“Investigation of the impact of a combination of micronutrients on the wheat growth and yield parameters”

ABSTRACT

The field experiments were conducted at the agriculture farm of BFIT Crop Research Centre, Dehradun, Uttarakhand, during 2021–22 on the title**- “Investigation of the impact of a combination of micronutrients on the wheat growth and yield parameters”**. 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) + LF Grade V 10kg/ha mixture of micronutrient on SA only, **T_4** - RDF (NPK) + LF GradeV 10kg/ha mixture of micronutrient on SA + 0.25% FS of micronutrient mixture @ tillering stage only,**T_5** - RDF(NPK) + LF Grade V 15kg/ha mixture of micronutrient on SA only,**T_6** - RDF(NPK) + LF Grade V 15kg/ha mixture of micronutrient on SA + 0.25 % FS @ tillering stages only, **T_7** - RDF (NPK) + LF GradeV 25kg/ha mixture of micronutrient on SA only, **T_8** - RDF (NPK) + LF Grade V 25kg/ha mixture of micronutrient 0.25% FS of micronutrient mixture @ tillering stage only. Significant 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 T8 only. The highest grain yield was achieved by T8. While lower yield of growth attributes / parameters are found in the control plot**.**

Key Words- Micronutrients, Growth,Yield, Fertilizers, NPK.

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). Wheat is the food crop which covers about 14% of the global crop area and has the largest share in global food trade (OECD/FAO, 2020).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. 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. (Sendhil et al., 1997). 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 (Atli Arnason, 2019).

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 (2007), 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 (Grewal et al. 1997). 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 (1991). 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 (Narmani et al., 2010). 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

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biological processes (Cakmak et al., 1988). 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 (Aslam *et al.,* 2014). 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 (Keen et al. 1990; Ho et al. 2003; Black et al. 2008).

In the real world, boron is essential for the formation of pollen tubes, flower male fertility, floral organ development, and plant consumption of carbohydrates (Blevins and Lukaszewski, 1998). As a result of boron shortage, poor anther and pollen development occurs during the grain setting stage (Cheng and Rerkasem, 1993), and the resulting grain is often starch-free (Dell and Huang, 1997). 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 (Shorrocks, 1997).

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 O2 soils, where Mn bioavailability can fall well below the level required for normal plant growth (Broadley *et al.,* 2007).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) (Goulding, 2016).

The main component of those changes is the transport process. Many eukaryotic creatures have previously had their Mn transporters discovered at the molecular level (Pittman, 2005). 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 haveselected 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 2^{nd} 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:

1. To study the effect of micronutrient mixture on growth and parameters of wheat crop.
2. Tostudy the effect of micronutrient mixture on growth and yield attributes parameters/characters of wheat crop.

MATERIALS AND METHODS

The present test took place during 2021–2022 at the BFIT Crop Research Centre's agriculture farm in Dehradun, Uttarakhand.The testing site's geographic coordinates were 30°33'44" North latitude, 77095'96" East longitude, and 25.5 meters above mean sea level (KRCADEPS). The PBW 292 (Late sown variety) was sown on 28 December 2021. The climate of Dehradun is generally temperate, although it various from tropical. When compared with winter, the summer has much more rainfall. In Dehradun the average annual temperature is 20.4 ^{o}C /68.8 ^{o}F. June is the hottest month and January is the coldest month in whole year. The area receives an average annual rainfall 2073 mm. The weeks of June through September bring in the most of the city's annual rainfall, with July and August being the wettest. These regions grow a variety of major crops, including wheat, rice, sugarcane, maize, soybeans, pulses, and various fruits and edible plant parts.

The experimental material comprised of one variety of wheat. A hand drill driven by a man was used to sow the seeds, with a distance of 10 cm within plants and 30 cm between rows. The plot's measurements were 2 × 1 m2. Utilizing the late-sown variety PBW-292 of wheat, a suggested seed rate of 120 kg ha-1 was used.The experimental field had an even topography with a gentle slope and good drainage.The ground water table is more than 10 m depth.In these areas ground water table fluctuated substantially in recent years.There is fertile alluvial

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soil in Dehradun that has sandy,clay and rocky element found in the areas.The composite soil sample was collected from the experimental plot up to depth of 15 cm before sowing of the crop and analyzed for determination of the physical and chemical properties of the soil, details of which are presented given below.

Sr. no.	Physical properties of experimental field	Intial value	Method employed
1.	**Mechnical analysis Soil seprate (%)**		Hydrometric method (Bouyoucos,1962)
	Sand (%)	75.09	
	Silt (%)	19.91	
	Clay (%)	5.0	
2.	Texture class	Sandy loam	
	Chemical properties of experimental field	**Initial value**	
3.	pH	7.03	Systronic glass electrode pH meter (Jackson, 1967)
4.	EC (dsm^{-1})	0.23	Conductivity bridge meter (Jackson,1973)
5.	Organic Carbon (g kg^{-1})	0.63	Walkley and Black" s titration method (1934)
6.	Available N (kg ha^{-1})	200.7	Alkaline potassium permanganate method (Subbiah and Asija 1956)
7.	Available P_2O_5 (kg ha^{-1})	26.8	Bray's and Kurtz method (Jackson, 1973)
8.	Available K_2O (kg ha^{-1})	135.5	Flame photometer method (Jackson, 1973)
9	**Micronutrients (mg kg^{-1})**		
	Fe	4.10	Colorimetic Datta *et al*.(2002)
	Mn	4.43	
	Zn	1.71	
	Cu	0.57	
	B	0.32	

Table 1- Analyzed for determination of the physical and chemical properties of the soil

	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	$2\times1m^2$

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5.	Fertilizer (N:P:K)	80:40:40
6.	Date of Sowing	28/12/2022
7.	Date of Harvesting	26/04/2022

Table 2- Experiment 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 Treatments Details

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 1 Details of micronutrient mixture Local Formulation Grade V

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Parameters on which the work was done are Growth and Yield Attributes are Germination count, Plant height (cm), Plant population and tillers (m^{-2}), Spike length (cm), Grains spike^{-1}, Leaf area index, Test weight (1000 grains weight, g), Biological yield, Harvest index (%), Grain yield, Straw yield, Leaf area index (LAI).

Operation	Method	Date
Field Preparation	Tractor operator	25/12/2021
Field Layout	By hand one time	25/12/2021
Seed Treatment	By hand one time	27/12/2021
Seed Sowing	By hand one time	28/12/2021
Method of Sowing	Line sowing method	28/12/2021
Application of basal dose of fertilizer	One time by hand	28/12/2021
Application of micronutrient mixture on SA with in basal dose of fertilizer	One time by hand	28/12/2021
Plant Protection	One time by sprayer	17/01/2022
1st Irrigation	Through surface check basin method	18/01/2022
Thinning weeding & earthing up	Manually by hand and khurpa	24/01/2022
1st spray of micronutrient mixture	By Hand sprayer	25/01/2022
Second spilt doses of Nitrogen	By hand through broadcasting	27/01/2022
2nd Irrigation	Through surface check basin method	21/02/2022
3rd Irrigation	Through surface check basin method	16/03/2022
4th Irrigation	Through surface check basin method	01/04/2022
5th Irrigation	Through surface check basin method	13/04/2022
Harvesting	By hand Sickle	26/04/2022
Threshing	Manually	27/04/2022

Table 4 Details of field preparation

Statistical analysis of the data was recorded done through randomized block design. It was determined by applied two factor ANOVA Test of significance were recorded on the basis of CD difference at 5%.

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

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 -21. The field treatment details and field layout details are given in Table 3.While the field layout design was presented in Fig.2.

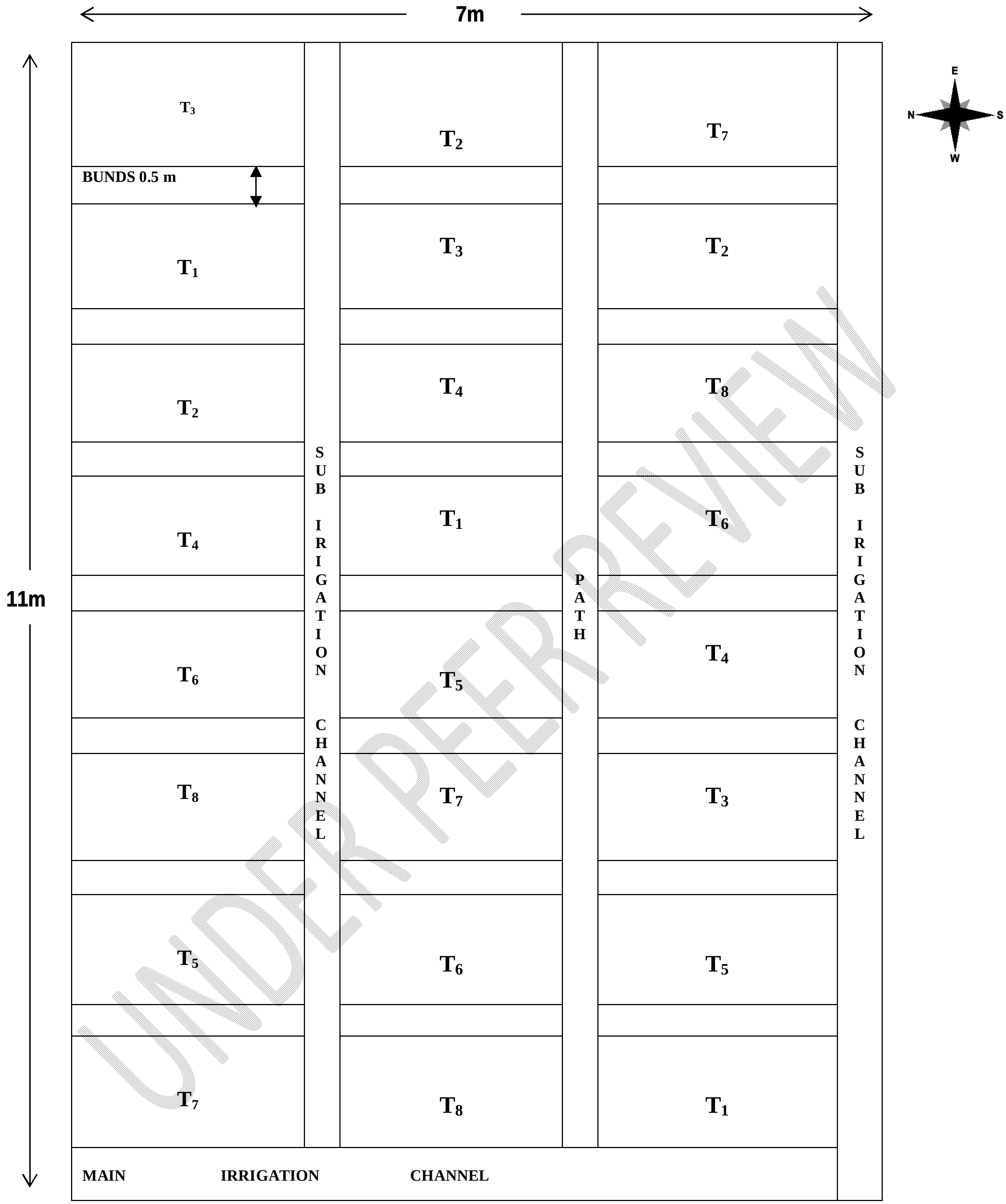

Fig.2 Field Layout Design

Result and Discussion

A. Effect of micronutrients mixture on the growth on wheat

Table 5 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. (2010) 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 thatwhen Cu was applied, Kumar *et al.* (2009) saw an increase in the number of tillers, whereas Manal *et al.* (2010) 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 are 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 (2014) 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_7with37.17, and 36.92 grains spike^{-1}respectively.In the T1 (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.

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

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

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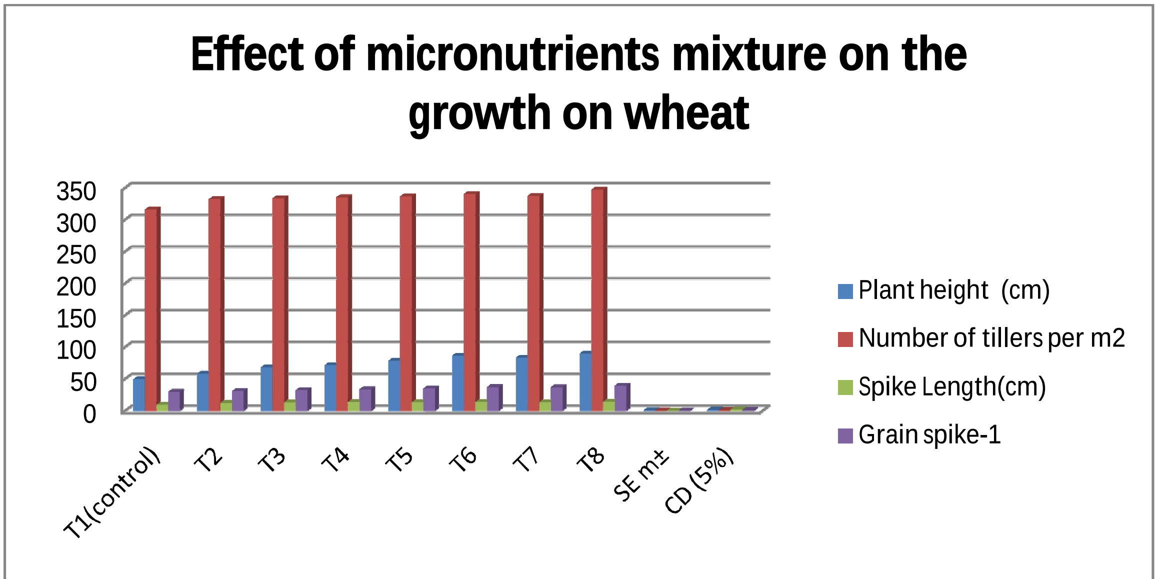

Fig 3 - Graphical Representation of Effect of micronutrients mixture on the growth on wheat

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.* (2018) 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 (2005) 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 (Reddy, 2004). 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/hac 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. (2007), who reported a considerable increase in wheat production when boron was applied in conjunction with a modest dose of NPK. Uddin et al. (2008) 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})

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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. (2008) 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 GradeV 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 (2013)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 (Reddy, 2004). Leaf area index was estimated at CRI, Tillring 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 (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.

Treatment	**Test weight (1000 grain) in gm**	**Grain yield(t ha^{-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

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CD(5%)	0.71	0.27	0.24	4.095	0.408	0.0394

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

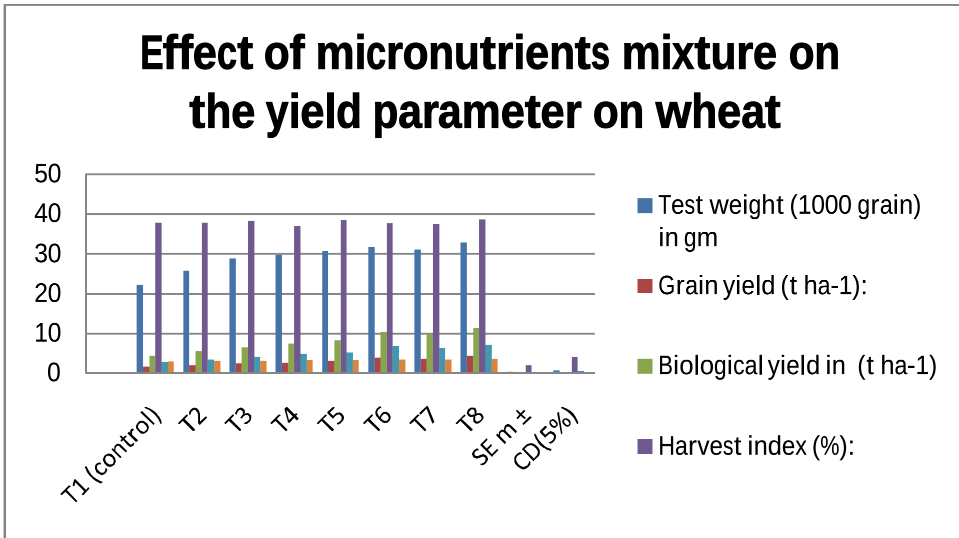

Fig 4- Graphical Representation of Effect of micronutrients mixture on the yield parameter on wheat

Conclusion:

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 Cropcould 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.

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