Original Research Article

Influence of long-term application of fertilizers and manure on growth, yield attributes and yield of wheat

Comment [DS1]: The authors' work is excellent and shows great effort, but the manuscript's language needs to be revised. The materials and methods need references. Updated references are needed.

ABSTRACT

A fertilizer experiment was conducted on wheat (GW 366) during Rabi session 2020-21 and 2021-22 under all India Coordinative Research Project on Long Term Fertilizer Experiment at College of Agriculture, Jawaharlal Nehru KrishiVishwaVidyalaya, Jabalpur, to study the effect of long-term application of fertilizers and manure on growth, yield attributes and yield of wheat. Eight treatments comprised of T_1 (50% NPK), T_2 (100% NPK), T_3 (150% NPK), T_4 (100% NP), T_5 (100% N), T_6 (100% NPK + FYM), T_7 (100% NPK - S) and T_8 (Control) were replicated four times in a randomized block design. The application of 50% NPK, 100% NPK and 150% NPK successively and significantly increased plant height, number of tillers plant^{-1}, number of effective tillers plant^{-1}, number of grains spike^{-1} and grain yield. While the test weight and straw yield at 150% NPK was found significantly superior to 50% NPK but it was found at par with 100% NPK in both the cases. The application of 100% NPK was found significant over 100% NPK - S for grain yield.

The application of 100% NPK + FYM significantly increased the plant height, number of tillers plant^{-1}, number of effective tillers plant^{-1}, number of grains spike^{-1}, test weight, grain and straw yield over 100% NPK, 100% NPK - S, 100% NP and 100% N, but it was found at par with 150% NPK for all the growth and yield attributes. Growth and yield attributes were found significantly and positively correlated with grain and straw yield of wheat.

Keywords: Wheat, plant height, number of tillers plant^{-1}, number of effective tillers plant^{-1}, number of grains spike^{-1}, test weight, grain and straw yield and correlation coefficient.

1. INTRODUCTION

Wheat is an excellent diet for humans because it is high in protein and carbohydrates. One of the most important crops used for basic food is wheat, which has been called "Staff of life or the king of cereals. Continuous cropping and insufficient application of organic and mineral fertilizers, our soil usually has low fertility. Soil fertility is a key component of the technological package for enhancing crop yield according to [1]. It is necessary to make efforts to preserve soil fertility via the use of either organic matter or inorganic material in order to assure greater crop output. Mineral fertilizers are clearly simple to use and provide quick results, but when used improperly, they harm both the environment and people. It is viable to supply organic manure to partially or entirely replace the inorganic material. Therefore, it is crucial to encourage environmentally friendly and commercially successful ideas for sustainable agriculture. When added to the soil, FYM is regarded as a good source of organic matter and plant nutrients [2, 3]. It has been stated that adding FYM and inorganic fertilizers to soil would enhance the efficacy of fertilizer application [4]. The yield of wheat was greatly boosted by residual effects of 100% NPK + FYM compared to

100% NPK. When FYM was added, nutrient removal by the crops was greater than with chemical fertilizers, and soil N, P, K and organic carbon concentrations increased while the pH of the soil decreased [5].

2. MATERIAL AND METHODS

2.1Experimental site, climate and soil characteristics

The present study is a part of ongoing All India Coordinated Research Project (ICAR) on Long Term Fertilizer Experiment (LTFE) at Jawaharlal Nehru KrishiVishwaVidyalaya, Jabalpur, Madhya Pradesh, India. The experimental field is situated in Kymore Plateau and Satpura Hills agroclimatic zone of Madhya Pradesh. It is located at an altitude of 411.8 m above mean sea level and has coordinates of 23.9° N latitude and 79.6° E longitude. The semi-arid area where Jabalpur is located has a subtropical climate with hot, dry summers and cold winters. The above-mentioned experiment was started in 1972 on soybean (*Kharif*), wheat (*Rabi*) and maize fodder (*Jayad*), however the present study deals with the wheat (*Rabi*) crop. The appearance of soil in the experimental field is a medium black colour and belonging to the TypicHaplustertKheri series of fine montmorillonitichyperthermic family.

2.2 Treatments detail

The experiment has been running since 1972. Based on initial soil test values since 1972, the wheat N, P_2O_5 and K_2O dosages were 120, 80, and 40 kg ha^{-1}, respectively. Urea was employed as a nitrogen source, single super phosphate as a source of phosphorus, muriate of potash as a source of potassium and 100% NPK - S, where application of sulphur was omitted therefore, di-ammonium phosphate was used as a source for phosphorus. The farm yard manure (FYM) treatment was applied @ 5-ton ha^{-1} $year^{-1}$ (only *Kharif*). There were eight treatments comprised of T_1 (50% NPK), T_2 (100% NPK), T_3 (150% NPK), T_4 (100% NP), T_5 (100% N), T_6 (100% NPK + FYM), T_7 (100% NPK - S) and T_8 (Control). These treatments were replicated four times in a randomized block design (RBD). One third dose of N and full dose of P and K were applied at the time of sowing. Remaining one third N was applied at crown root initiation (CRI) stage and one third N at flag leaf initiation stage.

2.3 Growth and yield attributes

The wheat (GW 366) was grown in *rabi*season of 2020-21 and 2021-22. The seed was sown @ 100 kg ha^{-1} with 22.5 cm row to row distance on 04-12-2020 and 02-12-2021 and harvested at physiological maturity on 07-04-2021 and 06-04-2022 respectively. Growth and yield attributes were recorded in five randomly selected plants in each plot. The physiological observations such as plant height, number of tillers and effective tillers $plant^{-1}$, number of grains $spike^{-1}$ and test weight were recorded at harvest.

3. RESULTS AND DISCUSSION

3.1 Growth and yield attributes

The data presented in Table 1 and Fig 1. showed that the application of 50% NPK, 100% NPK and 150% NPK significantly increased the plant height, number of tillers $plant^{-1}$, number of effective tillers $plant^{-1}$, number of grains $spike^{-1}$ and test weight of wheat significantly increased over control. However, the plant height, number of tillers $plant^{-1}$, number of effective tillers $plant^{-1}$ and number of grains $spike^{-1}$ were successively and significantly increased with 50% NPK, 100% NPK and 150% NPK. While the test weight at

150% NPK was found significant over 50% NPK but it was found at par with 100% NPK. The plant height, number of tillers plant^{-1}, number of effective tillers plant^{-1}, number of grains spike^{-1} and test weight at 100% NPK were found significantly superior to 100% NP and 100% N. However, the plant height and effective tillers plant^{-1} with 100% NPK was also found significantly superior to 100% NPK - S. The application of 50% NPK was found significantly superior to 100% N for plant height and all yield attributes. This increase of growth and yield attributes of wheat with increasing levels of NPK might be due to increased nutrients availability in soil which promotes the root and shoot growth of wheat which enhanced the nutrients absorption by plants under intensive cultivation.

The application of 100% NPK + FYM significantly increased the plant height, number of tillers plant^{-1}, number of effective tillers plant^{-1}, number of grains spike^{-1} and test weight of wheat over 100% NPK, 100% NP, 100% N, 100% NPK - S but it was found at par with 150% for all the growth and yield attributes. It might be due to continuous application of FYM along with 100% NPK supply better nutrition (major and minor nutrients) under better soil condition promotes better root and shoot growth resulted higher growth and yield attributes of wheat. The similar results were also reported by Dixit and Gupta [6], Sing and Agrawal[7], Verma et al. [8], Singh et al. [9] and Tejalben et al. [10].

Table 1: Influence of long-term application of fertilizers and manure ongrowth and yield attributes of wheat at harvest (Pooled data of 2020-21 and 2021-22)

Treatments	Plant height (cm)	No. of tillers plant^{-1}	No. of effective tillers plant^{-1}	No. of grains spike^{-1}	Test weight (1000 grains)
50% NPK	79.60	12.22	5.16	26.85	38.12
100% NPK	91.18	15.23	6.13	33.29	39.02
150% NPK	95.98	18.89	6.62	50.52	40.08
100% NP	85.45	14.01	4.38	21.59	37.13
100% N	68.93	9.25	4.06	17.23	36.90
100% NPK + FYM	98.00	19.23	7.06	52.13	41.14
100% NPK - S	74.23	14.69	5.56	32.74	38.76
Control	64.69	8.41	3.58	16.14	35.69
SEm ±	1.44	0.33	0.17	0.61	0.47
CD (*p*=0.05)	4.11	0.95	0.49	1.75	1.33

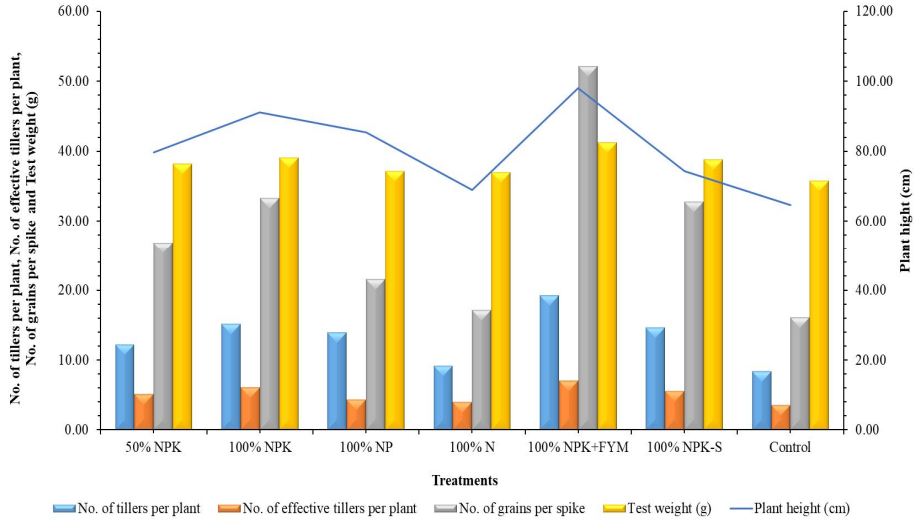

Fig. 1: Influence of long-term application of fertilizers and manure ongrowth and yield attributes of wheat at harvest

3.2 Grain and straw yield of wheat

The data presented in Table 2 and Fig. 2 revealed that the application of 50% NPK, 100% NPK and 150% NPK significantly increased the grain and straw yield of wheat over control. However, the grain yield successively and significantly increased with the increasing level of NPK. While the stover yield at 150% NPK was found significant over 50% NPK but it was found at par with 100% NPK. The application of 100% NPK was found significant over 50% NPK, 100% NP, 100% N and 100% NPK - S but it was found at par with 150% NPK for grain yield. All the treatments of inorganic source of nutrients (fertilizers) were found at par for straw yield. Whereas, the application of 50% NPK was found significantly superior to 100% N for grain yield but the treatment was found at par for straw yield. This increase of grain and straw yield of wheat with increasing levels of NPK which support normal development of the crops, their residues and decaying root induced soil aggregation which promote root and shoot development enhanced growth and yield attributes responsible for higher grain and straw yield.

The application of 100% NPK + FYM significantly increased the grain and straw yield of wheat over 100% NPK, 100% NP, 100% N and 100% NPK - S but it was found at par with 150% NPK in both the cases. It might be due to beneficial effect of continuous application of FYM + 100% NPK supply better nutrients (including major and minor nutrients) under better soil condition produced higher growth and yield attributes resulted significantly higher grain and straw yield than 100% NPK alone. The grain and straw yield of wheat was found significantly and positively correlated with plant height (r = 0.928 and 0.858), number of tillers plant^{-1} (r = 0.970 and 0.902), number of effective tillers plant^{-1} (r = 0.944 and 0.877), number of grains spike^{-1} (0.900 and 0.821) and test weight (r = 0.927 and 0.912). Similar results were also found by Rehman*et al*. [11], Khan *et al*. [12], Bhatt *et al*. [13] and Holik*et al*. [14].

Table 2: Influence of long-term application of fertilizers and manure ongrain and straw yield of wheat (Pooled data of 2020-21 and 2021-22)

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
50% NPK	4210	5611
100% NPK	5263	6094
150% NPK	6040	6343
100% NP	4164	5871
100% N	1818	5469
100% NPK + FYM	6160	6836
100% NPK - S	4583	6008
Control	1433	4191
SEm ±	190	250
CD (*p*=0.05)	542	713

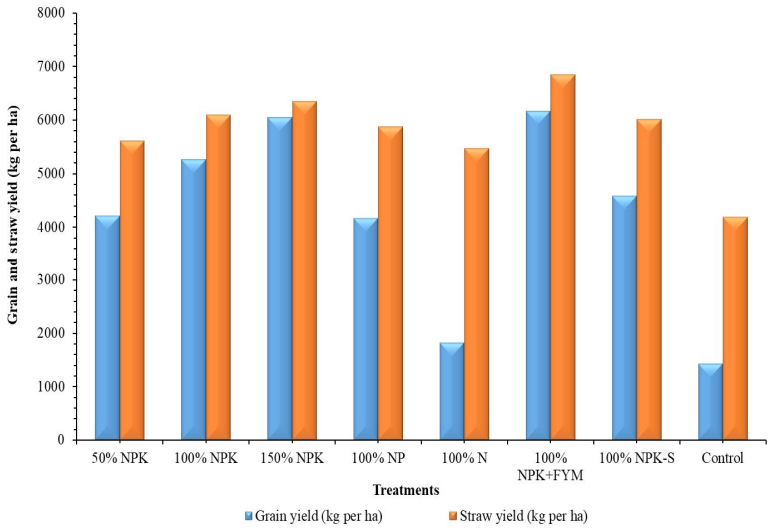

Fig. 2: Influence of long-term application of fertilizers and manure ongrain and straw yield of wheat

3.3 Correlation Studies

Grain and straw yield vs plant height, number of tillers plant^{-1}, number of effective tillers plant^{-1}, number of grains spike^{-1} and test weight, correlation co-efficient values ("r") were calculated. Plant height (r = 0.928), number of tillers plant^{-1} (r = 0.970), number of effective tillers plant^{-1} (r = 0.944), number of grains spike^{-1} (0.900), and test weight (r = 0.927) all demonstrated statistically positive correlation with grain yield. Plant height (0.858), the number of tillers plant^{-1} (0.902), the number of effective tillers plant^{-1} (0.887), the number of grains spike^{-1} (0.821), and test weight (0.912) all strongly positively correlated with straw yield. Similar findings were also reported by Liu et al. [15], Rajeshwari [16], Kovacevic et al. [17], Sree [18] and Rakshit et al. [19].

Table 3: Correlation between yield and growth/yield attributes of wheat

Characters	Grain yield	Straw yield
Plant height	0.928	0.858
Number of tillers plant^{-1}	0.970	0.902
Number of effective tillers plant^{-1}	0.944	0.877
Number of grains spike^{-1}	0.900	0.821
Test weight	0.927	0.912
Significant at 5% level of significance (critical r value is 0.707)		

4. CONCLUSION

The application of 50% NPK, 100% NPK and 150% NPK successively and significantly increased the plant height, number of tillers plant^{-1}, number of effective tillers plant^{-1}, number of grain spike^{-1} and grain yield. The 100% NPK was found significant over 100% NPK - S for grain yield. The application of 100% NPK + FYM significantly increased the growth, yield attributes, grain and straw yield over 100% NPK and 100% NPK - S.

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