Environment & Ecology 29 (1) : 194—197, 2011
 ISSN 0970-0420

Response of Wheat to Micronutrients Applied in Conjunction with NPK

S. TYAGI[1*], B. S. MAHAPATRA, VINOD KUMAR AND D. K. SHUKLA

Department of Agronomy, G. B. Pant University of Agriculture & Technology
Pantnagar, Uttarakhand 263145, India
[1]Department of Agronomy, Bihar Agricultural College, Sabour, Bhagalpur 813210, India
E-mail : drshashank_tyagi@rediffmail.com
**Correspondence*

Abstract

A field experiment was conducted during *rabi* season of 2002-03 and 2003-04 to study the effect of micronutrient cations on growth, yield and nutrient uptake of wheat (*Triticum aestivum* L.). Application of $ZnSO_4$ at either 10 kg or 5 kg/ha along with recommended NPK dose of 150 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha showed the best expression reflected through growth and yield attributes and yield. The highest grain yield of 46.8 q/ha was obtained by application of $ZnSO_4$ at 10 kg /ha along with recommended NPK doses which was about 10.1% more than the grain yield obtained with NPK alone. However, application of 5 kg $ZnSO_4$/ha along with recommended NPK dose produced 46.2 q/ha of grain yield, statistically at par with this treatment. The uptake of nutrients viz., Zn, Fe, Mn and Cu by wheat crop also showed superiority in the treatments having application of respective nutrients. The N and K uptake, however, were calculated maximum by the application of zine sulfate, while the P uptake was found to be higher by application of Fe and Mn. Regarding nutrient uptake in grain and straw the uptake of N, P, Zn and Cu was found to be more in grain of wheat, while uptake of K, Fe and Mn was observed to be more in straw of wheat.

Key words : Micronutrient cations, Growth, Yield, Nurient uptake, Wheat.

Wheat is the second most important cereal crop next to rice in India. In recent years, due to intensive cultivation coupled with imbalanced fertilization resulted in depletion of soil fertility to a great extent, which has increased the nutrient requirement of crops considerably (1). Among the various nutrients, micronutrients play a crucial role in wheat production. Zinc is an important micronutrient cation, playing a significant role in different enzymatic and physiological activities of plant body and helps in formation of chlorophyll and auxins. Widespread deficiency of zinc is found in India.Evidences showed that increased NPK fertilization in rice-wheat cropping system has depleted the soil available micronutrient reserve, particularly available Zn, leading to decline in crop productivity. An integrated plant nutrient supply system is recommended for sustainable crop production and maintenance of soil health (2). Hence, management of micronutrients is necessary for increasing the growth and yield of wheat. The present investigation was, therefore, undertaken to find out the effect of micronutrient cations on growth, yield and nutrient uptake of wheat.

Methods

A field experiment was conducted during *rabi* season of 2002-03 and 2003-04 at Crop Research Centre G.B.Pant University of Agriculture and Technology, Pantnagar. The soil of the experimental plot was silty clay loam having organic carbon (0.83%), available nitrogen (189.7 kg/ha), available P_2O_5 (29.1 kg/ha) and available K_2O (279.5 kg/ha), available Zn (0.54ppm), available Fe (5.4 ppm), available Mn (3.6 ppm) and available Cu (2.1 ppm). The pH of the soil was 7.2. Ten treatments comprising four micronutrients viz, Cu, Fe, Mn and Zn each with two doses (5 and 10 kg/ha) in addition to recommended dose of NPK were tested along with control and NPK alone in randomized block design replicating thrice. The test wheat variety was UP 2338, sown on 4 and 6 December of 2002 and 2003, respectively. The row spacing of wheat was 23 cm having 100 kg/ha of seed rate. The crop was harvested on 28 and 30 April during 2003 and 2004 respectively. The sources of N, P, K, Zn, Fe, Cu and Mn applied were urea, single super phosphate (SSP), muriate of potash, zinc sulfate, iron sulfate, copper sulfate and manganess sulfate.Half of N and full dose of P_2O_5 and K_2O were applied as basal and remaining half N was top dressed after irrigation i. e. at CRI stage of crop. All the micronutrients were applied as basal as per treatment. Crop was irrigated

Table 1. Effect of different treatments on growth, yield and yield attributes of wheat (data pooled over 2 years).

Treatments	Plant height (cm)	No. of effective tillers/ m row length	Spike length (cm)	Grains/ spike	Spike-lets/ spike	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Bio-logical yield (q/ha)
Control (0 kg NPK)	82.5	52	9.4	33.0	14.2	34.5	21.5	37.6	59.1
NPK (150 : 60 : 40 kg/ha)	89.0	78	10.7	42.8	15.4	36.1	42.5	58.6	101.1
NPK + 5 kg $CuSO_4$/ha	90.1	79	10.4	43.6	15.6	36.3	43.0	59.6	102.6
NPK + 10 kg $CuSO_4$/ha	91.3	84	10.6	43.7	15.8	36.8	43.3	60.0	103.3
NPK + 5 kg $FeSO_4$/ha	96.2	86	10.5	43.4	16.0	37.4	44.2	61.4	105.6
NPK + 10 kg $FeSO_4$/ha	96.6	88	10.6	43.9	16.4	37.6	44.4	62.0	106.4
NPK + 5 kg $MnSO_4$/ha	95.8	81	10.7	43.1	16.3	37.0	43.4	60.8	104.2
NPK + 10 kg $MnSO_4$/ha	94.7	83	10.7	43.8	16.7	37.1	44.0	61.5	105.5
NPK + 5 kg $ZnSO_4$/ha	97.7	90	11.2	45.0	17.0	38.8	46.2	63.4	109.6
NPK + 10 kg $ZnSO_4$/ha	99.8	91	11.4	45.4	17.4	38.9	46.8	64.5	111.3
SE ±	2.8	1.38	0.12	0.9	0.3	2.3	0.64	0.8	2.2
CD (P=0.05)	8.1	4.1	0.36	2.4	0.8	NS	1.96	2.3	6.5

four times in addition to pre-sowing irrigation. In interculturing operations, one hoeing followed by hand weeding was done 30 days after sowing . The data obtained during two years were pooled and subjected to statistical analysis. The uptake of nutrients viz., N, P, K, Zn, Fe, Mn and Cu were computed by standard procedures.

Results and Discussion

Growth, Yield Attributes and Yield

Plant height increased significantly with the application of NPK (150 : 60 : 40 kg/ha) over control. The application of $ZnSO_4$ either 10 or 5 kg/ha along with recommended NPK recorded significantly higher plant height than other applications. Highest plant height (99.8 cm), however, was measured by the application of higher doses (10 kg/ha) of $ZnSO_4$, which was 12.1% taller the plant height attained by recommended dose of NPK alone.

Yield attributing characters viz., number of effective tillers/m row length, grains/spike, length of spike, spikelets/spike were also significantly affected with the application of different treatments. The highest number of effective tillers (91.0), spike length (11.4 cm), grains/spike (45.4) and spikelets/spike (17.4) were recorded with the application of 10 kg $ZnSO_4$ along

Table 2. Effect of different treatments on Zn, Fe, Mn and Cu uptake (g/ha) by wheat (data pooled over 2 years).

	Uptake (g/ha)											
	Zinc			Iron			Manganese			Copper		
Treatments	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Control (0 kg NPK)	15.0	18.4	33.4	196.3	321.5	517.8	25.8	64.7	90.5	24.0	22.6	46.6
NPK (150:60:40 kg/ha)	74.8	53.9	128.7	937.1	1133.9	2071.0	94.8	144.7	239.5	91.8	66.2	158.0
NPK + 5 kg $CuSO_4$/ha	84.7	56.0	140.7	942.9	1241.5	2184.4	102.8	159.1	261.9	110.8	118.3	229.1
NPK + 10 kg $CuSO_4$/ha	88.8	58.8	147.6	960.0	1279.8	2239.8	109.6	170.4	280.0	126.0	127.6	253.6
NPK + 5 Kg $FeSO_4$/ha	88.4	57.1	145.5	1000.3	1351.4	2351.7	117.6	184.8	302.4	102.1	76.8	178.9
NPK + 10 kg $FeSO_4$/ha	95.9	60.1	156.0	1020.3	1380.1	2400.4	127.9	200.3	328.2	107.0	76.9	183.9
NPK + 5 kg $MnSO_4$/ha	94.2	62.6	156.8	964.4	1316.3	2280.7	154.9	243.9	398.8	91.6	69.9	161.5
NPK + 10 kg $MnSO_4$/ha	94.2	63.4	157.6	972.0	1318.6	2290.6	163.7	257.1	420.8	103.8	74.4	178.2
NPK + 5 kg $ZnSO_4$/ha	117.8	89.7	207.5	894.0	1200.8	2094.8	121.5	178.8	300.3	98.9	72.3	171.2
NPK + 10kg $ZnSO_4$/ha	124.4	100.6	225.0	892.0	1205.5	2097.5	130.6	193.5	324.1	105.8	74.8	180.6
SE ±	4.5	3.6	6.2	43.0	52.0	57.4	5.36	6.6	11.7	5.10	3.92	7.4
CD (P = 0.05)	12.8	10.9	17.8	135.0	154.0	170.0	16.3	19.6	33.6	15.2	11.6	22.0

Table 3. Effect of different treatments on N, P and K uptake (kg/ha) by wheat (data pooled over 2 years).

	Uptake (kg/ha)								
	N			P			K		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Control (0 kg NPK)	18.9	11.3	30.2	5.6	4.1	9.7	10.3	35.7	46.0
NPK (150 : 60 : 40 kg/ha)	74.8	29.3	104.1	14.5	7.6	22.1	25.5	60.9	86.4
NPK + 5 kg $CuSO_4$/ha	77.0	36.4	113.4	16.8	8.3	25.1	30.5	68.5	99.0
NPK + 10 kg $CuSO_4$/ha	77.9	39.0	116.9	17.8	9.6	27.4	32.0	69.6	101.6
NPK + 5 kg $FeSO_4$/ha	82.7	41.8	124.5	18.6	9.2	27.8	34.9	78.6	113.5
NPK + 10 kg $FeSO_4$/ha	85.2	45.9	131.1	19.1	9.9	29.0	33.3	78.1	111.4
NPK + 5 kg $MnSO_4$/ha	74.2	38.9	113.1	18.0	10.5	28.5	31.0	75.4	107.1
NPK + 10 kg $MnSO_4$/ha	76.1	41.2	117.3	19.1	10.9	30.0	33.0	77.5	110.5
NPK + 5 kg $ZnSO_4$/ha	89.6	46.9	136.5	14.8	8.9	23.7	30.5	73.5	104.0
NPK + 10 kg $ZnSO_4$/ha	91.7	49.0	140.7	14.5	7.7	22.2	31.8	78.7	110.5
SE ±	2.25	1.55	4.4	0.80	0.56	1.2	1.24	2.1	4.4
CD (P = 0.05)	6.7	4.6	12.7	2.3	1.6	3.5	4.4	6.4	12.7

with recommended dose of NPK. However, application of NPK + 5 kg $ZnSO_4$/ha also exhibited statistical parity with this treatment. All micronutrients application either 5 or 10 kg/ha showed no any significant difference in influencing the growth and yield attributing characters. It was also noted that all applied micronutrients in any doses were equally effective in increasing the number of grains per spike. Musande and Palaskar (3) also reported significantly higher number of tillers/m row length, grains/spike and length of spike of wheat with the application of 5 kg zinc/ha over NPK alone. Since, zinc plays a pivotal role in regulating the auxin concentration in plant and nitrogen metabolism and this might have improved these growth and yield attributes.

Yields of grain and straw and biological yield were also increased significantly with the application of different fertilizers. Recommended dose of NPK produced 42.5 q/ha of grain yield against control (21.5 q/ha), which was 71% more over the control. Among micronutrients application along with NPK, addition of zinc at either 10 or 5 kg/ha gave significantly highest grain and straw yields and biological yields of wheat over rest of the combinations. Table 1 also indicated that both the doses of micronutrients were equally effective. This increase in yields due to the zinc application might be the result of favorable effect of zinc in biosynthesis of indole butyric acid and initiation of primordial (3) and Sakal et al. (4). Minimum grain, straw and biological yields were recorded in control where no fertilizer was applied. The application of micronutrients (Cu, Fe and Mn) along with recommended dose of NPK did not show significant effect on grain and straw yields over NPK alone.

Nutrient Uptake

The significantly highest total N uptake (140.7 kg/ha) by crop was recorded with the application of 10 kg $ZnSO_4$ along with NPK except NPK + 5 kg $ZnSO_4$ (136.5 kg/ha) and 10 kg NPK + $FeSO_4$/ha (131.1 kg/ha). Higher N uptake by crop in these treatments might be due to more grain and straw yields obtained by their application. However, maximum P uptake (30 kg/ha) was calculated with the application of 10 kg $MnSO_4$ along with NPK. Application of its lower (5 kg/ha) doses and higher (10 kg/ha) and lower doses of $FeSO_4$ and higher doses (10 kg/ha) of $CuSO_4$ were equally effective in increasing P uptake, but were superior to NPK alone. It was also noticed that increase in levels of zinc decreased the P-uptake by crop might be due to antagonistic effect of Zn with P. Similar results were also reported by Sharma and Bapat (5). Contrary to this, the total K uptake (113.5 kg/ha) was found maximum with the application of lower doses (5 kg/ha) of $FeSO_4$ along with NPK. Although it is higher doses along with lower and higer doses of $MnSO_4$ and $ZnSO_4$ showed statistical parity. This may be due to synergistic interaction between Fe and K.

The uptake of nutrients viz., Zn, Fe, Mn and Cu by crop also showed their maximum removal in the

treatments having application of respective nutrients. Even their lower doses gave 61.2, 13.6, 66.5 and 45.0 per cent more uptakes of Zn, Fe, Mn and Cu than the uptake of these micronutrients obtained from recommended dose of NPK alone, respectively. Further increase in levels of Zn, Fe, Mn and Cu each at 10 kg/ha could not bring significant improvement in their nutrient uptake. Fertilizer application might have improved the availability of nutrients in the soil, which led to increased nutrient content in plant and ultimately their uptake. A close view of the data of the Table 3 also reflected that uptake of N, P, Zn and Cu were found more in grain of wheat, while uptake of K, Fe and Mn were observed more in straw of wheat.

Hence, a balanced fertilization schedule of 150 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha along with 5 kg ZnSO/ha needs to be adopted for obtained higher productivity of wheat.

References

1. Dewal G. S. and R. G. Pareek. 2004. Effect of phosphous, sulfur and zinc on growth, yield and nutrient uptake of wheat (*Triticum aestivum* L.) *Ind. J. Agron*. 49 : 160—162.
2. Jain N. K. and A. K. Dahama. 2006. Direct and residual effects of phosphorus and zinc fertilization on productivity of wheat (*Triticum aestivum*) pearlmillent (*Pennisetum glaucum*) cropping system *Ind. J. Agron* 51: 165—169.
3. Musande V. G. and M. S. Palaskar. 1997. Nutrient management practices in wheat and wheat based cropping systems. Pp. 1—26. In C. P. Ghonsikar and V. S. Shinde, (eds.) *Nutrient management practice in crops and cropping system.* Scientific Publ. Jodhpur, India.
4. Sakal R., V. K. Nayyar, M. V. Singh, T. D. Biwas and G. Narayanasamy. 1997. Micronutrient status under rice-wheat cropping system for sustainable soil productivity. *J. Ind. Soc. Soil Sci*. 18 : 39—47.
5. Sharma B. L. and P. N. Bapat. 2000. Levels of micronutrients cations in various plant parts of wheat as influenced by zinc and phosphorus application. *J. Ind. Soc. Soil* 48 : 130—134.