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Effect of integrated use of inorganic fertilizers and organic manures on growth, yield attributes and yield of wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted at R. B. S. College research farm Bichpuri, Agra (U.P.) on sandy loam soil to evaluate the effect of integrated nutrient management on growth parameter at various intervals,yield attributs and yield of wheat (Triticum aestivum L). The eleven treatments were evaluated in randomized block design with three replications. Results revealed that there was a steady rise in plant height and dry matter accumulation. But number of tillers increased markedly up to 60 days after sowing and declined gradually till the harvest. Application of NPK levels showed a positive effect on the growth parameters at all the stages of growth. Application of 100% NPK + FYM and 100% NPK + GM also improved these growth parameters. Yield attributes i.e grain/ear and test weight of wheat increased significantly up to 150% NPK dose. Addition of Zn and S with 100% NPK also improved these yield attributes. Integrated use of 100% NPK + FYM and 100% NPK + GM also increased these attributs over control. Application of NPK fertilizers improved the grain and straw yield significantly over control. Conjoint use of inorganic fertilizers and FYM produced the higher yield of grain (41.66 q ha^{-1}) and straw (62.72 q ha^{-1}). Protein content in grain (12%) and straw (4.9%) were maximum with 150% NPK dose.

Key words: Inorganic fertilizers, organic manures, yield attributes, yield, wheat

INTRODUCTION

Wheat (*Triticum aestivum*) is the most important staple food of our country. Wheat is the second important cereal crop after rice in India. It provides nearly 55% of the carbohydrates and 20% of the food calories. Wheat crop has been reported to show the sign of productivity decline. Major cause of this decline has been attributed to the imbalanced use of plant nutrients which adversely affect the physico-chemical and biological properties of soil. Development of appropriate nutrient management techniques is necessary to sustain the wheat productivity and soil fertility. Integrated use of organic manures and inorganic fertilizers has assumed great importance for sustainable production and maintain for fertility. The organic manures not only supply macro and micronutrients but also improve the soil physical, chemical and biological properties of the soil. Response to zinc application in cereal crops was highly economical. The deficiency of zinc under semi-arid climate has emerged as serious limitation to crop production. Zinc deficiency is being widely expressed in the light textured soil. Sulphur is involved in the formation of chlorophyll. It is component of co-enzyme A, vitamins such as biotin, thiamine and lipoic acid. Sulphur improves crop yields, plant protein and cereal quality. A judicious combination of organic manures and fertilizers can better maintain the long-term soil fertility and sustain high level of productivity. Therefore, use of both organic manures and chemical fertilizer in appropriate proportion assumes special significance as complementary and supplementary to each other in crop production. No systematic information is available on the response of wheat to organic manure and inorganic fertilizers in alluvial soils of Agra. Therefore, a field experiment was conducted to study the effect of integrated use of inorganic fertilizers and organic manures on growth, yield attributes and yield of wheat.

MATERIALS AND METHODS

A field experiment was conducted at research farm, R.B.S. College Bichpuri, Agra (U.P.). The experimental soil was sandy loam in texture, alkaline in reaction (pH 8.1), low in organic carbon (3.9 g kg^{-1}), available N (190 kg ha^{-1}), P (8.5 kg ha^{-1}) and available K (110 kg ha^{-1}). Treatments were T_1 control, T_2 100 % RDN, T_3 100 % RDNP, T_4 100 % RDNPK, T_5 100 %NPK + 5kg Zn ha^{-1}, T_6 100 % NPK + 20 kg S ha^{-1}, T_7 100 % NPK + 12.5 t FYM ha^{-1}, T_8 100 %

NPK + 7.5 t GM, T_9 12.5 t FYM ha^{-1}, T_{10}7.5 t GM ha^{-1} and T_{11} 150 % RDNPK. The experiment was laid out in randomized block design with three replications. Wheat (PBW 343) was sown in second week of November using 100 kg seed ha^{-1}. Phosphorus, potassium and one-third of N were applied as basal dressing and the remainder of N was top dressed in two splits. Well decomposed FYM was applied before one week of sowing. Green manure was also incorporated in the soil before sowing. The crop was grown by adopting standard agronomic practices. At harvest grain and straw yields of wheat were recorded. The growth characters (plant height, number of tillers / 25 cm row length and dry matter production / 25 cm row length), were recorded at different intervals during growth of the plant. Yield attributes (ear length and test weight) and yields were recorded at harvest. All the data were statistically analyzed using the F test as per Gomez and Gomez (1984). Critical difference (CD at P= 0.05) was used to determine the significance of difference between treatment means.

RESULTS AND DISCUSSION

Growth studies

Number of tillers: A study of Table 1 indicates that the number of tillers in wheat crop increased markedly up to 60 days after sowing and attained the maximum number at this stage. Thereafter, the number of tillers declined gradually till harvest. The various treatments had a favourable influence on the no. of tillers per 25 cm row length at each growth stages. The differences in number of tillers due to 100%N, 100% NP,100% NPK treatments were significant over control at all the stages of growth. Among these three treatments, 100% NPK produced relatively higher number of tillers at all the stages of growth. This might be due to balanced use of NPK fertilizers in soil, which increased the availability of NPK to plants. These results are in close conformity with the findings of Chandel *et al.* (2014). The number of tillers was further improved when 5 kg Zn ha^{-1} was applied in combination with 100% NPK. Similarly, application of 20 kg S ha^{-1} with 100% NPK also improved the number of tillers at all the stages of growth over 100% NPK alone. This increase in number of tillers may be attributed to increased availability of zinc and sulphur to plants.

Table 1: Effect of various treatments on growth parameter of wheat

Treatments	Plant height (cm)			Tillers/metre row/length			Dry matter production/25 cm		
	Tillering	Flowering	Maturity	Tillering	Flowering	Maturity	Tillering	Flowering	Maturity
T_1	8.8	69.8	70.8	6.7	70.7	73.2	1.5	17.4	46.4
T_2	10.1	76.7	78.0	78.0	90.0	90.7	1.7	18.6	50.2
T_3	11.0	76.2	77.6	82.5	94.7	95.7	2.0	20.9	53.6
T_4	12.1	78.4	80.0	92.7	99.5	101.7	2.1	22.8	55.9
T_5	12.6	78.7	80.8	94.0	104.5	105.7	2.1	24.0	57.2
T_6	12.3	78.5	79.9	94.2	105.0	106.0	2.0	23.5	56.3
T_7	15.1	79.9	82.0	104.5	115.2	115.2	2.1	26.3	59.1
T_8	17.8	81.7	83.3	105.5	118.7	118.7	2.2	26.6	58.2
T_9	11.1	80.9	82.6	101.2	112.5	112.7	2.0	22.2	50.3
T_{10}	10.5	76.8	78.6	97.0	108.7	109.2	1.8	20.0	48.9
T_{11}	16.4	82.9	84.7	111.2	121.0	123.0	2.3	29.0	60.0
CD (P=0.05)	0.60	2.70	2.90	3.33	3.42	2.71	0.48	2.23	2.90

T_1 control, T_2 100% RDN, T_3 100% RDNP, T_4 100% RDNPK, T_5 100% NPK + 5kg Zn ha^{-1}, T_6 100% NPK + 20kg S ha^{-1}, T_7 100% NPK + 12.5t FYM ha^{-1}, T_8 100% NPK + 7.5t GM, T_9 12.5t FYM ha_{-1}, T_{10} 7.5t GM ha^{-1} and T_{11} 150% RDNPK

Application of 12.5 t FYM ha^{-1} showed a positive effect on the number of tillers per 25 cm row length at all the stages of growth. The increase may be attributed to increased availability of nutrients in soil due to addition of FYM. Similar results were reported by Singh and Pandey (2018). Similarly, application of 7.5 t green leaf manure ha^{-1} also improved the

number of tillers at all the stages of growth over control. The maximum numbers of tillers were recorded at 150% NPK at all the stages of growth which was at par with 100% NPK + 12.5t FYM ha^{-1}.

Plant height: A perusal of the data (Table 1) reveals that the plant attained only a nominal height with in the first 30 days (maximum tillering stage). Thereafter, there was a steady rise in this character, which continued till harvest. However, the rate of increase in plant height was quite slow after 90 days of sowing. Addition of inorganic fertilizers (100% N, 100% NP and 100% NPK) showed a positive and significant effect on this character. The supply of 100% NPK + 12.5 t FYM ha^{-1} recorded the greater height of the plants at all the stages of the growth which may be attributed to greater availability of nutrients in soil with the application of chemical fertilizer and FYM. These results are in close conformity with the findings Pandey and Singh (2017). The application of 100% NPK along with 7.5 t GLM ha^{-1} produced taller plants over 100% NPK alone but the magnitude of increase in this growth character was more or less similar to FYM. Application of 100% NPK in combination with 5 kg Zn ha^{-1} enhanced the values of this growth characters which may be due to increased availability of zinc in zinc deficient soil. Similar results were also recorded with 100% NPK + 20 kg S ha^{-1} in both crop seasons at all the stages of growth. Application of 12.5 t FYM ha^{-1} produced taller plants than in control at all the stages of growth. This increase in plant height may be attributed to increased availability of nutrients due to mineralization of FYM or through solublization of the nutrient from the native source during the process of decomposition. Similar results have also been reported by Singh (2017).

Dry matter production: It may be seen from the data (Table 1) that the accumulation of dry matter took place at slow rate up to maximum tillering stages in wheat. The dry matter was accumulated continuously and almost linearly up to maturity of the crops irrespective of the treatment effect. During early growth period roots are not well established and the leaves are not able to manufacture enough food materials, thus, the initial rate of dry matter accumulation was very slow. The differences in dry matter accumulation in wheat due to various treatments were quite visible after maximum tillering stages. Application of inorganic fertilizers (100% N, 100% NP and 100% NPK) increased the dry matter accumulation significantly over control. The dry matter accumulation was further enhanced when 100% NPK were applied in combination with 12.5 t FYM ha^{-1}. This could have due to increased efficiency of applied chemical fertilizers by FYM (Singh and Patra 1917). The application of 7.5 t GLM ha^{-1} along with 100% NPK also enhanced the dry matter production at all the stages of growth. Application of 5 kg Zn ha^{-1} + 100% NPK also improved the dry matter production of wheat over 100% NPK alone. Similarly 20 kg S ha^{-1} + 100% NPK also improved the dry matter accumulation in wheat which may be ascribed to increased availability of S to plants. Application of 12.5 t FYM ha^{-1} and 7.5 t GYM ha^{-1} alone increased the dry matter production favourably from an early stage and these differences further enlarged at successive latter stages. The increase in dry matter accumulation with FYM application has also been reported Singh *and Patra* (2017). The highest dry matter accumulation of course was obtained with 150% NPK treatment. However the difference in dry matter accumulation with 150% NPK and 100% NPK + 12.5t FYM ha^{-1} was statistically non-significant.

Yield attributing characters: It is evident from the data (Table 2) that the lower values of these characters were recorded in control (no fertilizer) treatment. Application of fertilizers (100% N, 100% NP and 100% NPK of recommended dose) enhanced the values of these characters significantly over control. The combined application of 100% NPK+12.5t FYM ha^{-1} resulted in an additive effect on these characters probably due to beneficial effect of FYM on soil fertility and physical properties (Singh and Patra, 2017). Application of 100% NPK + 7.5 t GLM ha^{-1} also enhanced the values of these characters over 100% NPK alone. Integrated use of 100% NPK and 5Kg Zn ha^{-1} proved more beneficial in respect of yield attributing characters. Application of 20 Kg S ha^{-1} +100%NPK also improved the values of these characters which may be attributed to increased availability of sulphur to plants. Application of both 12.5 t FYM ha^{-1} and 7.5t GLM ha^{-1} alone enhanced the values of these characters significantly over

control. The maximum impact on yield attributing characters was recorded under with 150% NPK treatments. However, 150% NPK alone and 100%NPK +12.5t FYM or 7.5t GLM ha^{-1} were statistically at par with respect to values of these yield attributes indicating the significance of integrated use of nutrients.

Table 2: Effect of various treatments on yield attribute, yield and protein content in wheat

Treatments	Grain/ear	Test weight (g)	Grain yield (q ha^{-1})	% response	Straw yield (q ha^{-1})	Protein content (%)	
						Grain	Straw
T_1	41.0	29.94	28.04	-	39.40	10.0	3.4
T_2	52.5	31.35	32.70	16.6	33.41	10.5	4.1
T_3	53.0	31.91	34.77	24.0	46.56	10.8	4.3
T_4	58.2	33.47	36.66	30.7	51.52	11.1	4.4
T_5	63.7	32.98	38.35	36.7	57.90	11.4	4.5
T_6	59.0	33.0	37.20	32.6	56.72	11.5	4.4
T_7	65.7	33.82	41.66	48.5	62.72	11.8	4.4
T_8	66.5	34.01	40.33	43.8	58.38	11.8	4.8
T_9	67.5	32.56	34.14	21.7	116.27	10.5	4.4
T_{10}	59.7	34.55	34.50	23.0	46.13	10.9	4.1
T_{11}	68.2	37.19	41.67	48.6	62.06	12.0	4.9
CD (P=0.05)	0.68	0.35	1.23	-	2.93	0.18	0.11

Yield studies

A study of Table 2 reveals that the minimum yields of grains and straw of wheat were recorded in control plots (no fertilizer), which may be attributed to low fertility status of the soil. There were significant increases in wheat yield over control with the application of 100%N, 100%NP and 100%NPK fertilizers. This could be attributed to increased availability of NPK in the soil. The increases in grain and straw yield with 100%N, 100%NP and 100%NPK over control were 16.6 and 10.2, 24.0 and 18.2 and 30.7 and 31.0 percent. Application of FYM (12.5 t ha^{-1}) and 7.5 t GLM ha^{-1} along with 100%NPK fertilizer further improved the crop production. This could be attributed to a sustained availability of major as well as trace elements, which is evident from higher accumulation of nutrients. Similar synergistic influences of manures and inorganic fertilizers on the crop yield have been reported by Singh and Patra (2017) and Pandey (2018). Application of both FYM (12.5 t ha^{-1}) and GLM (7.5 t ha^{-1}) significantly improved the wheat production over control. The increases in grain and straw production due to 12.5 t ha^{-1} FYM and 7.5 GLM ha^{-1} over control were 21.7 and 17.4 and 23.0 and 17.1 percent, respectively. The improved grain and straw production with FYM and GLM may be attributed to increased availability of nutrients to the wheat crop and improvement in physico-chemical and biological properties of the soil which is very much in agreement with the findings of Singh (2017), The maximum grain and straw yields were recorded with T_{11} (150%NPK) treatment. The increases in grain and straw yield with 150% NPK over control were 48.6 and 57.5 and 43.9 and 55.4 percent. This treatment (T_{11}) however, did not produce significantly higher grain and straw yield over 100% NPK +12.5t FYM ha^{-1} treatment.

Qualitative studies

A study of the data on protein content (Table 2) reveals that the percentage of protein in wheat grain and straw was significantly affected by different treatments. There was significantly higher percentage of protein in grain and straw under all the treatments as compared to control. The minimum values of protein content in grain and straw were recorded under T_1 (no fertilizer) treatment, which may be ascribed to lower concentration of nitrogen in wheat crop. From quality point of view, treatments T_{11} (150%NPK) and T_9 (100%NPK+12.5 t FYM ha^{-1}) appear to be the best. This may be due to the fact that the plants accumulated more nitrogen with these treatments and ultimately showing more protein percent (Pandey, 2018).

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