European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 7, Issue 07, 2020

Response Of Wheat To Foliar Application Of Iron At Different Growth Stages

Vicek[1], C. M. Mehta[2]

[1,2]School of Agriculture, Lovely Professional University, Punjab

email: [2]chandra.18376@lpu.co.in

Abstract: The experiment was conducted in Agriculture filed of Lovely Professional University, Jalandhar with wheat variety viz. HD 3086 to know the effect of foliar application of iron on nitrogen uptake and its combined impact on growth and yield of wheat. The plot design was RCBD with three replications and eight treatments. T1: Control (without fertilizer), T2: Control (with RDF), T3: RDF+ FeSO4 + Urea (at flowering stage), T4: RDF + FeSO4 (at flowering stage), T5: RDF + FeSO4 + Urea (at milking stage), T6: RDF+ FeSO4 (at milking stage), T7: RDF+ FeSO4 + Urea (at pre-maturity), T8: RDF + FeSO4 (at pre-maturity). The observed parameters plant height, length of spike, number of tiller, effective number of tillers, test weight of grain, number of spike lets per spike, number of grain per spike were taken at regular interval of 60, 90 ,120 DAS. In case of yield parameter the maximum test weight was recorded in T3 (49.75) and minimum was in T3 (45.09). For harvest index maximum value was recorded in T3 (45.42) and minimum in T1 (43.49). According to result, better growth and yield parameter was observed in treatments T3 due to foliar spray of iron and urea. Iron acts as catalyst and regulate many enzymatic activities which helps in better growth and increase in the yield, whereas urea is a source of nitrogen and in plants growth nitrogen play very important role because it helps in the synthesis of chlorophyll and many other activities.

Keywords: Foliar application, Iron, RCBD, Treatments, Wheat.

1. INTRODUCTION

Wheat is the one of extremely essential cereal crop that's grown-up across vary of environments around the world. Wheat is a rabi season crop that is grown-up in tropics and sub tropics region and conjointly want warm temperature throughout its growth cycle. Heat stress is that the main issue for growth stage like grain filling and if heat stress is additional then it conjointly cut back the yield. The fertilization of chemical element boosts the macromolecule content considerably. The micronutrients play a necessary role in rising crop yield. Micronutrients have distinguished effects on dry matter, grain yield and straw yield in wheat (ChitraMani & Kumar, P. (2020); Sharma, M., & Kumar, P. (2020); Chand, J., & Kumar, P. (2020); Naik, M., & Kumar, P. (2020); Kumar, P., & Naik, M. (2020); Kumar, P., & Dwivedi, P. (2020); Devi, P., & Kumar, P. (2020); Kumari, P., & Kumar, P. (2020); Kaur, S., & Kumar, P. (2020); Devi, P., & Kumar, P. (2020); Sharma, K., & Kumar, P. (2020); Kumar, S. B. P. (2020); Devi, P., & Kumar, P. (2020); Chand, J., & Kumar, P. (2020). Iron plays role in biological oxido reduction system, accelerator activation and atomic number 8 carrier in biological process Romheld and Marschner, (1991). Many reports indicate that either soil or foliar application of micronutrients have correlation with wheat yield (Habib, 2009). Foliar spray of micronutrients is simpler to regulate deficiency downside than soil application Torun *et al.,* (2001). There is very little printed information in literature addressing the role of iron fertilization on Fe concentrations within the edible elements of staple food crops. Extremely of the studies regarding iron fertilization cantered additional on correction of Fe deficiency downside. Additionally, in distinction to zinc, iron fertilization looks to be not effective in rising Fe concentrations of cereal grains Rengel *et al.,* (1999). Recent proof in literature indicates that chemical element organic process standing of plants incorporates a positive influence on grain accumulation of iron Kutman *et al.,* (2010). Therefore present study was aimed to investigate the evaluate the response of Fe application on growth and yield of wheta.

2. MATERIALS AND METHODS

Field experiment was conducted out at experimental farm of faculty of agriculture, throughout Rabi season 2017-2018. The situation of farm is at line of longitude 75^0 with altitude of 232 m higher than water level and latitude 31.25^0. The farm is underneath central plain agro geographical zone of geographical region. Winter wheat crop (variety HD3086) was selected for the study. Taking iron and recommended fertilizers (NPK) total eight treatments i.e. T1: Control (without fertilizer), T2: Control (with RDF), T3: RDF+ FeSO4 + Urea (at flowering stage), T4: RDF + FeSO4 (at flowering stage), T5: RDF + FeSO4 + Urea (at milking stage), T6: RDF+ FeSO4 (at milking stage), T7: RDF+ FeSO4 + Urea (at pre-maturity), T8: RDF + FeSO4 (at pre-maturity) were selected in the study. Three replication of each treatment was selected in the study. Standard package of practice was adopted for crop cultivation with 15 kg ha^{-1} as per treatment. Crop harvested at maturity stage (panicles contained 80% of the ripened spikelet) and straw and grain had 20 per cent wet from main field. Every plot harvested on an individual basis, packed and separated. It was left for drying and on an individual basis from every plot taken reading for yield parameters

Growth and yield attributing characters

Growth and yield parameters i.e. i.e. plant height, no. of productive tillers, spike length, dry biomass, thousand grain weight, grain yield, straw yield and harvest index were noted as per standard protocols.

Statistical analysis

All data tabulated according treatment wise under three replications. To develop ANOVA table was done data entry while has rejected the null hypothesis. For identify most efficient treatment applied Duncan Multiple Range Test (DMRT) and mean separation technique. Regarding software programs Ms Word 2010 used for processing and Ms Excel used for making graphs and tables. For running statistical analysis used IBM SPSS 22 licence. ANOVA was done for test significance difference for each parameter. Calculation has done 5 per cent significant level.

3. RESULTS AND DISCUSSIONS

Effect of iron on plant height

The periodic plant height at 60, 90 and 120 days after sowing (DAS) are presented in figure 1. At 60 DAS plant height vary from 27.5 to 42.4 cm. The highest value was observed (42.4 cm) in T3 RDF+FeSO4+Urea (at flowering stage) and it was statically followed by T5 40.2 cm (at milking stage) and lowest value was observed 27.5 in T1 (i.e. control). At 90 DAS plant height ranged from 80.2 to 85.03 cm. The height value was observed in T3 85.03 cm RDF+FeSO4+Urea (at flowering stage) and the value is followed by T5 82.23 cm RDF+FeSO4+Urea (at milking stage) and lowest value was observed in T1 80.2 cm control (without RDF). Plant height ranged from 86.6 to 93.5 cm at harvesting time. The highest value observed was 93.5 cm in T3 RDF+FeSO4+Urea (at flowering stage) and that was followed by T5 92 cm that is RDF+FeSO4+Urea (at milking stage). The lowest height was observed was 85.6 cm in T1 control (without RDF). Iron have a significant role in energy transfer within the plant, (Abbas *et al.*,2009; Ali,2012; Bameri *et al.*, 2013).

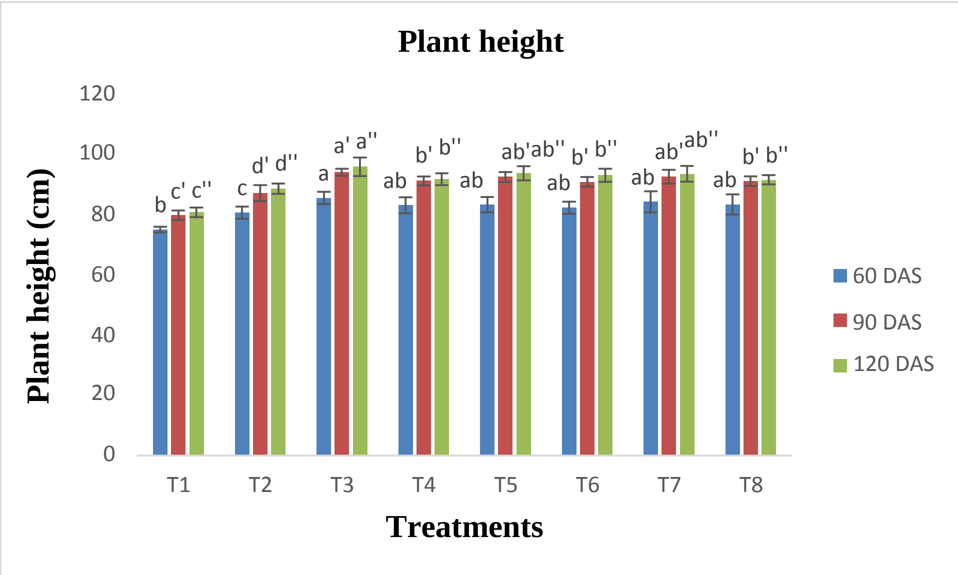
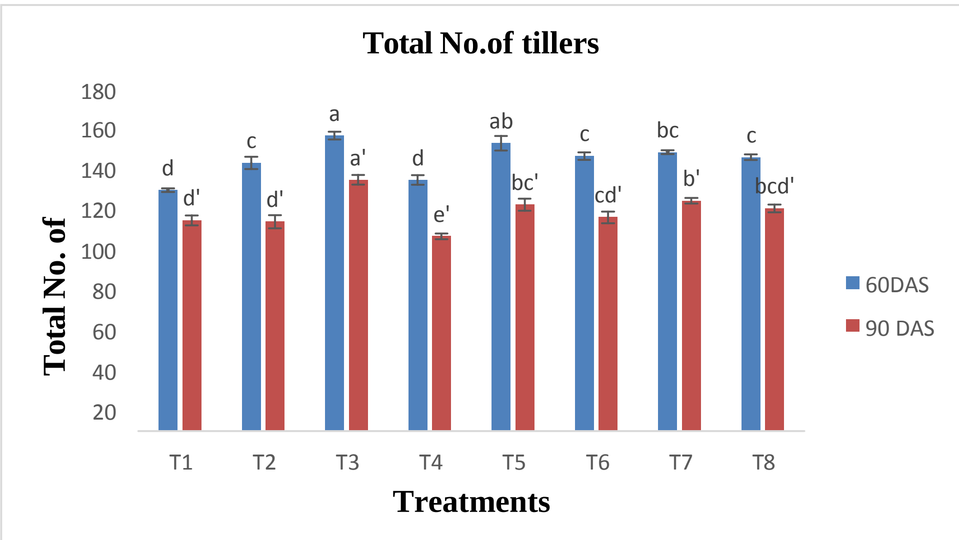


Fig. No. 1 Effect of iron foliar spray on plant height

4.1.1 Tillers Number

Tiller are responsible for both the grain yield and straw yield. If tiller number are more than the straw yield would be more. In this result we are discussing about what was the impact of foliar application of iron on the tiller numbers of wheat. The tiller numbers are recorded at 60, 90 days after sowing (DAS) and at harvest are presented in Fig 2. There was significant variation in the plant height of T3 treatment as compare to control. At 60DAS total No. of tiller vary from 127 to 155. The highest value was observed 155 in T3 RDF+FeSO4+Urea (at flowering stage) and it was statically value was followed by T5 151 (at milking stage) and lowest value was observed 127 in T1 i.e. control (without RDF). At 90 DAS total No. of tiller ranged from 111 to 132..

Fig No.2. Effect of iron foliar spray on No. of tiller



The height value was observed in T3 132 RDF+FeSO4 (at flowering stage) and the value is followed by T5 119 RDF+FeSO4+Urea (at milking stage) and lowest value was observed 111 in T1 i.e. control (without RDF). Similar results were obtained by Abbas *et al.*, (2009), Nadim *et al.*, (2012) that when iron was applied alone or in combination with other nutrient it significantly helps in increasing No. of tillers as compared to control. Jatav (2004), reported that the increase in the grain and straw yield of wheat due to increase in number of effective tillers, number of grain per ear and number of effective tiller per meter row length therefore increase uptake of NPK and micronutrient due to iron application (Kumar, P. (2019); Kumar, D., Rameshwar, S. D., & Kumar, P. (2019); Dey, S. R., & Kumar, P. (2019); Kumar et al. (2019); Dey, S. R., & Kumar, P. (2019); Kumar, P., & Pathak, S. (2018); Kumar, P., & Dwivedi, P. (2018); Kumar, P., & Pathak, S. (2018); Kumar et al.,2018; Kumar, P., & Hemantaranjan, A. (2017); Dwivedi, P., & Prasann, K. (2016). Kumar, P. (2014); Kumar, P. (2013); Kumar et al. (2013); Prasann, K. (2012); Kumar et al. (2011); Kumar et al. (2014).

Spike Length (cm)

In this we are discusing about that what was the impact of intercropping of wheat with chickpea and mustard on spike length. spike length was taken at harvesting time. It is the parameter that included in the straw yield and grain yield**.** The maximum spike length at harvesting was 11.45cm recorded in T3, it was at statically at per T1. Length of spike at harvesting in is near about the highest length recorded. In treatment T5 the length of spike is 10.79 cm which was statically at per T7 that is 10.19cm, spike length directly affects the yield. But in some case if spike height is more and grain per spike is less than yield gets decreased and if length of spike is less but grains number of grains per spike is more than yield get increased. The results were supported by Amal *et al.*, (2011) that the spray of urea effectively increase the spike length significantly as compare to control (Reddy, 2004).

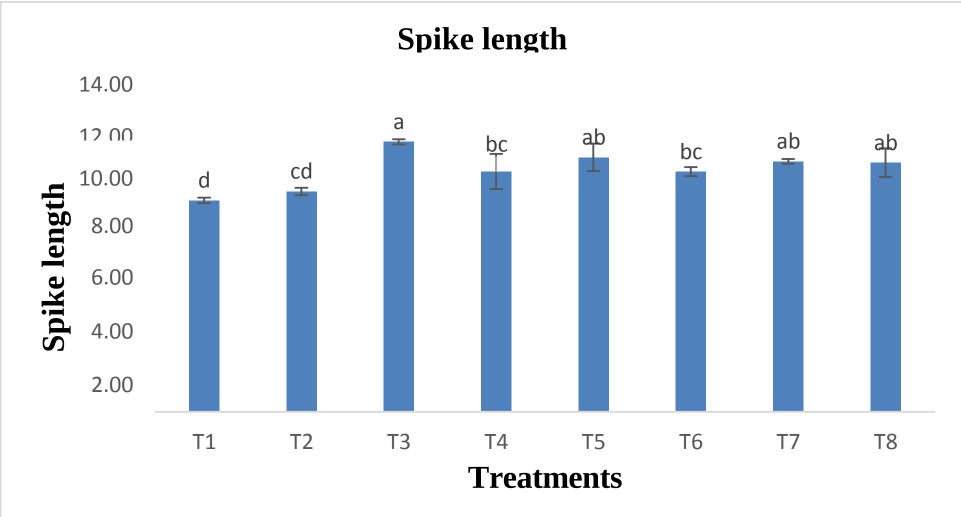


Fig.3. Effect of iron application on spike length (cm)

Test weight (g) (1000 seed)

Grain weight represents the development and plumpness of grains. It is index of yield. Grain test weight used as a grain quality indicator. Lower test weight is more common when crops have stress on some point of the grain-filling period. Any disease and insect or environmental condition can affect the test weight these condition may reduce the movement of nutrients to the kernel during grain filling period. The data on 1000-grain weight are presented in Fig.4. Maximum test weight (49.75 g) was recorded in treatment T3: RDF+FeSO4+Urea (at flowering stage) it was statistically at per treatment T5: RDF+FeSO4+Urea (at milking stage) and T7: RDF + FeSO4+Urea (at pre-maturity) and was significantly different from T1 and T4. Lowest test weight is observed in treatment T1: Control (without fertilizer) is 43.49 gm. There was significant increase in test weight in all treatments as compared to control. Same results were recorded by Yaseen *et al.*, (2010) that when plants were treated with urea and iron foliar spray there was significant increase in test weight as compared to control.

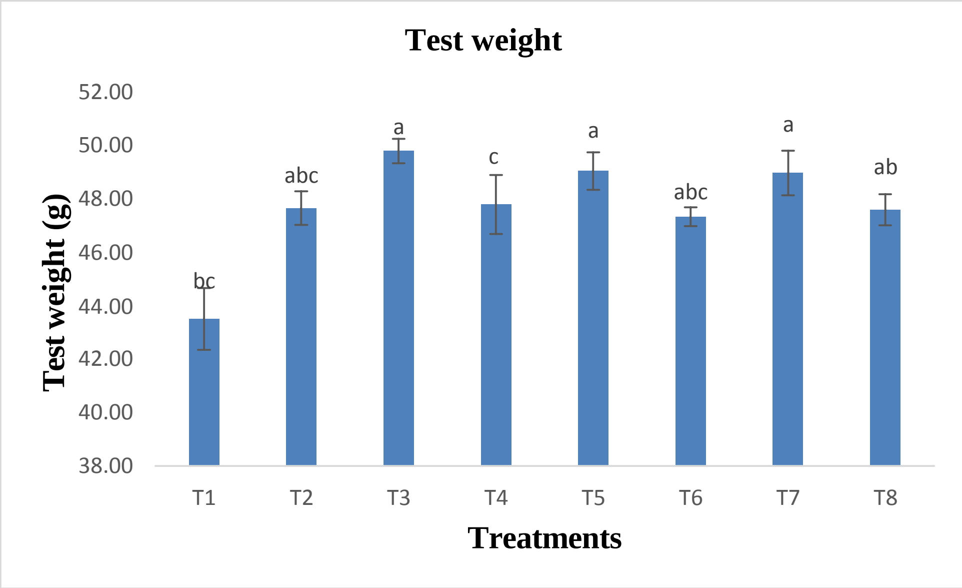


Fig.4. Effect of iron application on test weight (g)

Number of spikelet per spike

Number of kernals per spike is also a factor that effect the yield. In current experiment there is not much effefct on no, of keranals. There is slightly variation in total number of kernals per spike of wheat. The heighest number of kernals was recorded in treatment T3: RDF+FeSO4+Urea (at flowering stage) and it was statically at per T5: RDF+FeSO4+Urea (at milking stage) and T7: RDF + FeSO4+Urea (at pre-maturity). Treatmet T4: RDF+FeSO4(at flowering stage) and treatment T8: RDF+FeSO4 (at pre-maturity) has very less variation in total number of spikelets per spike in T4: RDF+FeSO4 (at flowering stage) has 74 number of spikelets and T8: RDF+FeSO4 (at pre-maturity) has 74.33 number of total spikelets perspike of wheat. The lowwest number of spikelets was recorded in T1: Control (without RDF) that was 70. Jatav (2004), reported that the increase in the grain and straw yield of wheat due to increase in number of effective tillers, number of grain per ear and number of effective tiller per meter row length therefore increase uptake of NPK and micronutrient due to iron application.

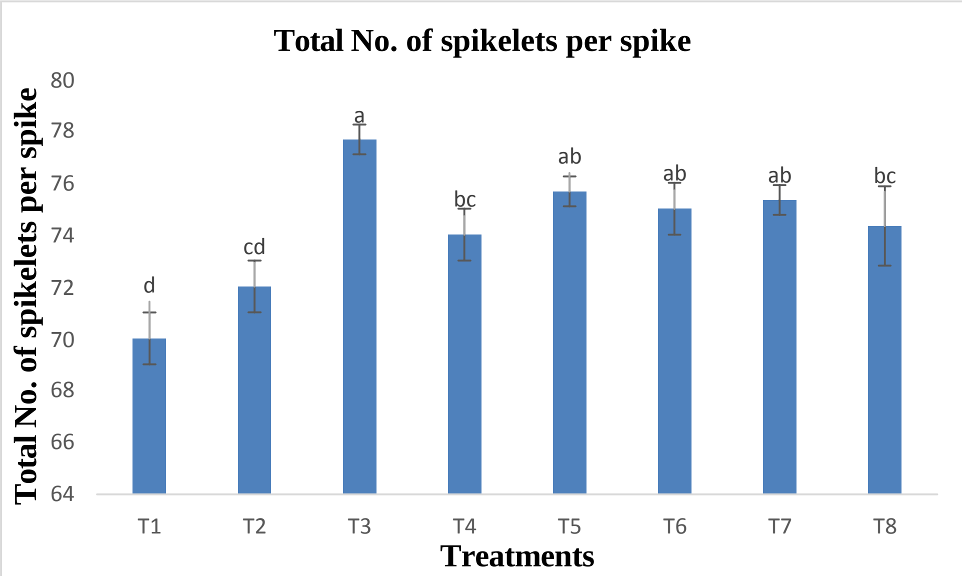


Fig. 5 Effect of iron application on No. of spikelet per spike

4.1.1 Number of grain per spike.

Number of grains per spike directly effect the yield. If the number of grains per spike was more than yield was good. And if the number of grain was less per spike than it reduce the yield. Number of grain per spike get effected at grain felling stage. In current experiment the maximum number of grain per spike was recorded 55 in T3: RDF+FeSO4+Urea (at flowering stage) it was statically at per T5: RDF+FeSO4+Urea (at milking stage) and T7: RDF + FeSO4+Urea (at pre-maturity). The lowest number of grain per spike 43.67 was recorded in T1: control(without RDF). It was statically at per T2: control(with RDF). There is significant increase in the No. of spike per spikelets in treatments as compared to control.

The results were supported by Bimeari *et al.,* (2010) the foliar application of iron with nitrogen significantly increased the No. of grains per spike, 1000 grain weight and grain yield. The results obtained by the study suggested that the foliar application of micronutrients had better effect on the growth and yield parameters og wheat. Jatav (2004), reported that the increase in the grain and straw yield of wheat due to increase in number of effective tillers, number of grain per ear and number of effective tiller per meter row length therefore increase uptake of NPK and micronutrient due to iron application.

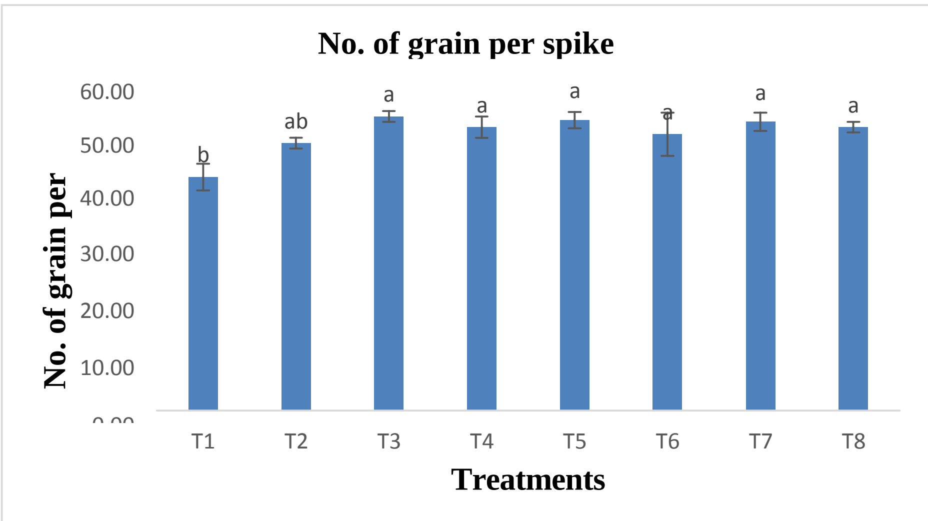


Fig.6 Effect of iron application on No. of grain per spike

Total No. of productive tillers

It was observed that height number of effective tiller in per meter row length of wheat is 105.33 in T3: RDF+FeSO4+Urea (at flowering stage). It was statically at per T5: RDF+FeSO4+Urea (at milking stage). The lowest number of effective tiller was observed in one meter row length is 90.66 in T1: control (without RDF). T2: control (with RDF) was statically at per T4: RDF + FeSO4 (at flowering stage). Number of effective tiller was always less than the total number of tiller. Effective tiller are those which has grains or those tiller which produce grain.

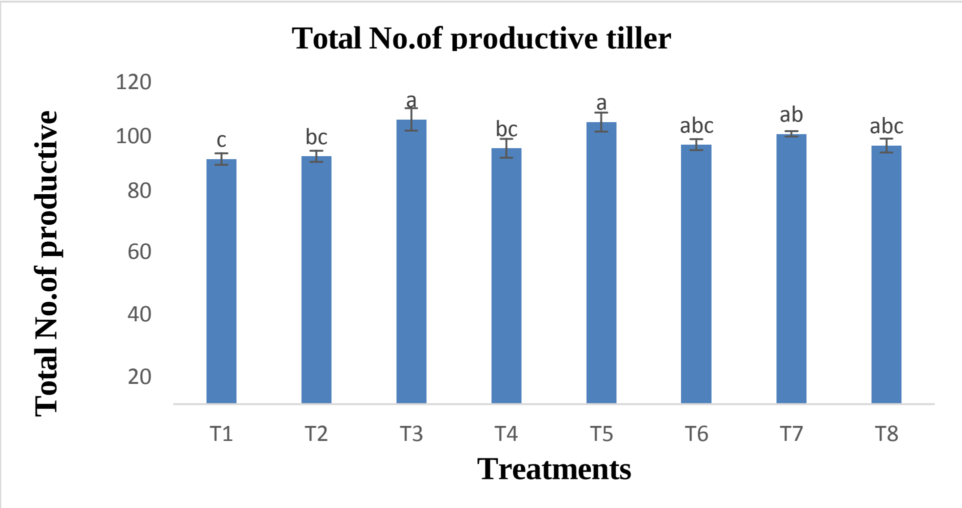


Fig.7 Effect of iron application on total No. of productive tiller

The results were supported by Yaseen *et al.*, (2011) that the foliar application of micronutrients at different rates increased the No. of productive tillers which results in the increase of grain yield. Jatav (2004), reported that the increase in the grain and straw yield of wheat due to increase in number of effective tillers, number of grain per ear and number of effective tiller per meter row length therefore increase uptake of NPK and micronutrient due to iron application.

Grain yield (q ha^{-1})

Grain yield per plot was obtained in the current experiment under different treatments is depicted in figure 8. A significant increase in yield was reported in T3 as compare to T1and T2 however in other treatments no clear significant increase was reported. It was observed that highest grain is 53.56 q ha^{-1} in T3: RDF+ FeSO4 + Urea (at flowering stage). It was statically at per T7: RDF+ FeSO4 + Urea (at pre-maturity), and T5: RDF + FeSO4+ Urea (at milking stage. The lowest yield was observed 38.73 q ha^{-1} in T1: control (without RDF) and it was statically at per T2: control (with RDF).

The results obtained were similar with Yaseen *et al.*, (2010) that the foliar application of nitrogen increase the grain yield but not at significant level, but when iron and nitrogen both applied in combination was resulted in highest grain yield as compare to control and nitrogen application. Chaudry *et al.*, (2007) reported that micronutrients (Zn, Fe, B) significantly increased the wheat yield over control when applied in single and in combination, along with basal dose of NPK.

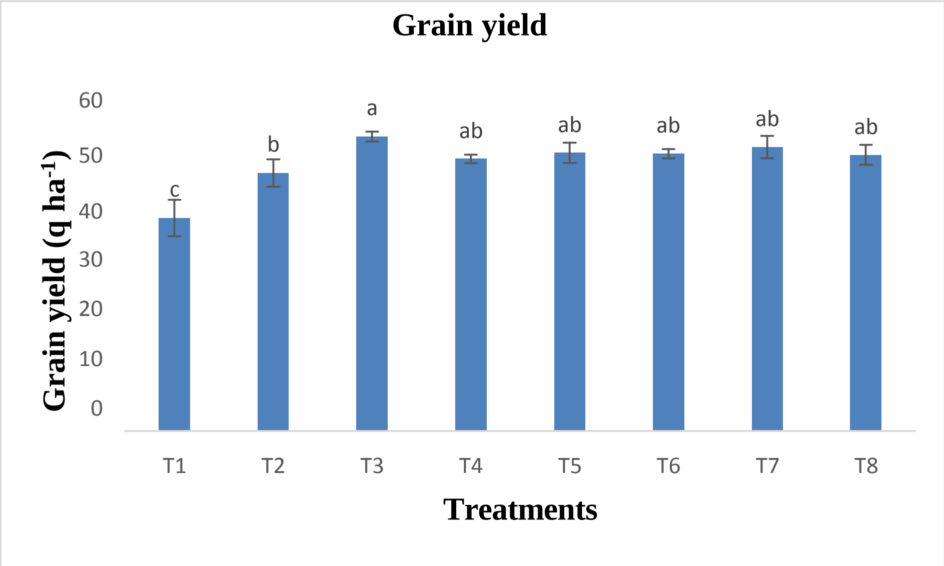


Fig.8 Effect of iron application on grain yield (q ha^{-1})

Straw yield (q ha^{-1})

Highest straw yield was obtained 70.23 q ha^{-1} in T3: RDF+ FeSO4 + Urea (at flowering stage) followed by 69.6 q ha^{-1} in T5: RDF+ FeSO4 + Urea (at pre-maturity),68.73 q ha^{-1} T6: RDF+ FeSO4 (at milking stage), 68.7q ha^{-1} T7: RDF+ FeSO4 + Urea (at pre-maturity), 68.03 q ha^{-1} T8: RDF + FeSO4 (at pre-maturity. The lowest straw yield was recorded 57.73 q ha^{-1} T1: Control (without fertilizer) followed by 66.63 q ha^{-1} T2: Control (with RDF). There was significant increase in straw yield in all treatments as compared to control. The results were supported by Shahrokhi *et al.*, (2012), that there was significant increase in the straw yield when iron was applied in different concentrations as compared to control. Bai and Malakouti (2003), conducted an experiment, detailed that maximum straw yield was obtained when18kg ha^{-1} iron sulfate and 21 kg ha^{-1} manganese was applied.

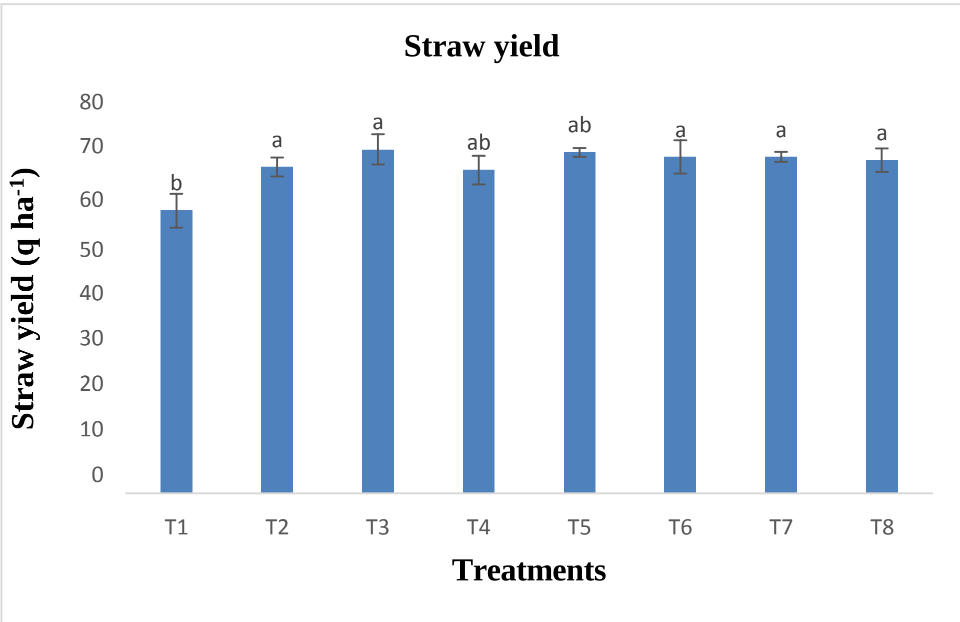


Fig.9 Effect of iron application on straw yield (q ha^{-1})

Total yield (q ha^{-1})

In the current experiment the highest total yield was in T3: RDF+ FeSO4 + Urea (at flowering stage) 121.33 q ha^{-1} followed by T7: RDF+ FeSO4 + Urea (at pre-maturity) 120.33 q ha^{-1} and T5: RDF + FeSO4 + Urea (at milking stage) 120.2 q ha^{-1}. The minimum yield was obtained in the T1: Control (without fertilizer) 96.46 q ha^{-1}. In T6: RDF+ FeSO4 (at milking stage) and T8: RDF + FeSO4 (at pre-maturity) had little variation in the total yield that is 119.16 q ha^{-1} and 118.23 q ha^{-1}. There data obtained in the present study of total yield was non-significant in all treatments. Different results were given by Shahrokhi *et al.*, (2012), that there was significant increase in the straw yield when iron was applied in different concentr

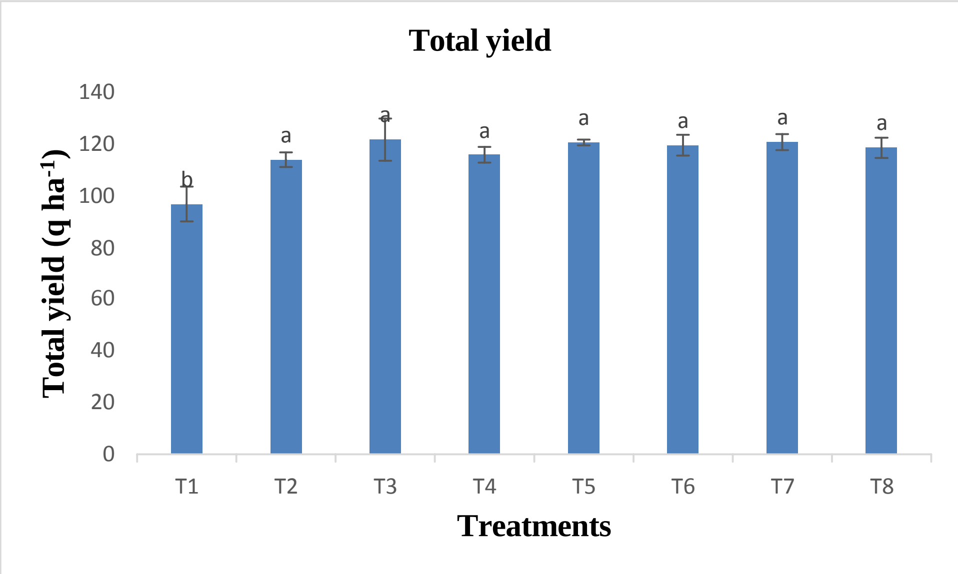


Fig.10 Effect of iron application on total yield (q ha^{-1})

4.1.2 Harvest Index (%)

Effect of foliar application of iron and nitrogen on harvesting index is shown in figure 11. Harvesting index the highest harvesting was observed (43.28) in T3: RDF+ FeSO4 + Urea (at flowering stage) followed by (42.90) T7: RDF+ FeSO4 + Urea (at pre- maturity), (42.84) T4: RDF + FeSO4 (at flowering stage), (42.46) T8: RDF + FeSO4 (at pre-maturity), (42.34) T6: RDF+ FeSO4 (at milking stage). The lowest harvest index was observed in (40.12) T1: Control(without fertilizer). There was significant increase in the harvest index in treatments as compared to control. The results were supported by Rawashdeh (2013), that foliar application of iron and boron increase the harvest index significantly.

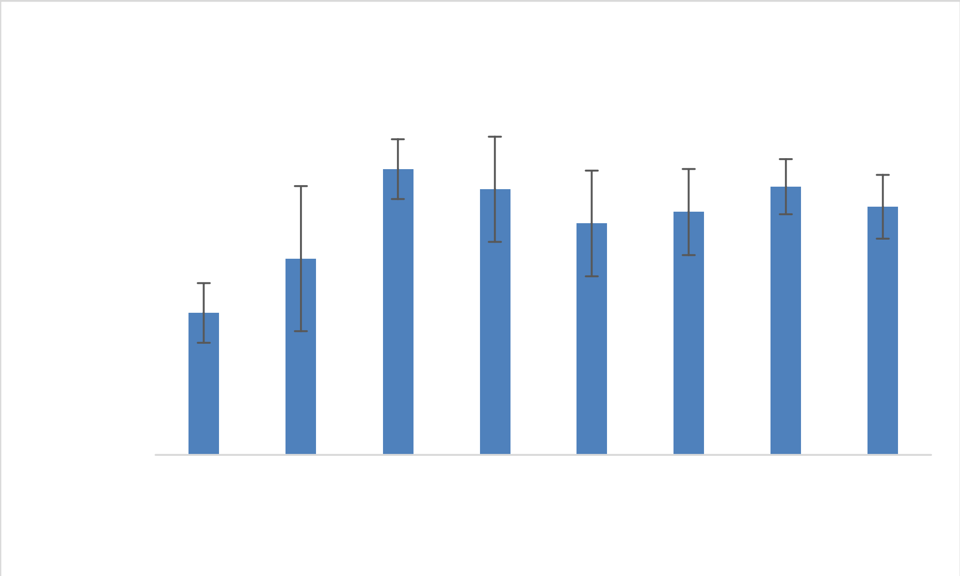


Fig.11 Effect of foliar application of iron on harvest index

4. CONCLUSION

The results of the present study reports that treatments with application of foliar iron have significant impact on plant height, productive tillers, spike length, dry biomass, test weight, grain yield, straw yield and harvest index as compare to control. Therefore, foliar applicaton of Fe have a significant impact on wheat crop growth and yield.

REFERENCE

[1] Abbas, G., Khan, M. Q., Khan, M. J., Hussain, F. and Hussai, I. 2009**.** Effect of Iron on the Growth and Yield Contributing Parameters of Wheat (*Triticum a estivum*L.). *J. Anim. Plant Sci.*, 19: 135-139.

[2] Amal, G. Ahmed, M. M. Tawfik and Hassanein, M. S., 2011, Foliar Feeding of Potassium and Urea for Maximizing Wheat Productivity in Sandy Soil. Australian J. Basic Appl. Sci., 5(5) : 1197-1203.

[3] Bai, B. A., & Malakouti, M. J. (2003). Effects of iron, manganese, zinc, and copper on wheat yield and quality under saline condition.

[4] Bameri M, Abdolshahi R, Mohammadi-Nejad G, Yousefi K, Tabatabaie SM (2012). Effect of different microelement treatment on wheat (*Triticum aestivum*) growth and yield. *Intl. Res. J. Appl. Basic. Sci*. 3(1): 219-223.

[5] Chaudry, E. H., Timmer, V., Javed, A. S., & Siddique, M. T. (2007). Wheat response to micronutrients in rainfed areas of Punjab. Soil & Environ, 26(1), 97-101.

[6] Habib, M., 2009. Effect of Foliar Application of Zn and Fe on Wheat Yield and Quality. *Afr.*

a. *J, Biotechnol.,* **8**: 6795-6798.

[7] Jatav M. K. (2004). Effect of application of phosphorus, manganese and iron on yield and nutrient uptake by wheat (*Triticum aestivum* L.) in inceptisols**.**

[8] Kutman UB, Yildiz B, Ozturk L, Cakmak I (2010) Biofortification of durum wheat with zinc through soil and foliar applications of nitrogen. *Cereal Chemistry* **87,** 1-9

[9] Nadim AM, Awan UI, Baloch SM, Khan AE, NaveedK, Khan AM, Zubair M, Hussain N. Effect of Micronutrients on Growth and Yield of Wheat. *Pak J Agri Sci.* 2011;*48(3):191-196.*

[10] Rawashdeh HM, Sala F (2013). The effect of foliar application of iron and boron on early growth parameters of wheat (*Triticum aestivum* L.). Research Journal of Agricultural Science, 45 (1): 21-26.

[11] Reddy S R (2004) Agronomy of Field Crops. Kalyani Publishers, India.
[12] Rengel Z, Batten GD, Crowley DE (1999) Agronomic approaches for improving the micronutrient density in edible portions of field crops. *Field Crops Research* **60,** 27- 40.
[13] Romheld V, Marschner H (1991). Functions of micronutrients in plants. In: Mortvedt JJ, Cox FR, Shuman LM, Welch RM (Ed). Micronutrients in Agriculture (pp. 297- 328): 2ed No. 4 in the Soil Science Society of America Book Series. Soil Sci. Soc. Amer., Inc. Madison, Wisconsin, U.S.A.
[14] Shahrokhi, N., Khourgami, A., Nasrollahi, H., & Shirani-Rad, A. H. (2012). The effect of iron sulfate spraying on yield and some qualitative characteristics in three wheat cultivars. Annals of Biological Research, 3(11), 5205-5210.
[15] Torun, A., Gültekin, I., Kalayci, M., Yilmaz, A., Eker, S., & Cakmak, I. (2001). Effects of zinc fertilization on grain yield and shoot concentrations of zinc, boron, and phosphorus of 25 wheat cultivars grown on a zinc-deficient and boron-toxic soil. Journal of plant nutrition, 24(11), 1817-1829.
[16] Yassen A, El-Nour AA, Shedeed S. Response of Wheat to Foliar Spray with Urea and Micronutrients. J American Sci. 2010;6(9):14-22.
[17] ChitraMani, P. K. (2020). Evaluation of antimony induced biochemical shift in mustard. Plant Archives, 20(2), 3493-3498.
[18] Sharma, M., & Kumar, P. (2020). Biochemical alteration of mustard grown under tin contaminated soil. Plant Archives, 20(2), 3487-3492.
[19] Chand, J., & Kumar, P. (2020). Yield attribute shift of mustard grown under cadmium contaminated soil. Plant Archives, 20(2), 3518-3523.
[20] Naik, M., & Kumar, P. (2020). Role of growth regulators and microbes for metal detoxification in plants and soil. Plant Archives, 20(2), 2820-2824.
[21] Kumar, P., & Naik, M. (2020). Biotic symbiosis and plant growth regulators as a strategy against cadmium and lead stress in chickpea. Plant Archives, 20(2), 2495-2500.
[22] Kumar, P., & Dwivedi, P. (2020). Lignin estimation in sorghum leaves grown under hazardous waste site. Plant Archives, 20(2), 2558-2561.
[23] Devi, P., & Kumar, P. (2020). Concept and Application of Phytoremediation in the Fight of Heavy Metal Toxicity. Journal of Pharmaceutical Sciences and Research, 12(6), 795-804.
[24] Kumari, P., & Kumar, P. (2020). Trichoderma fungus in mitigation of rhizosphere arsenic: with special reference to biochemical changes. Plant Archives, 20(2), 3512-3517.
[25] Kaur, S., & Kumar, P. (2020). Ameliorative effect of trichoderma, rhizobium and mycorrhiza on internodal length, leaf area and total soluble protein in mung bean (Vigna radiata [L.] R. Wilazek) under drought stress. Journal of Pharmacognosy and Phytochemistry, 9(4), 971-977.
[26] Devi, P., & Kumar, P. (2020). Effect of bioremediation on internodal length and leaf area of maize plant cultivated in contaminated soil with chromium metal. Journal of Pharmacognosy and Phytochemistry, 9(4), 1408-1413.
[27] Sharma, K., & Kumar, P. (2020). Mitigating the effect of biofertilizers on morphological and biochemical level in pearl millet grown under mercury toxicity. Journal of Pharmacognosy and Phytochemistry, 9(4), 955-961.
[28] Kumar, S. B. P. (2020). Salinity stress, its physiological response and mitigating effects of microbial bio inoculants and organic compounds. Journal of Pharmacognosy and Phytochemistry, 9(4), 1397-1303.
[29] Devi, P., & Kumar, P. (2020). Enhancement effect of biofertilizers on germination percentage and plant height in maize grown under chromium toxic soil. Journal of Pharmacognosy and Phytochemistry, 9(4), 702-707.
[30] Chand, J., & Kumar, P. (2020). Biochemical shift of mustard grown under cadmium contaminated soil. Journal of Pharmacognosy and Phytochemistry, 9(3), 178-183.
[31] Kumar, P. (2019). Evaluation Of Internodal Length And Node Number Of Pea Treated With Heavy Metal, Polyamines And Glomus. Journal of the Gujarat Research Society, 21(10s), 518-523.
[32] Kumar, D., Rameshwar, S. D., & Kumar, P. (2019). Effect Of Intergated Application Of

Inorganic And Organic Fertilizers On The Roots Of Chickpea. Plant Archives, 19(1), 857-860.

[33] Dey, S. R., & Kumar, P. (2019). Analysis of Available Nitrogen of Wheat Cultivated Soil Treated with Organic and Inorganic Source of Fertilizers. Int. J. Curr. Microbiol. App. Sci, 8(8), 2986-2990.

[34] Kumar, P., Siddique, A., Thakur, V., & Singh, M. (2019). Effect of putrescine and glomus on total reducing sugar in cadmium treated sorghum crop. Journal of Pharmacognosy and Phytochemistry, 8(2), 313-316.

[35] Dey, S. R., & Kumar, P. (2019). Cadmium induced biochemical shift in maize. Journal of Pharmacognosy and Phytochemistry, 8(1), 2038-2045.

[36] Kumar, P., & Pathak, S. (2018). Short-Term Response of Plants Grown under Heavy Metal Toxicity. Heavy Metals, 69.

[37] Kumar, P., & Dwivedi, P. (2018). Plant lectins, agricultural advancements and mammalian toxicity. Molecular Physiology of Abiotic Stresses in Plant Productivity, 360.

[38] Kumar, P., & Pathak, S. (2018). Nitric oxide: a key driver of signaling in plants. MOJ Eco Environ Sci, 3(3), 145-148.

[39] Kumar, P., Pathak, S., Amarnath, K. S., Teja, P. V. B., Dileep, B., Kumar, K., ... & Siddique, A. (2018). Effect of growth regulator on morpho-physiological attributes of chilli: a case study. Plant Archives, 18(2), 1771-1776.

[40] Kumar, P., & Hemantaranjan, A. (2017). Iodine: a unique element with special reference to soil-plant-air system. Advances in Plant Physiology (Vol. 17), 314.

[41] Dwivedi, P., & Prasann, K. (2016). Objective plant physiology. Objective plant physiology., (Ed. 2).

[42] Kumar, P. (2014). Significance of soil-root system and aquaporins for water homeostasis in plant-a review. Advances in Plant Physiology (Vol. 15), 15, 324.

[43] Kumar, P. (2013). Food Security and Nutritional Safety: A Challenge Ahead. Journal of Functional and Environmental Botany, 3(1), 12-19.

[44] Prasann, K., Biswapati, M., & Padmanabh, D. (2013). Combating heavy metal toxicity from hazardous waste sites by harnessing scavenging activity of some vegetable plants. Vegetos, 26(2), 416-425.

[45] Prasann, K. (2012). Feeding the future: crop protection today. Acta Chimica and Pharmaceutica Indica, 2(4), 231-236.

[46] Kumar, P., & Dwivedi, P. (2011). Future Habitat Loss: Greatest Threat to the Soil Microbial Biodiversity. Journal of Functional And Environmental Botany, 1(2), 82-90.

[47] Kumar, P., Singh, B. N., & Dwivedi, P. Plant Growth Regulators, Plant Adaptability And Plant Productivity: Areview On Abscisic Acid (Aba) Signaling In Plants Under Emerging Environmental Stresses. Sustaining Future Food Security In Changing Environments, 81.