Eco. Env. & Cons. 28 (August Suppl. Issue) : 2022; pp. (S185-S189)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i04s.027

Productivity, Nutrient Content and Uptake of Wheat (*Triticum aestivum* L.) as Influenced by Integration of Organic, Inorganic and Biofertilizers Nutrient Sources

Sandeep Kumar Verma, A.S. Yadav, Raghvendra Singh, Ankit Kumar Tiwari and Aneeta Yadav

Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur 209 217 (U.P.), India

(Received 19 December, 2021; Accepted 12 January, 2022)

ABSTRACT

A field experiment was conducted during *Rabi* season of 2019-20 and 2020-21 at the Agricultural research farm of Rama University, Mandhana, Kanpur (U.P), to assess the response of integrated nutrient management on yield and economics of wheat. The soil of the experimental field was sandy loam with pH 7.5, 0.41% organic carbon, 0.13 dSm^{-1} electrical conductivity, having available nitrogen 227.6 kg ha^{-1}, available phosphorous 13.9 kg ha^{-1} and available potassium 173.9 kg ha^{-1}. The experiment comprised 11 treatments, viz., T_1-Control, T_2-100% NPK (120:60:40 kg ha^{-1}), T_3-100% NPK+ Zn (5 kg ha^{-1}), T_4-100% NPK + Zn + S (25 kg ha^{-1}), T_5-100% NPK + Zn + S + *Azotobactor* + PSB, T_6-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1}), T_7-100% NPK + Zn + S + FYM (5.0 t ha^{-1}), T_8-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1}) + *Azotobactor* + PSB, T_9-100% NPK + Zn + S + FYM (5.0 t ha^{-1}) + *Azotobactor* + PSB, T_{10}-75% NPK + Zn + S + Vermicompost (10.0 t ha^{-1}) + *Azotobactor* + PSB, T_{11}-75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + *Azotobactor* + PSB. The experiment was laid out in randomized block design, replicated thrice. The maximum grain yield (4.84 t ha^{-1}), protein content (%), nitrogen, phosphorous and potassium content and uptake were recorded in application of 75% NPK + Zn + S + Vermicompost (10.0 t ha^{-1}) + *Azotobactor* + PSB (T_{10}) however organic carbon and available N, P_2O_5, K_2O were found higher treatment T_{11} (75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + *Azotobactor* + PSB) in during both the years.

Key words : *Azotobactor, FYM, Inorganic, Nutrient uptake, PSB, Vermicompost, Wheat, Yield*

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important food crops of the world in terms of area, production and nutrition which contribute 20% of total food requirement of the world's population. Moreover, it is a major source of energy by providing more than 19% food calories and 21% of dietary proteins and fibres in human nutrition (FAO, 2013). The fertilizer consumption in India including Uttar Pradesh is grossly unbalanced, tilted more towards N, followed by P. This has implications on yield response to fertilizer as it decreases the crop quality and adversely affects the overall soil fertility and productivity. The over or imbalanced use of major plant nutrients and neglect of organic manures which otherwise provide balanced supply of nutrients to plants, rendered micro-nutrients deficiencies resulting into decreasing trend in fertilizer use efficiency. It is well known that integration of organic sources with inorganic offer balanced supply of nutrients and improves soil quality. Higher wheat productivity on sustained basis can be maintained by judicious use of chemical fertilizers in combinations

with organic manures. Application of Farmyard manure increased water holding capacity of soil cation exchange capacity, soil aeration, seed germination and plant growth. The total nutrients contain by farmyard manure is not available immediately. About 30-35% of nitrogen, 60-70% phosphorous and 70-72% of potassium are available to the first crop. However, under integrated nutrient management (INM), the big challenge is to ensure the efficient utilization of nutrients from applied sources. Organic manures as a source of humus and plant nutrients need to improve the soil fertility and soil health. Vermicompost, an improved organic manure possess excellent structure, high concentration of nutrients and low C:N ratio than other organic manures (Srivastava *et al*., 2014). Under INM, VC, FYM and biofertilizers may improve the efficiency of applied fertilizer and also improve soil physical, chemical and biological properties. The overall strategy for enhancing the crop yield per unit of resources and sustaining them at a high level must include an integrated approach to the management of soil nutrients. Hence present field investigation was carried to evaluate the effect of fertilizers levels and organic sources of nutrients on the production potential of wheat, nutrient content and uptake and physico-chemical properties of soil.

Materials and Methods

A field experiment was conducted during *Rabi* season of 2019-20 and 2020-21 at the Agricultural research farm of Rama University, Mandhana, Kanpur, U.P., which is situated at latitude of 26^0 58′ N and longitude of 80^0 34′ E and an altitude of 125.9 meters above the mean sea level (Arabian Sea). The soil of the experimental field was sandy loam with pH 7.5, 0.41% organic carbon, 0.13 dSm^{-1} electrical conductivity, having available nitrogen 227.6 kg ha^{-1}, available phosphorous 13.9 kg ha^{-1} and available potassium 173.9 kg ha^{-1}. The experiment comprised 11 treatments, viz., T_1-Control, T_2-100% NPK (120:60:40 kg ha^{-1}), T_3-100% NPK+ Zn (5 kg ha^{-1}), T_4-100% NPK + Zn + S (25 kg ha^{-1}), T_5-100% NPK + Zn + S + Azotobactor + PSB, T_6-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1}), T_7-100% NPK + Zn + S + FYM (5.0 t ha^{-1}), T_8-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1}) + Azotobactor + PSB, T_9-100% NPK + Zn + S + FYM (5.0 t ha^{-1}) + Azotobactor + PSB, T_{10}-75% NPK + Zn + S + Vermicompost (10.0 t ha^{-1}) + Azotobactor + PSB, T_{11}-75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB. The experiment was laid out in randomized block design, replicated thrice. The organic manures were applied as per their nutrient content on oven-dry weight basis. Composite samples from each manure were collected one week before application to plots and were analyzed for nutrient composition. The FYM and vermicompost contained 0.48 and 1.83% N; 0.21 and 0.62% P_2O_5; and 0.48 and 1.19 % K_2O, respectively. Organic manures were applied as per treatment at sowing mixed thoroughly in top soil layer. Wheat (cv. 'K 1006') was sown during the second fortnight of November each year. Inoculation of wheat seed with *Azotobactor* and phosphorus-solubilizing bacteria were done by mixing the seed with 10% jaggery-biofertilizers solution before to sowing. Only recommended dose of N, P_2O_5 and K_2O (120:60:40 kg ha^{-1}) were applied through urea, dia ammonium phosphate and muriate of potash, respectively. Out of which full dose of nitrogen, P_2O_5 and K_2O was uniformly applied in all the plots before sowing of wheat. Nitrogen was used in 3 equal splits, i.e. at seeding, after first irrigation and at boot stage. Need based cultural operations were followed. Soil samples were collected from the surface layer (0-15 cm) from all the plots before treatment application and after wheat harvesting. Economics of wheat cultivation as influenced by organic manures, chemical fertilizers and integrated nutrient management were calculated by considering the prevailing market price of wheat grain, straw and different inputs.

Results and Discussion

Yield

Grain and straw yields of wheat were significantly influenced by integrated nutrient management treatments (Table 1). Application of 75% NPK + Zn + S + Vermicompost (10.0 t ha^{-1}) + *Azotobactor* + PSB (T_{10}) was recorded maximum grain (4.84 t ha^{-1}) and straw (6.46 t ha^{-1}) which was statistically at par with application of 75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + *Azotobactor* + PSB (T_{11}) and 100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1}) + *Azotobactor* + PSB (T_8) during both the years. The lowest grain (3.06 t ha^1) and straw (4.65 t ha^1) yields were recorded in control (T_1). The beneficial effect of organic manures on grain and straw yields might be assigned to the fact that after proper decomposition and mineralization, these manures supplied available plant nutrients

directly to the plants and also had solublising effect on fixed forms of nutrients in soil. The organic manures also increase the adsorptive power of soil for cations and anion particularly phosphates and nitrates and these adsorbed ions are released slowly for the benefit of crop during entire crop growth period leading to higher yields reported by Gul *et al.* (2011).

Protein content

The higher value of protein content in grain (11.38%) was recorded under treatment application of 75% NPK + Zn + S + Vermicompost (10.0 t ha^{-1}) + *Azotobactor* + PSB (T_{10}) which was significantly superior than treatments T_1, T_2, T_3, T_4 and T_5 however on par with treatments T_6, T_7, T_8, T_9 and T_{11} during both the years. The lowest protein content in grain (8.94%) was recorded in control (T_1). Integrated nutrient management improved the protein content in grains as compare to single source of nutrient. Similar results were also reported by Roy *et al*. (2013).

Nutrient content and uptake

The data related to nitrogen, phosphorus and potassium content had been shown in the Table 1and 2. Application of various treatments affected nitrogen, phosphorus, potassium content, their uptake and total uptake by wheat grain and straw. Among various fertility levels, highest value for NPK content and uptake was recorded with 75% NPK + Zn + S + Vermi-compost (10.0 t ha^{-1}) + Azotobactor + PSB yield followed by 75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB. Highest content might be due to the more availability of nutrient solubilisation effect of organic manures on native nutrients solubilisation and releasing of nutrients for a longer duration. Mahapatra *et al.* (1991) reported that organic sources had a longer and greater efficiency as compared to inorganic source that might be responsible for higher uptake by building material with application of various fertility levels. The uptake of NPK in grain and straw over control increased significantly. Among the fertility levels treatments 75% NPK + Zn + S + Vermi-compost (10.0 t ha^{-1}) + Azotobactor + PSB recorded maximum NPK uptake respectively. Similar findings were also reported by Rathor and Sharma (2010), Fattah *et al.* (2015) and Sheoran *et al.* (2015). N, P and K content

Table 1. Effect of integrated nutrient management practices on yield protein and nutrient content in grain and straw of wheat (pooled data of two years)

Treatment	Yield (t ha^{-1})		Protein content in grain (%)	N content (%)		P content (%)		K content (%)	
	Grain	Straw		Grain	Straw	Grain	Straw	Grain	Straw
T_1-Control	3.06	4.65	8.94	1.43	0.3	0.28	0.11	0.16	0.80
T_2-100% NPK (120:60:40 kg ha^{-1})	4.40	6.09	9.88	1.58	0.36	0.30	0.13	0.17	0.88
T_3-100% NPK+ Zn (5 kg ha^{-1})	4.47	6.12	10.06	1.61	0.39	0.29	0.14	0.18	0.89
T_4-100% NPK + Zn + S (25 kg ha^{-1})	4.51	6.15	10.25	1.64	0.4	0.3	0.12	0.20	0.94
T_5-100% NPK + Zn + S + Azotobactor + PSB	4.53	6.19	10.31	1.65	0.41	0.32	0.13	0.20	0.80
T_6-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1})	4.55	6.22	10.50	1.68	0.43	0.30	0.13	0.21	0.99
T_7-100% NPK + Zn + S + FYM (5.0 t ha^{-1})	4.53	6.27	10.69	1.71	0.46	0.32	0.12	0.23	1.01
T_8-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1}) + Azotobactor + PSB	4.75	6.39	11.06	1.77	0.49	0.31	0.12	0.25	1.05
T_9-100% NPK + Zn + S + FYM (5.0 t ha^{-1}) + Azotobactor + PSB	4.65	6.28	11.00	1.76	0.48	0.31	0.13	0.25	1.03
T_{10}-75% NPK + Zn + S + Vermicompost (10.0 t ha^{-1}) + Azotobactor + PSB	4.84	6.46	11.38	1.82	0.56	0.32	0.15	0.28	1.09
T_{11}-75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB	4.79	6.42	11.19	1.79	0.51	0.31	0.14	0.26	1.07
SEm (±)	0.51	0.53	0.33	0.005	0.01	0.002	0.003	0.01	0.01
C.D. (P=0.05)	1.51	1.6	1.06	0.014	0.04	0.005	0.008	0.03	0.03

in wheat crop were not affected by different treatments, the only exception was P content in straw. However, the control measured significantly increased uptake of NPK over control.

O.C., pH and Nutrient availability

Incorporation of organic manures and chemical fertilizers affected organic carbon (%), pH, available N,

Table 2. Nitrogen, phosphorous and potassium uptake by grain and straw of wheat as influenced by different integrated nutrient management (pooled data of two years)

Treatment	N uptake (kg ha^{-1})		Total uptake (kg ha^{-1})	P uptake (kg ha^{-1})		Total uptake (kg ha^{-1})	K uptake (kg ha^{-1})		Total uptake (kg ha^{-1})
	Grain	Straw		Grain	Straw		Grain	Straw	
T_1-Control	45.47	14.41	59.88	8.90	5.28	14.19	4.96	38.40	43.36
T_2-100% NPK (120:60:40 kg ha^{-1})	71.89	22.45	94.34	13.65	8.11	21.76	7.69	54.72	62.41
T_3-100% NPK+ Zn (5 kg ha^{-1})	74.06	24.46	98.52	13.34	8.87	22.12	8.07	55.85	63.93
T_4-100% NPK + Zn + S (25 kg ha^{-1})	75.93	25.18	101.11	13.89	7.55	21.44	9.03	58.92	67.95
T_5-100% NPK + Zn + S + Azotobactor + PSB	76.56	25.92	102.48	14.85	8.22	23.07	9.65	61.24	70.89
T_6-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1})	78.67	27.29	105.97	14.05	8.25	22.30	10.05	62.71	72.75
T_7-100% NPK + Zn + S + FYM (5.0 t ha^{-1})	79.53	29.47	109.00	14.88	7.69	22.57	10.58	64.54	75.12
T_8-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1}) + Azotobactor + PSB	86.04	31.76	117.80	15.07	7.78	22.85	12.32	68.26	80.58
T_9-100% NPK + Zn + S + FYM (5.0 t ha^{-1}) + Azotobactor + PSB	83.83	30.79	114.62	14.77	8.34	23.10	11.76	65.87	77.64
T_{10}-75% NPK + Zn + S + Vermicompost (10.0 t ha^{-1}) + Azotobactor + PSB	90.11	36.72	126.83	15.84	9.83	25.67	13.84	71.61	85.45
T_{11}-75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB	87.58	33.18	120.77	15.17	9.11	24.28	12.72	69.78	82.50
SEm (±)	1.65	0.97	2.20	0.287	0.237	0.420	0.55	0.94	1.27
C.D. (P=0.05)	4.90	2.88	6.54	0.887	0.713	1.713	1.64	2.79	3.77

Table 3. Effect of integrate nutrient management practices on O.C., pH and available N, P, K of the soil after harvest of wheat (pooled data of two years)

Treatment	Organic carbon (%)	Soil pH	Available nutrients (kg ha^{-1})		
			N	P_2O_5	K_2O
T_1-Control	0.42	7.89	206.50	12.34	175.77
T_2-100% NPK (120:60:40 kg ha^{-1})	0.54	7.36	216.13	12.86	175.33
T_3-100% NPK+ Zn (5 kg ha^{-1})	0.50	7.35	217.55	13.05	177.35
T_4-100% NPK + Zn + S (25 kg ha^{-1})	0.43	7.68	219.57	13.15	178.28
T_5-100% NPK + Zn + S + Azotobactor + PSB	0.54	7.39	221.16	13.34	180.25
T_6-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1})	0.46	7.46	224.37	13.71	181.54
T_7-100% NPK + Zn + S + FYM (5.0 t ha^{-1})	0.45	7.68	226.25	13.96	183.67
T_8-100% NPK + Zn + S + Vermicompost (5.0 t ha^{-1}) + Azotobactor + PSB	0.44	7.67	231.18	14.77	186.56
T_9-100% NPK + Zn + S + FYM (5.0 t ha^{-1}) + Azotobactor + PSB	0.51	7.40	228.56	14.26	185.12
T_{10}-75% NPK + Zn + S + Vermicompost (10.0 t ha^{-1}) + Azotobactor + PSB	0.45	7.47	236.23	15.50	189.87
T_{11}-75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB	0.55	7.40	242.77	16.08	191.55
SEm (±)	0.01	0.59	0.95	0.44	0.89
C.D. (P=0.05)	0.03	N.S.	2.82	1.31	2.65

P_2O_5 and K_2O (Kg ha^{-1}) of soil. During this study available N, P_2O_5 and K_2O and organic carbon were analyzed after harvest of crop from various treatments. Available N, P_2O_5 and K_2O increased in soil with the application of different nutrient management treatments. Among various treatments maximum value for available N, P_2O_5 and K_2O in soils was recorded with 75.75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB. The application of organic manures have been reported not only to improve the nutrient content in the soil but also helps in bringing native nutrients into the available from thus, increased the available nutrient contents in the soil. Moreover, organic manures creates better environment for biological activity in the soil, which resulted into more fixation of N_2 and more solubilising effect of other fixed forms of nutrients. Increased in nutrients in soil by the application of organic manures was also reported by Sreenivash *et al.* (2000) and Upadhyay *et al.* (2004).

Maximum organic carbon content was recorded in 75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB which was statistically at par with 75% NPK + Zn + S + Vermi-compost (10.0 t ha^{-1}) + Azotobactor + PSB. Lowest organic carbon content was in control plot. Soil pH was non significantly different among different nutrient treatments. Studies conducted by various workers have established the fact of maintenance of soil fertility in terms of improved organic content and available nutrients in soil by application of organic manures in combination with chemical fertilizers in different ratio (Vasanthi and Kumarraswamy, 1999).

Conclusion

On the basis of study the application of 75% NPK + Zn + S + Vermi-compost (10.0 t ha^{-1}) + Azotobactor + PSB yielded more among all the nutrient management options but it was found at par with 75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB in grain yield, protein and nutrient content and uptake. In view the buildup of Soil organic carbon and improvement in nutrient availability, application of 75% NPK + Zn + S + FYM (10.0 t ha^{-1}) + Azotobactor + PSB was found best among all nutrient management options and may be suggested for higher productivity of wheat crop and soil health sustainability.

References

FAO, 2013. Food and Agriculture organization of the united nation. http://www.fao.org/statistic/en/

Fattah, A., Mohamed, K., Rahma, A. and Merwad, M.A. 2015. Effect of Different Sources of Nitrogen Fertilizers Combined with Vermiculite on Productivity of Wheat and Availability of Nitrogen in Sandy Soil. *Egypt American Journal of Plant Nutrition and Fertilization Technology*. 5(2): 50-60.

Gul, H., Said, A., Saeed, B., Ahmad, I. and Ali, K. 2011. Response of yield and yield components of wheat towards foliar spray of nitrogen, potassium and zinc. *Journal of Agricultural and Biological Science.* 6(2): 23-25.

Mahapatra, B.S., Sharma, K.C. and Sharma, G. L. 1991.Nitrogen fertility under rice-wheat fallow system with integrated nutrient management in low land rice *Indian Journal Agronomy.* 36 : 223-227.

Rathor, S.A. and Sharma, N.L. 2010.Effect of integrated nutrient management on productivity and nutrient uptake in wheat and soil fertility. *Asian Journal of Soil Science* 4(2): 208-210.

Roy, S., Verma, O. and Verma, R.S. 2013. Effect of nitrogen levels and foliar application of urea on yield and quality of late sowed wheat. *Pantnagar Journal of Research*. 11(1) : 153-156.

Sheoran, H. S., Duhan, B. S., Grewal, K. S., and Sheoran, S. 2015. Grain yield and NPK uptake of wheat (*Triticum aestivum* L.) as influenced by nitrogen, vermicompost and herbicide (*Clodinafop propargyl*). *African Journal of Agricultural Research.* 10 (42) : 3952-3961.

Sreenivas, C. H., Muraliahar, S. and Singh, R. 2000. Yield and quality of ridge guard fruit as influenced try different levels of inorganic fertilizer and vemicompost. *Annals. Agric. Res.* 21 : 262-266.

Srivastava, V.K., Singh, J.K., Bohra, J.S. and Singh, S.P. 2014. Effect of fertilizer levels and organic sources of nitrogen on production potential of hybrid rice (*Oryza sativa*) and soil properties under system of rice intensification. *Indian Journal of Agronomy.* 59 (4): 607-12.

Upadhyayaya, N.C., Rawal, S. and Khan, M.A. 2004. Organic wheat production paper presented in *National Symosium on Second Generation Problem and its remedies.* November 26-27.

Vasanthi, D. and Kunmarswamy, K. 1999. Efficacy of vermicompost to improve soil fertility and rice yield. *Journal of Indian Society of Soil Science*. 47(2) : 268-272.