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Effect of Nitrogen and KSB levels on growth and yield of wheat (*Triticum aestivum* L.)

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Abstract

A field experiment was conducted during the *Rabi* season of 2020-21 at the Student Instructional Field, Department of Agronomy, AKS University, Satna (M.P). The study aimed to assess the effects of varying nitrogen levels (0, 80, 100, and 120 kg/ha) and potassium-solubilizing bacteria (KSB) levels (1, 1.5, and 2 l/ha) on the growth, yield, and quality attributes of wheat (variety GW-322). Results revealed significant impacts of nitrogen and KSB levels on various parameters. Application of nitrogen at 120 kg/ha resulted in superior plant height, number of leaves per meter row length, tillers per meter row length, length of spike, number of grains per spike, test weight, grain yield, straw yield, and harvest index compared to lower nitrogen levels. Similarly, higher KSB levels (2.0 l/ha) led to enhanced growth, yield attributes, and grain yield. In conclusion, the application of nitrogen at 120 kg/ha and KSB at 2.0 l/ha exhibited the most favourable outcomes for wheat growth, yield, and quality attributes.

Keywords: Potassium solubilizing bacteria, wheat, nitrogen, KSB, growth, yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop of the world both with respect to area and production. It is a staple food for one-third of the world's population and provides a major source of energy, protein and dietary fiber in human nutrition. Thus, primary food security concerns are focused on improving and sustaining its productivity. Wheat is nature’s unique gift to mankind as it produces an excellent source of nutrition in terms of carbohydrates, minerals and proteins. Although wheat is grown in most of the states, the major production comes from the northwestern part of the country(Yadav and Dhanai, 2017). India ranks second in both area and production of wheat in the world producing 106.84 million tonnes and covering 30.45-million-hectare area in 2020-21. However, the country needs still higher production to feed the ever-increasing population. As we look at further opportunities to improve wheat production, it becomes evident that there is a still substantial yield gap within wheat-growing regions of the country, as well as between on-station and on-farm yields.

Fertilizer nitrogen (N) has become the key input in crop production. Cereals including rice, wheat, and maize account for more than half of the total fertilizer N consumption in the world (Kumar and Sharma, 1999). As per estimates 50-70% more cereal grain will be required by 2050 to feed over 9 billion world population (Singh et al., 2011). This will further increase the demand for fertilizer N at a greater magnitude unless the fertilizer N recovery efficiency in cereals is improved. It is only 30-50% ofthe wheat crop (Ladha et al., 2005). Efficient use of N fertilizer is important for economical wheat production; it is also important for the quality of ground and surface waters since the potential for nitrate enrichment of ground and surface water also increases with excessive N fertilization (Raun and Johnston, 1999). Insufficient N reduces wheat yield and profit, while excessive N results in wheat plants that are susceptible to water deficiency, disease and lodging, with consequently reduced quantity and quality of yield (David et al., 2004). Environmental constraints and economics are forcing farmers to apply nutrients based on crop demand. Therefore, demand-driven need-based fertilizer N management in wheat can help to improve N recovery efficiency and reduce N losses.

The potassium solubilizing microorganisms (KSMs) are rhizospheric microorganisms which solubilize the insoluble potassium (K) to soluble forms of K for plant growth and yield. K-solubilization is carried out by a large number of saprophytic bacteria (*Bacillus mucilaginous*, *B. edaphicus*, *B. circulans*, Acid thiobacillus ferroxidase, *Paenibacillus* spp.) and fungal strains (*Aspergillus* spp. and *Aspergillusterreus*). Major amounts of K-containing minerals (muscovite, orthoclase, biotite, feldspar, illite) are present in the soil as a fixed form which is not directly taken up by the plant. These potassium solubilizing bacteria (KSB) were found to dissolve potassium, silicon and aluminium from insoluble K bearing minerals such as micas, illite and orthoclases, by excreting organic acids which either directly dissolved rock K or chelated silicon ions to bring K into the solution (Maheta et al., 2020). Therefore, the present study was undertaken to investigate the suitable doses of nitrogen and KSB for higher growth, yield and quality of wheat.

MATERIALS AND METHODS

The experiment was carried out during the *Rabi* season 2020-21 at the Student Instructional Field, Department of Agronomy, AKS University, Satna (M.P). The soil of the experimental field was typical sandy loam possessing good water-holding and heat-absorbing capacity. It was slightly alkaline in reaction, well-drained, free from hard pan and medium in fertility. For analysis, the soil samples were collected from different spots of the experimental area during the trial prior to the application of fertilizers with the help of soil auger from 0 - 30 cm depth. These samples were mixed dried in air and powered thoroughly. The representative samples of 5 g soil for each analysis were taken and the same were analyzed in the laboratory. The experiment was laid out in a Factorial Randomized block design (FRBD) with three replications. The treatments were randomly allotted to different plots using a random number table (Fisher and Yates, 1963). The experiment consisted of two factors, The first is nitrogen with four levels viz., Control (N_0), 80 kg N/ha (N_1), 100 kg N/ha (N_2) and 120 kg N/ha (N_3) and the second factor is KSB with three levels viz., 1 l/ha (K_1), 1.5 l/ha (K_2) and 2 l/ha (K_3), thus making 12 treatment combinations. The seed of wheat variety of GW- 322 used for this experiment was sown on the furrow as per treatment and the furrows were covered by soils soon after seeding. As per treatment, the crop was sown using a seed rate of 100 kg/ ha. In order to obtain a uniform plant height stand, seeds were weighed for each plot separately in small packets for sowing. Sowing was done manually in furrows 22.5 cm x 5.0 cm apart. The full recommended dose of phosphorus and potassium at the rate of 60 kg P_2O_5 /ha and 40 kg K_2O /ha, respectively was uniformly applied to each plot as basal dose. Nitrogen was applied as per treatment to plots in the form of Urea. Half the dose of nitrogen was applied as basal dose at the time of sowing and the remaining half dose of nitrogen was applied in two equal splits at 30 and 60 DAS i.e., at tillering and late jointing stage. To reduce the weed competition, one spray of 2,4-D @ 0.5 kg + Isoproturon 1.0 kg/ ha was applied at 20 DAS as post-emergence spray through a knapsack sprayer fitted with a flat fan nozzle using 750 litres of water/ ha. No incidence of insect or disease was noticed during the growth cycle of the crop; hence no plant protection measure was adopted. The data were statistically analyzed by using Randomized Block Design (RBD) with two factors following the procedure outlined by Gomez and Gomez (1984). The significance of the difference among treatment means was tested by the F test. Wherever the F-test was found to be significant, the critical difference (C.D.) at a 5 percent level of significance was calculated.

RESULT AND DISCUSSION

Plant height

The result shows that plant height at 90 DAS was influenced significantly due to different dosages of Nitrogen. The data presented in Table 1 revealed that maximum plant height (80.97 cm) was observed in the application of nitrogen @ 120 kg/ha and found significantly superior over other treatments. Whereas minimum plant height (72.94 cm) was noted in control at 90 DAS. As evident from the tabulated data (Table 1) the effect of different levels of KSB was also significant in the experiment. Application of K_3 (KSB @ 2.0 l/ha) gave maximum plant height (77.33 cm) 90 DAS, which was at par with application of KSB at 1.5 l/ha (76.63 cm). The minimum plant height (75.11 cm) was recorded in KSB @ 1.0 l/ha. The strength of the aerial organ was caused by the high rate of protoplasmic protein synthesis, which in turn led to protein synthesis and an increase in cell size, which was primarily responsible for the vertical growth of the plant (Nova and Leomis, 1981). The findings of Saleem (1987), Khan et al. (2000), and Hussain et al. (2006), who indicated that raising the nitrogen level enhanced plant height, are consistent with the results of the present study.

Number of leaves/m row length

There was a significant difference in the different nitrogen levels on the number of leaves/m row of wheat as well as in different levels of KSB (Table 1). With respect to different levels of nitrogen, the significantly highest number of leaves/m row (189.42) was recorded at N3 (nitrogen @ 120 kg/ha). Whereas, the control gave a minimum number of leaves/m row (116.87) as compared to the rest of the treatments. Among the application of KSB treatments, K3 (KSB @ 2.0 l/ha) recorded a significant maximum number of leaves/m row (168.86), whereas, the minimum number of leaves/m row (145.07) was observed in K1 (KSB @ 1.0 l/ha). higher nitrogen and KSB levels further increased the nutrient-supplying capacity of the soil, which, in turn, resulted in a higher leaf growth rate. The results are in close conformity with the findings of Kaur et al. (2016).

Tillers/m row length

The data presented in Table 1 reveals that there was a significant effect of different levels of Nitrogen, KSB as well as interactions of nitrogen and KSB on tillers/m row length at 90 DAS. A significant maximum number of tillers/m row length (62.38) were recorded in the highest dose of nitrogen N3 (nitrogen @ 120 kg/ha) and also significantly higher than the rest of the treatments. Further, decrees in nitrogen doses caused a significant reduction in tillers/m row length. Control resulted in minimum tillers/m row length (29.22). Among the treatments of KSB, K1 (KSB @

2.0 l/ha) exhibited significant maximum tillers/m row length (47.83), whereas, minimum tillers/m row length (40.45) was observed in K1 (KSB @ 1.0 l/ha). Tillering ability is genetically controlled, but it is also much dependent on other inputs and increasing nitrogen supply further increases the tiller numbers. The growth of tillers is promoted by the phytohormone cytokinin which are purine and pyrimidine derivatives, both of which are N and KSB-containing ring structures and are synthesized by amino acids. The stimulating effect of nitrogen nutrition and KSB on tillering is thus probably due to the effect of nitrogen on cytokinin synthesis. The results from Goud et al. (2014) and Kumar et al. (2014) are all quite similar to the ones from this study.

Length of spike (cm)

The data pertaining to the effect of different levels of Nitrogen, KSB and their interactions on the length of spike of wheat are presented in Table 1. The perusal of the data depicts that, the effect of nitrogen was significant on the length of the spike, N3 (nitrogen @ 120 kg/ha) resulted ina significantly longer spike length (10.52 cm), which was higher than the other treatments. Whereas, the shortest length of spike of wheat (6.07 cm) was recorded in Control. KSB levels differences for spike length of wheat were also highly significant, the longest length of the spike (8.91 cm) was recorded in K3 (KSB @ 2.0 l/ha), which was significantly at par with K2 (8.26 cm), whereas, K1 (KSB @ 1.0 l/ha) produced theshortest length of the spike (7.89 cm).Khatri et al. (2019) and Kousar et al. (2015) found a notable increase in the length of the spike due to the influence of nitrogen.

Number of grains per spike

The result shows that the average number of grains per spike significantly increased from 33.28 to 40.02 with increasing the nitrogen level from 0 to 120 kg/ha. The data revealed that the maximum number of grains per spike (40.02) was observed in the application of nitrogen @ 120 kg/ha (N3) and found significantly superior over other treatments and closely followed by 38.56 with the application of nitrogen @ 100 kg/ha (N2). Whereas, the minimum number of grains per spike (33.28) was noted under the control. The number of grains per spike was also influenced significantly bythe KSB application. The average number of grains per spike significantly increased from 35.29 to 38.68 with the KSB application. The maximum number of grains per spike (38.68) was found under the KSB application @ 2.0 l/ha (K3). While, the minimum number of grains per spike (35.29) was recorded under the application of KSB (1.0 l/ha, K1). The number of grains per spike also increased as a result of the spikes' lengthening. By limiting spikelet degeneration during grain formation, enough nitrogen may have enhanced the number of grains produced per spike. These findings are consistent with numerous studies by Singh et al. (2019), and Amani and Behzad (2020),

Test weight (g)

The result shows that the test weight was significantly influenced due to different levels of nitrogen. The data presented in Table 1 revealed that the highest test weight (40.44 g) was observed in the application of nitrogen @ 120 kg/ha (N3) found to be significantly superior over other treatments. Whereas, the lowest test weight (28.12 g) was noted under the control. It is clear from the data that wheat seeding with increasing rate of nitrogen produced significantly maximum test weight as compared to the crop sown with other nitrogen. The test weight was influenced significantly bythe KSB application. The highest test weight (35.23 g) was found under the KSB application @ 2.0 l/ha (K3). While, the lowest test weight (33.05 g) was recorded under the application of KSB (1.0 l/ha, K1). It is clear from the data that wheat seeding with an increasing rate of KSB produced a significant maximum test weight as compared to the crop sown with other KSB. With the larger dosages of N, Singh et al. (2013) and Ullah et al. (2018) found a notable increase in test weight.

Grain yield (q/ha)

It is evident from the data (Table 1) that the effect of different levels of nitrogen and KSB on grain yield (q/ha) was highly significant. Significant maximum grain yield (48 q/ha) was observed in N3 (application of nitrogen @ 120 kg/ha) which was superior over the other treatments. Whereas, minimum grain yield (34.57 q/ha) was recorded under control. With respect to KSB levels, K3 (KSB @ 2.0 l/ha) exhibited a significant maximum grain yield (49.08 q/ha), which was significantly higher than the other treatments. However, the minimum grain yield(39.48 q/ha) was exhibited by K1 (KSB @ 1.0 l/ha). The higher grain yield may be a result of better yield attributing characteristics possessed by plants. These findings are consistent with numerous studies by Singh et al. (2019) and Amani and Behzad (2020), which found that increasing nitrogen levels significantly improved grain yield.

Straw yield (q/ha)

Perusal of data reveals that different levels of nitrogen brought about significant differences in straw yield. Amongst levels of nitrogen, application of nitrogen @ 120 kg/ha produced significantly higher straw yield (47.49 q/ha), which was superior over others. However lowest straw yield was recorded in control treatments (39.81 q/ha). Critical appraisal of data showed that application of KSB @ 2.0 l/ha recorded significantly the highest straw yield (45.42 q/ha). While the lowest straw yield (41.80 q/ha) was recorded in the treatment of K1 (KSB @ 1.0 l/ha). The higher straw yield may be a result of higher plant biomass including leaves, tillers etc. These findings are consistent with numerous studies by Singh et al. (2019), and Amani and Behzad (2020), which found that increasing nitrogen levels significantly improved the straw yield.

Harvest index (%)

The data revealed that the highest harvest index (40.77 %) was observed in the application of nitrogen @ 80 kg/ha (N1), which was at par with the application of nitrogen @ 100 kg/ha (40.15 %). Whereas, the lowest harvest index (39.17 %) was noted under control. The result shows that the average highest harvest index (40.75 %) was found under the KSB application @ 1.5 l/ha (K2), which was statistically at par with the application of KSB @ 2.0 l/ha (K3, 40.11 %). While, the lowest harvest index (38.78 %) was recorded under the application of KSB (1.0 l/ha, K1). The results obtained by Goud et al. (2014) are quite similar to the findings of the present study.

CONCLUSION

It may be concluded that the application of nitrogen @ 120 kg N/ha and KSB application @ 2.0 lit/ha was most effective for the enhancement of different growth, yield and quality attributes in wheat. The application of nitrogen @ 120 kg N/ha gave maximum and significantly higher growth characters. Furthermore, the yield attributes and higher grain yield (48.60 q/ha) were also higher under the same treatment. Similarly, KSB @ 2 l/ha brought about higher growth, yield attributes and yield (49.08) of wheat as compared to other levels of KSB. Hence, it can be concluded that the application of nitrogen @ 120 kg N/ha with KSB application @ 1.5 lit/ha can be used as a remunerative strategy.

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Treatments	Plant height (cm)	Number of leaves/ m row length	Number of tillers/ m row length	Length of spike (cm)	Number of grains/ spike	Test weight (g)	Grain yield (q/ha)	straw yield (q/ha)	Harvest index (%)
Nitrogen levels									
N_0	72.94	116.87	29.22	6.07	33.28	28.12	34.57	39.81	39.17
N_1	74.81	154.91	37.21	7.91	36.52	30.49	44.34	42.35	40.77
N_2	76.71	176.03	46.15	8.9	38.56	37.32	46.45	44.06	40.15
N_3	80.97	189.42	62.38	10.52	40.02	40.44	48.6	47.49	39.44
S.Em ±	0.29	0.6	0.28	0.12	0.15	0.09	0.46	0.24	0.22
C.D. (P=0.05)	0.86	1.78	0.83	0.35	0.45	0.27	1.36	0.71	0.64
KSB levels									
K_1	75.11	145.07	40.45	7.89	35.29	33.05	39.48	41.8	38.78
K_2	76.63	164	42.94	8.26	37.32	33.99	41.93	43.06	40.75
K_3	77.33	168.86	47.83	8.91	38.68	35.23	49.08	45.42	40.11
S.Em ±	0.44	0.92	0.43	0.18	0.23	0.14	0.71	0.37	0.33
C.D. (P=0.05)	1.31	2.72	1.27	0.53	0.69	0.42	2.09	1.08	0.98

Table 1: Growth, yield attributes and yield of wheat as influenced by nitrogen and KSB levels.

*Control (**N_0**), 80 kg N/ha (**N_1**), 100 kg N/ha (**N_2**), 120 kg N/ha (**N_3**), KSB 1 l/ha (**K_1**), KSB 1.5 l/ha (**K_2**) and KSB 2 l/ha (**K_3**)*

REFERENCES

Amani, A. and Behzad, M. A. (2020). Effect of Split Application of Nitrogen on Growth and Yield of Wheat (*Triticum aestivum* L.). Journal of Experimental Agriculture International, 42 (6): 44-48.

David, J., Bonfil, A., Karnielib, M., Razb, I., Mufradia, S., Asidoa, H., Egozic, A., Hoffmanc, Z. and Schmilovitch (2004). Decision support system for improving wheat grain quality in the Mediterranean area of Israel, Field Crops Research, 89, 153-163.

Fisher, R.A. and Yates, F. (1963). Statistical Tables. Oliver and Boyd, Edinburgh, London.

Gomez, KA, Gomez, AA, Statistical Procedure for Agricultural Research, 2nd Edn. John Wiley & Sons, New York, Pp. 241-271, 1984.

Goud, V. V., Konde, N. M., Mohod, P. V. and Kharche, V. K. 2014. Response of chickpea to potassium fertilization on yield, quality, soil fertility and economic in vertisols. Legume Research, 37 (3): 311-315

Hussain, I, Khan, M.A. and Khan, E.A. (2006). Bread wheat varieties as influenced by different nitrogen levels. Journal of Zhejiang University Science, 7(1), 70- 78.

Khatri, N., Nabin, R. Pandey, B.P. and Bista, M. (2019). Agronomic performance of wheat genotypes in response to nitrogen levels. International Journal of Agricultural Sciences and Veterinary Medicine, 7 (4): 7- 12.

Kousar, P., Ali, L., Raza, A., Maqbool, A., Maqbool, S., Rasheed, S. and Irum, N. (2015). Effect of different levels of nitrogen on the economic yield of Wheat (*Triticum aestivum* L.) variety Aas-11. International Journal of Agronomy and Agricultural Research, 6(3): 7-11.

Kumar, P., Singh, T., Anil, K. and Ram, Y. (2014). Effect of different potassium levels on mung bean under custard apple based agri- horti system. African Journal of Agricultural Research, 9 (8): 728- 734.

Kaur, Navdeep and Kumar, Santosh (2016). Effect of tillage and nitrogen scheduling on growth and yield attributes of wheat (*Triticum aestivum* L.) in central Punjab. International Journal of Chemical Studies, 6 (1): 1666-1669.

Khan, M.A., Hussain, I. and Baloch, M.S. (2000). Wheat yield potential current status and future strategies, Pakistan Journal of Biological Sciences, 3, 82- 86

Kumar R and Sharma S N. 1999. Effect of nitrogen on dry matter and nutrient accumulation pattern in wheat (*Triticum aestivum*) under different dates of sowing. Indian J. Agron., 44 (4): 738-744.

Ladha, J.K., Pathak, H., Krupnik, T.J., Six, J. and Kessel, C.V. (2005). Efficiency of fertilizer nitrogen in cereal production: retrospect‟s and prospects, Advances in Agronomy, 87, 85-156.

Maheta, A.A., Vaghani, J.J., Bavaliya, A.H. and Gajera, K.C. (2020). Effect of Potassium (K) And Potassium Solubilizing Bacteria (KSB) Growth, Yield, Quality Parameters and Nutrient Uptake by Wheat (*Triticum aestivum* L.), Int. J Chem. Studies, 8(5):1736-1740.

Nova, R., and Leomis, R.S. (1981). Nitrogen and plant production, Plant and Soil, 58 (1-3), 177-204.

Raun, W. and Johnston, G. (1999). Improving nitrogen use efficiency for cereal production, Agronomy Journal 91, 357-363.

Saleem, A.N. (1987). Effect of nitrogen and seed rate on agronomic parameters of wheat, Journal of Agricultural Research, 18(2), 34-38.

Singh, S. Singh, V. and Singh, A. (2019). Effect of planting geometry and NPK levels with phosphorus solubilizing bacteria on growth and yield of wheat (*Triticum aestivum* L.). Ann. Agric. Res. New Series, 40 (3): 239- 247.

Singh, B., Singh, Y., Singh, B., Thind, H.S., Kumar, A. and Vashistha, M. (2011). Calibrating the leaf colour chart for need based fertilizer nitrogen management in different maize (Zea mays L.) genotypes, Field Crops Research, 120, 276-282.

Singh, J., Mahal. S.S. and Singh. A. (2013). Productivity and quality of malt barley (*Hordeum vulgare* L.) as affected by sowing date, rate and stage of nitrogen application. Indian Journal of Agronomy. 58: 72-80.

Ullah, I., Ali, N., Durrani, S., Shabaz, M.A., Hafeez, A., Ameer, H., Ishfaq, M., Fayyaz, M.R., Rehman, A. and Waheed, A. (2018). Effect of different nitrogen levels on growth, yield and yield contributing attributes of Wheat. International Journal of Scientific & Engineering Research, 9(9): 595-602.

Yadav, M.S. and Dhanai, C.S. (2017). Effect of different doses of nitrogen and seed rate on various characters and seed yield of wheat (*Triticum aestivum* L.). Journal of Pharmacognosy and Phytochemistry, 6(2): 01-05.