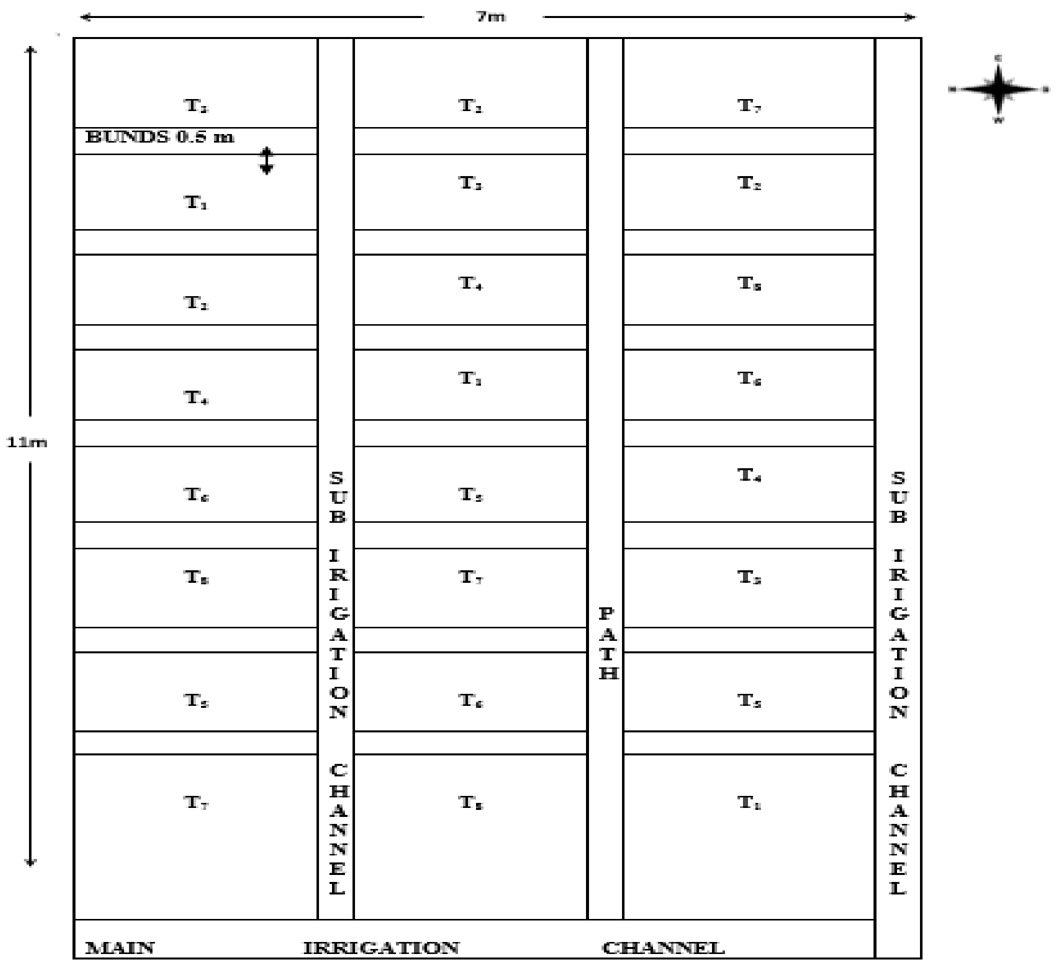

Fig. 2. Field layout design

Table 4. Details of field preparation

Source of variance	Degree of freedom
Replication	2
Treatment	7
Error	14
Total	23

Table 5. Effect of micronutrients mixture on the growth on wheat

Treatment	Plant height (cm)	Number of tillers per m^2	Spike Length(cm)	Grain spike^{-1}
T_1(control)	49.63	316.17	9.4	29.83
T_2	58.47	332.25	12.4	30.83
T_3	68.37	333.58	13.3	32.50
T_4	71.67	335.25	13.7	33.83
T_5	78.57	336.58	13.5	35.00
T_6	86.50	340.25	13.9	37.17
T_7	83.50	337.42	13.4	36.92
T_8	89.87	347.08	14.3	39.25
SE m±	0.86	0.47	0.22	0.54
CD (5%)	1.79	0.98	2.11	1.13

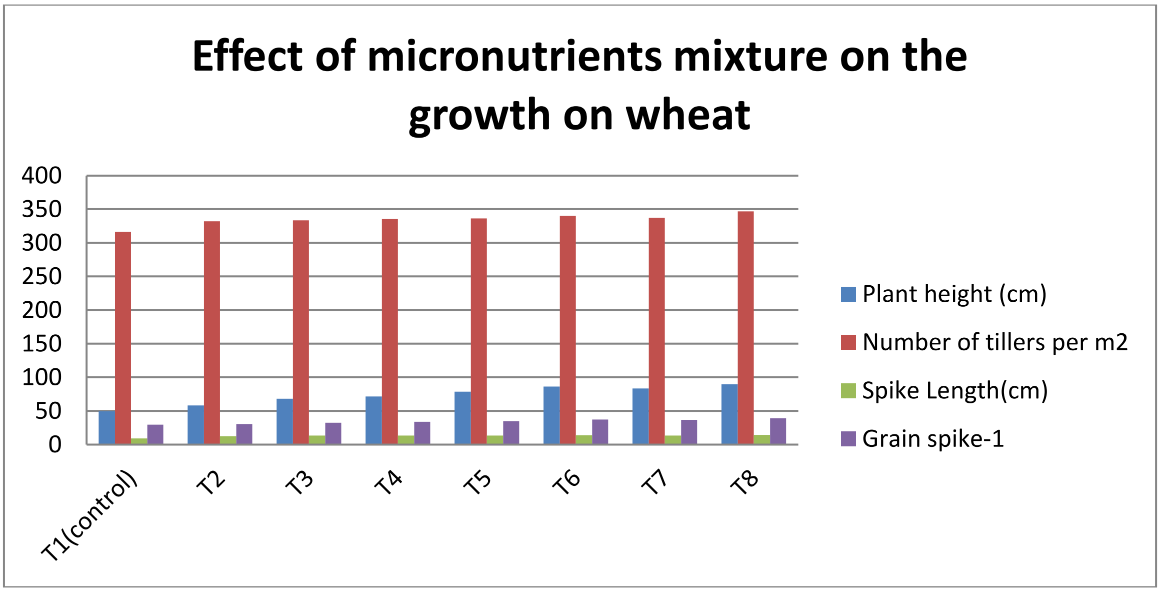

Fig. 3. Graphical Representation of Effect of micronutrients mixture on the growth on wheat

4.2 Effect of Micronutrients Mixture on the Yield Parameter on wheat

The available data show that the administration of micronutrients significantly affected the grain weight. T8 (RDF (NPK) + 25 kg/hac mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only) recorded the maximum grain weight of 32.93g, which was statistically equal to 31.83g obtained in T6 (RDF (NPK) + 15 kg/hac mixture of micronutrient on SA + 0.25 % FS @ tillering stages only). Minimum number of grain weight (22.33) was recorded in T_1(control) plot. Present results are supported by Kumar *et.al.* [29] who recorded by combining Zn, Fe, Mn, and Cu, they were able to significantly increase seed weight. A lot of research were taken out in the last ten years to explain the impacts of micronutrient The findings by Lalit Bhatt and BK Srivastava [30] indicated that adding individual micronutrient (Fe, Zn, Cu, and B) or a combination of Fe + Zn + Cu + B to NPK fertilizer increased grain quality.Crop productivity is the rate at which a crop gathers organic matter as a result of photosynthesis, the process by which green plants transform light energy into chemical energy [31]. Three parameters determine the grain yield: the weight of the kernels, the number of spikes, and the number of kernels spike-1. According to the results provided, the doses of NPK and micronutrients had a significant impact on grain production across different treatments; the treatment T8 (RDF (NPK) + 25 kg/ha micronutrient mixture 0.25% FS of micronutrient mixture @ tillering stage only) had the highest grain yield (4.43 t ha^{-1}). While (T6 and T7) gave grain yields of 3.93 and 3.73 t ha^{-1}, respectively, with statistical parity.In the T1 (control), the Minimum Grain Yield t ha^{-1} (1.67) was noted. The current findings are corroborated by Chaudry et al. [32]. who reported a considerable increase in wheat production when boron was applied in conjunction with a modest dose of NPK. Uddin et al. [33] also applied 2 kg ha-1 of boron and saw a 50% improvement in yield. The biological yield data showed that the micronutrient mixture applied topically and via RDF had a substantial impact (Table 6). Maximum biological yield was produced by T_8(RDF (NPK) + 25kg/hac mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only)(11.43 t ha^{-1}) followed by T6 (10.43 ton ha^{-1}), whereas the T1 (control) treatment had the lowest biological output (4.40 tons ha-1). Additionally, Khan et al. [34] showed increases in wheat yield following Mn treatment to the soil. They suggested that the apparent reason for the enhanced wheat production resulting from Mn application can be attributed to improvements in leaf area index, which would give the crop a better base upon which to generate resources that is, a better supply of carbohydrates. The crop's overall biomass and yield components have increased as a result of this better source. The Harvest index (HI) shows the distribution of biomass between grain and straw production both directly and indirectly. Maximum harvest index was recorded T_8 RDF (NPK) + 25kg/hac mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only) followed by T_5 RDF (NPK) + LF Grade V 15kg/hac mixture of micronutrient on SA only.But minimum harvest index recorded T_4RDF(NPK) + LF GradeV 10kg/hac mixture of micronutrient on SA + 0.25% FS of micronutrient mixture @ tillering stage only(Table 6).This is contrary to Salih Hemn Othman [35] who said that micronutrient did not affect significantly to harvesting index.The crop material that obtained after grain extracted is called straw yield., the straw yield was affected significantly by RDF & Micronutrient Mixture.The highest straw yield of 7.07t/ha was obtained with T_8 RDF (NPK) + 25kg/hac of micronutrient mixture + 0.25% FS of micronutrient mixture @ tillering stage only, being at par (6.83 t/ha) T_6RDF(NPK) + 15kg/hac micronutrient mixture on SA + 0.25 % FS @ tillering stages only. The lowest straw yield (2.73t/ha) was recorded in T_1 (control) treatment (2.73t/ha). LAI is the ratio of total leaf area to ground cover. Usually, it reaches its peak during crop emergence [31]. Leaf area index was estimated at CRI, Tillering and Harvesting stage and data is presented in Table. The data clearly show that the leaf area index increased progressively during crop growth period, higher LAI was recorded at tillring stage. The rate of increase in leaf area index was recorded maximum between the stages of CRI to tillring indicating the grand growth period of the crop. The highest leaf area index was found in T8 plot

Table 6. Effect of micronutrients mixture on the yield parameter on wheat

Treatment	Test weight (1000 grain) in gm	Grain yield(tha^{-1}):	Biological yield in (t ha^{-1})	Harvest index (%):	Straw yield (t/ha)	Leaf Area Index (LAI):
T_1 (control)	22.33	1.67	4.40	37.85	2.73	2.92
T_2	25.80	2.10	5.53	37.97	3.43	3.04
T_3	28.90	2.53	6.60	38.43	4.10	3.11
T_4	29.87	2.70	7.47	37.10	4.77	3.18
T_5	30.77	3.23	8.37	38.60	5.13	3.31
T_6	31.83	3.93	10.43	37.72	6.83	3.45
T_7	31.17	3.73	9.93	37.58	6.27	3.38
T_8	32.93	4.43	11.43	38.79	7.07	3.61
SE m ±	0.34	0.13	0.11	1.974	0.197	0.0190
CD(5%)	0.71	0.27	0.24	4.095	0.408	0.0394

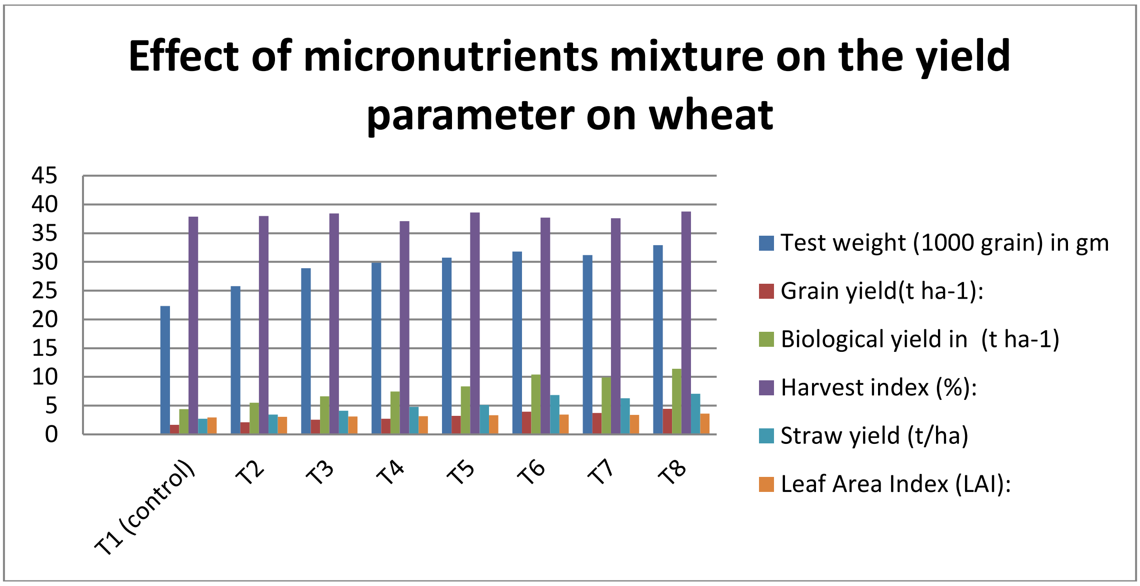

Fig. 4. Graphical Representation of Effect of micronutrients mixture on the yield parameter on wheat

Table 7. Economics of micronutrients mixture mixture on the growth and yield parameter on wheat

Parameters	T1	T2	T3	T4	T5	T6	T7	T8
Grain yield, t/ha	1.67	2.1	2.53	2.7	3.23	3.93	3.73	4.43
Production costs, ruble/t	4,185	4680	4485	4407	4446	4682	4527	4131
Labor costs, man h/t	1.01	0.95	0.94	0.94	0.91	0.91	0.91	0.90
Cost of grain, ruble/t	6,875	7,087	6,985	6,914	6,542	6,838	6,936	7,214
Labor productivity of a machine operator, ruble/person	1,128	1,186	1,212	1,268	1,265	1,263	1,262	1,206
Annual savings in total cash costs, ruble/t	119	355	37	86	216	0,46	124	476

(RDF (NPK) + 25kg/hac mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only). The second best treatment was recorded in T6 plot. Lowest leaf area index was recorded in T1 (control) plot. The administration of boron generally improved tissue development and plant growth, which raises the concentration of the mineral in leaves and raises the leaf area index [36,37].

According to the economic assessment, T8 differ insignificantly in terms of production costs, labor costs, the cost of grain and the productivity of machine operators. However, the combination of micronutrients is much more expensive than the T_{8} - RDF (NPK) + Local Formulation (LF) Grade V 25kg/ha mixture of micronutrient 0.25% Foliar Spray (FS) of micronutrient mixture @ tillering stage only. Therefore, only the T_{8} - RDF (NPK) + Local Formulation (LF) Grade V 25kg/ha mixture of micronutrient 0.25% Foliar Spray (FS) of micronutrient mixture @ tillering stage only showed positive annual savings in total costs of 476 rubles / t. Other treatments in comparison with the T8 turned out to be unprofitable.

5. CONCLUSION

An extensive review of previous studies' findings and limitations was undertaken for this study, with a focus on the ways in which wheat responds to micronutrient fertilizers. The usage of micronutrients combined with macronutrients has been found by numerous authors to greatly boost physiological attributes, yield components, plant development, and most grain quality traits. Additionally, micronutrients are essential for the growth and development of animals. This study could be concluded that the response of wheat crop to micronutrient mixture was positive with irrespective of concentration that means the growth and yield of wheat Crop could be improved with increasing when the soil application RDF (NPK) + 25 kg/ha mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only showed significant high performance. The result of spraying micronutrients mixture with broadcasting gives more result as compare to alone broadcasting. Similar results were reported by researcher.

Increasing the usage of micronutrient fertilizers is one of the key strategies used by farmers to raise wheat yields and their nutritional value. The primary factors that impact the efficacy of micronutrient applications are the kind and origin of the fertilizer, the features of the soil, the application technique, the nutritional status and traits of the wheat, and the weather.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS DISCLAIMER

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1. Khan MA, Hussain I, Baloch MS. Wheat yield potential – current status and future strategies. Pak J. Bio. Sci. 2000;3:82-86.
2. OECD/FAO. OECD-FAO Agricultural Outlook 2020-2029, OECD Publishing, Paris/FAO, Rome; 2020.
3. Melash AA, Mengistu DK, Aberra DA, Tsegay A. The influence of seeding rate and micronutrients foliar application on grain yield and quality traits and micronutrients of durum wheat. Journal of Cereal Science. 2019;85:221-7.
4. Aziz MZ, Yaseen M, Abbas T, Naveed M, Mustafa A, Hamid Y, Saeed Q, Xu MG. Foliar application of micronutrients enhances crop stand, yield and the biofortification essential for human health of different wheat cultivars. Journal of Integrative Agriculture. 2019;18(6):1369-78.
5. Rehm G, Sims A. Micronutrients and production of hard red spring wheat. Minnesota Crop News, Univ. Minnesota; 2006.
6. Atli Arnarson. Wheat 101-Nutrition Facts and Health Effects BSc, PhD — Updated on; 2019.
7. Uttarakhand State Planning Commission. Draft Eleventh Five Year Plan 2007-12 & Annual Plan 2007-08. Volume-I (General Profile). Govt,of Uttarakhand; 2007.
8. Grewal, HS, Zhonggu L, Graham RD. Influence of subsoil zinc on dry matter production, seed yield and distribution of zinc in oilseed rape genotypes differing in zinc efficiency. Plant and Soil. 1997;192(2):181–189.
9. Marschner H. Mineral Nutrition of Higher Plants. Academic Press. 2nd ed.; 1995.
10. Narmani H, Rahimi MM, Ahmadikhah A, Vaezi B. Study on the effects of foliar spray of micronutrient on yield and yield components of durum wheat. Archives ofAppl Sci. Rese. 2010;2(6):168-176.
11. Cakmak I, Marschnerj H. Increase in membrane permeability and exudation in roots of zinc deficient plants. J. Plant Physiol. 1988;132:356-361.
12. Aslam H, Ansari MA, Baloch SK, Baloch SU, Baloch AS. Persian Gulf Crop Protection. 2014;3(2):15-29.
13. Keen CL, Gershwin ME. Zinc deficiency and immune function. Annual Review of Nutrition. 1990;10:415–431.
14. HoE Courtemanche, Ames BN. Zinc deficiency induces oxidative DNA damage and increases p53 expression in human lung fibroblasts. The Journal of Nutrition. 2003;133:2543–2548.
15. Black R, Lindsay H, Bhutta Z, Caulfield L, de Onnis M. Maternal and child under-nutrition: Global and regional exposures and health consequences. Lancet. 2008;371:243–260.
16. Blevins DG, Mkrystyna L. Boron In Plant Structure and Function. Annu Rev Plant Physiol Plant Mol Biol. 1998;49:481-500.
17. Cheng C, Rerkasem B. Effects of Boron on Pollen Viability in Wheat. Plant Nutrition from Genetic Engineering to Field Practice. 1993;405–407.
18. Dell B, Huang L. Physiological Response of Plants to Low Boron. Plant and Soil. 1997;193:103-120.
19. Shorrocks VM. The occurrence and correction of boron deficiency. Plant Soil. 1997;193:121-148
20. Chaudry EH, Timmer V, Javad AS, Siddique MT. Wheat response to

micronutrients in rained areas of Punjab. Soil & Environ. 2007;26:97-101.
21. Mandal A, Patra AK, Singh D, Swarup A, Masto RE. Effect of long-term application of manure and fertilizer on biological and biochemical activities in soil during crop development stages. Bioresour. Technol. 2007;98:3585-3592.
22. Broadley MR, White PJ, Hammond JP, Zelko I, Lux A. Zinc in plants. New Phytol. 2007;173: 677–702.
23. Goulding KWT. Soil acidification and the importance of liming agricultural soils with particular reference to the United Kingdom. Plant archives. 2016;32:390-399.
24. Pittman JK. Managing the manganese: molecular mechanisms of manganese transport and homeostasis. New Phytol. 2005;167:245–248.
25. Shivam Sahu AS, Choudhary, Shani Raj, Nishant Ghode, Ashish Kumar. Effect of micronutrients on yield attributes of tomato. International Journal of Agriculture and Nutrition. 2022;4(1):34-38.
26. Kumar Aravinda BSN, Shanwad UK. Effect of micronutrients on growth and yield in sunflower (Helianthus annuus). Current Advances in Agricultural Sciences. 2009; 2(1):51-52.
27. Manal FM, Thalooth AT, Khalifa RKM. Effect of foliar spraying with uniconazole and micronutrients on yield and nutrients uptake of wheat plants grown under saline condition. J. Amer. Sci. 2010;6:398-404.
28. Mekkei MER, El-Haggan EAMA. Effect of foliar application of Cu, Fe, Mn, Zn on productivity and quality of some wheat cultivars (*Triticum aestivum* L.). J. Agric. Food App. Sci. 2014;2(9): 283-291.
29. Kumar K, Singh P, Singh SN. Influence of foliar spray boron and thiourea doses on biochemical and productive tillers of wheat cultivars in two sowing conditions. Journal of Pharmacognosy and Phytochemistry. 2018;7(2):3446-3452.
30. Lalit Bhatt andBK Srivastava. Effect of foliar application of micronutrients on physical characteristics and quality attributes of tomato (Lycopersiconesculentum) fruits. Indian Journal of Agriculture Science. 2005; 75(9):591-592.
31. Reddy SR. Principles of Crop Production – Growth Regulators and Growth Analysis, 2nd Ed. Kalyani Publishers,Ludhiana India; 2004.
32. Chaudry EH, Timmer V, Javed AS, Siddique MT. Wheat response to micronutrients in rainfed areas of Punjab. Soil & Environ. 2007;26:97-101.
33. Uddin MN, Islam MS, Islam ABMS. Effect of boron on wheat at different boron application methods. J. Subtrop Agric Res Dev. 2008;6:483-486.
34. Khan MA, Fuller MP, Baloch FS. Effect of soil applied zinc sulphate on wheat (*Triticum aestivum* L.) grown on calcareous soil. Pakistan Cereal Research Communications. 2008;36(4): 571-582.
35. Salih Hemn Othman. Effect of Foliar Fertilization of Fe, B and Zn on nutrient concentration and seed protein of Cowpea ("*Vigna Unguiculata*"L). Journal of Agriculture and Veterinary Science. 2013; 6(3):42-46.
36. Marten JM, Westermann DT. Fertilizer applications for correcting micronutrient deficiencies. In: Mordtvedt, J.J., et al. (Eds.), Micronutrients in Agriculture, SSSA Book Series. 1991;549–592.
37. Sendhil Ramadas, Kiran TMK, Gyanendra PSSVM. The occurrence and correction of boron deficiency. Plant Soil. 1997;193:121-148.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/119408