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Effect of nutrient management on yield of wheat (*Triticum aestivum*) and soil fertility

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ABSTRACT

A field experiment was conducted at R.B.S. College research farm Bichpuri, Agra (U.P.) to study the effect of different nutrient management practices on yield of wheat (Triticum aestivum) and soil fertility. Thirteen treatments were evaluated in randomized block design with three replications. The results revealed that the grain and straw yields were maximum with the application of 150 kg + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} closely followed by 150 kg N + 5 kg Zn + 10t FYM ha^{-1}. The increases in grain and straw yield with 150 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} were 70.0 and 44.2 per cent over control, respectively. The corresponding increases in grain and straw yield with 150 kg + 5 kg Zn + 10t FYM ha^{-1} were 71.6 and 72.1 per cent. The protein contents were maximum in grain (13.6%) and straw (4.6%) with 150 kg N + 20 kg S + 10t FYM ha^{-1}. The maximum protein yield (775.2 kg ha^{-1}) was recorded with 150 kg + 20 kg S + 10t FYM ha^{-1} treatment. The status of available N and P in post harvest soil was 160 and 13.6 kg ha^{-1} respectively with 150 kg N + 20 kg S + 10t FYM ha^{-1}. The maximum values of available K (185 kg ha^{-1}) and S (11.2 mg kg^{-1}) were recorded under 150 kg N + 20 kg S + 10t FYM ha^{-1} and 20 kg S + 20 t FYM ha^{-1}, respectively. On the other hand, maximum value of DTPA-Zn (0.70 mg kg^{-1}) was recorded with the application of 5 kg Zn + 20t FYM ha^{-1}.

Key words: Nutrient management, wheat, soil fertility, yield

INTRODUCTION

Adequate nutrition, among other improved technologies, is important for getting potential yield of wheat. Wheat is an important prime cereal crop among the food grains grown in India. The decline in wheat productivity is attributed to imbalance fertilizer application and low soil fertility. Optimum nutrition is required for getting the maximum yield and quality. Organic manures are good complimentary source of nutrients and improve the efficiency of the applied mineral nutrients on one hand and improve physical, chemical and biological properties of soil on the other hand. Therefore, any nutrient management practice that can improve organic matter status of soil is important. A judicious and combined use of organic and inorganic sources of plant nutrients is essential to maintain soil health and augment the efficiency of nutrients. Additionally, such integration of organic and inorganic nutrients plays an important role in economizing the use of fertilizers under increasing cost, which is restricting their use to an optimum level. Hence present experiment was carried out to find out the effect of organic manures and fertilizers on yield of wheat quality and soil fertility.

MATERIALS AND METHODS

A field experiment was carried out at R.B.S. College farm, Bichpuri, Agra (U.P.). The soil was sandy loam in texture with pH 8.0, organic carbon 3.9 g kg^{-1}, available N 180 kg ha^{-1}, P 8.3 kg ha^{-1}, K 160 kg ha^{-1}, available S 17 kg ha^{-1} and DTPA-Zn 0.56 mg kg^{-1}. The treatments namely T_1 control, $T_2$150 kg N + 60 kg P_2O_5 + 40 K_2O ha^{-1}, T_3 75 kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1}, T_4 75 kg N + 10t FYM ha^{-1} T_5 150 kg N + 10t FYM ha^{-1}, T_6 75 kg N + 5 kg Zn + 10t FYM ha^{-1}, T_7 150 kg N + 5 kg Zn + 10t FYM ha^{-1}, T_8 75 kg N + 20 kg S + 10t FYM ha^{-1}, T_9 150 kg N + 20 kg S + 10t FYM ha^{-1}, T_{10} 5 kg Zn + 10t FYM ha^{-1}, T_{11} 5 kg Zn + 20t FYM ha^{-1}, T_{12} + 20 kg S + 10t FYM ha^{-1} and 20 kg S + 20t FYM ha^{-1} were evaluated in randomized block design with three replications. Wheat (HD 2338) was sown in second week of November using 100 kg seed ha^{-1}. Half of the N and full amount P, K and Zn as per treatments were applied at the time of sowing and the remaining N was top-dressed at different stages in equal amounts. The required amount of FYM (0.51% N, 0.25% P and 0.48% K) as per treatment was incorporated in to soil 15 days before sowing of wheat crop. Sulphur and zinc were applied through elemental sulphur and zinc chloride, respectively at the time of sowing of wheat. Grain and straw yields were

recorded at harvest. Soil samples collected after harvest of wheat crop were analysed for available N, P, K and S following standard procedures (Jackson 1973). Available Zn in soil was determined as per procedure given by Lindsay and Norvell (1978). The data were statistically analysed by the procedure of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Yield studies

A study of Table 1 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. A further study of the data reveals that there were significant increases in wheat yield over control with the application of both levels of NPK fertilizers. This could be attributed to increased availability of NPK in the soil. The increases in grain and straw yield with $N_{150} P_{60} K_{40}$ over control were 70.0 and 44.2 percent respectively. Similar results were reported by Singh (2018), Application of FYM (10t ha^{-1}) along with $N_{75} P_{30} K_{20}$ and $N_{150} P_{60} K_{40}$ further improved the crop production. Thus, the results reveal a higher productivity due to combined application of organics and inorganics. This could be attributed to a sustained availability of major as well as trace elements, which is evident from higher accumulation of nutrients. Similar influence of integrated use of FYM and chemical fertilizers on productivity of agricultural crops like rice, wheat and maize were reported by several workers (Chandel *et al.* 2014, Pandey 2018). Singh and Patra (2017) observed that presence of easily decomposable organic residue helps in mineralization of immobilized inorganic nitrogen, which is subsequently made available to the plants for a longer period. Similar synergistic influences of manures and inorganic fertilizers on the crop yield have been reported by Pandey and Singh (2017). Application of FYM (10t FYM ha^{-1}) along with 5 kg Zn + 75 and 150 kg Nha^{-1} significantly improved the wheat production over control. The increases in grain and straw production due to 10 t ha^{-1} FYM + 5 kg Zn + 150 kg N ha^{-1} over control were 71.6 and 72.1 percent, respectively. The maximum grain and straw yields were recorded with $N_{150} Zn_5$ FYM10 treatment. This treatment however, did not produce significantly higher grain and straw yield over $N_{150} FYM_{10}$ and $N_{150} S_{20} FYM_{10}$ treatments.

Qualitative studies

A study of the data on protein content (Table 1) reveals that the percentage of protein in wheat grain and straw was significantly affected by different treatments. The minimum values of protein content in grain and straw were recorded under control treatment, which may be ascribed to lower concentration of nitrogen in wheat crop. From quality point of view, treatments $N_{150} P_{60} K_{40,}$ $N_{150} Zn_5 FYM_{10}$ and $N_{150} S_{20} FYM_{10}$ treatments 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. In general; the minimum protein yield of wheat crop was recorded under control treatment. This may be attributed to lower yield of wheat crop. The protein yield of wheat was improved with both levels of NPK fertilizers over control. Singh (2018) also reported that the crude protein yield increased by chemical fertilizers. The addition of FYM (10 t ha^{-1}) along with both levels of NPK ($N_{75} P_{30} K_{20}$ and $N_{150} P_{60} K_{40}$) enhanced the protein yield of wheat significantly over chemical fertilizers. Singh and Patra (2017) also reported similar results with the application of organic manures and inorganic fertilizers. Application of both Zn (5 Kg Zn ha^{-1}) and S (20 Kg ha^{-1}) coupled with 10 t FYM and N_{75} and N_{150} also improvement the protein yield but beneficial effect was grater with zinc treatment. This improved may be attributed to increased crop production and improvement in protein content with Zn and S application. There was a significant increase in protein yield with 10 and 20 t FYM + 5 kg Zn addition which may be attributed to higher crop production and improvement in protein content. Application of 10 and 20 t FYM ha^{-1} with S_{20} increased the protein yield synergistically over control (Pandey 2018). The maximum protein yields of wheat crop were recorded under $N_{150} Zn_5 FYM_{10}$ and $N_{150} S_{20} FYM_{10}$ treatments showing the beneficial effect on grain and straw production.

Table 1: Effect of nutrient management practices on yield and quality of wheat

Treatment	Yield (q ha^{-1})		Protein content (%)		Protein yield (kg ha^{-1})
	Grain	Straw	Grain	Straw	
T_1 Control	32.05	38.03	10.1	3.5	323.7
T_2 150 Kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}	54.50	54.85	13.5	4.8	735.0
T_3 75 Kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1}	46.88	55.79	12.0	4.1	562.5
T_4 75 kg N + 10 t FYM ha^{-1}	47.76	56.83	11.9	3.9	568.3
T_5 150 kg N + 10 t FYM ha^{-1}	52.65	62.65	13.2	4.6	695.0
T_6 75 Kg N + 5 Kg Zn + 10 t FYM ha^{-1}	49.62	59.05	12.0	4.0	595.0
T_7 150 Kg N + 5 Kg Zn + 10 t FYM ha^{-1}	55.00	65.45	13.5	4.5	742.5
T_8 75 Kg N + 20 Kg S + 10 t FYM ha^{-1}	52.30	62.24	12.0	4.0	627.5
T_9 150 Kg N + 20 Kg S + 10 t FYM ha^{-1}	57.00	67.03	13.6	4.6	775.2
T_{10} 5 Kg Zn + 10 t FYM ha^{-1}	41.55	49.44	11.4	3.8	473.6
T_{11} 5 Kg Zn + 20 t FYM ha^{-1}	46.05	54.79	12.1	4.1	557.2
T_{12} 20 Kg S + 10 t FYM ha^{-1}	42.50	50.57	11.5	3.8	488.7
T_{13} 20 Kg S + 20 t FYM ha^{-1}	46.50	55.33	12.3	4.3	572.0
CD (P= 0.05)	3.44	3.26	0.79	0.51	10.2

Soil Fertility

The minimum values of available N content in soil after harvest of wheat crop were recorded in control treatment (Table 2). This may be ascribed to greater utilization of available nitrogen by wheat crop during growth period. Organic matter addition along with N levels significantly enhanced the available nitrogen status in soil over N alone. Application of zinc and sulphur along with N + FYM further improved the status of available nitrogen in soil after harvest of wheat. This increase may be attributed to supply of available nitrogen to the soil with FYM addition. Available N status of the soil also improved significantly with all the levels of NPK fertilizers. This increase may be due to addition of N through nitrogenous fertilizer in to the soil. These results are in agreement with the findings of Pandey (20188) who showed an increase in available N in the soil with FYM and N fertilizers. The maximum amount of available nitrogen was recorded with N_{150} S_{20} FYM_{10} treatment indicating the beneficial effect of combined use of all the three essential primary nutrients. The lowest amounts of available phosphorus were recorded in control treatment which may be ascribed to higher production of the crop, which must have exhausted the soil P. There was a significant increase in available P over control with increasing levels of NPK fertilizers and higher amount of available P were noted in N_{150} P_{60} K_{40} level. The increase in available P status may be attributed to addition of P in to the soil. Application of FYM + both the levels of N significantly improved the status of available P in soil, which may be ascribed to the solubilization effect of organic acids liberated during the decomposition of organic matter. These results are in close conformity with the findings of Singh and Patra (2017). The available phosphorus was further improved significantly when N levels and FYM were applied with 20 Kg S ha^{-1}. The maximum values of the available P were recorded under N_{150} + 20 kg S + 10 t FYM ha^{-1}. The relatively higher values of the available P content under this treatment may be accounted for by the fact that most of the P exists in available form. The levels of NPK fertilizers proved more beneficial in respect of available K content in soil over control. Zinc and S application along with N levels and FYM also enhanced the available K status over control. The highest amounts of available K content were recorded with N_{150} S_{20} FYM_{10} treatment. Application of FYM increased organic colloids, which probably caused greater adsorption of K from the soil solution, Application of FYM levels with Zn and S alleviated available K status of the soil. FYM containing K_2O when applied bound to enrich the K status of the soil. Besides this, native K becomes more available due to organic acids liberated during decomposition of organic matter.

Table 2: Effect of nutrient management practices on status of available nutrients in soil after harvest of wheat

Treatments	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Sulphur (kg ha^{-1})	Zinc (mg kg^{-1})
T_1 Control	125.0	10.0	160.2	8.2	0.51
T_2 150 Kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}	150.0	13.0	172.2	8.4	0.52
T_3 75 Kg N + 30 kg P_2O_5 + 20 kg K_2O ha^{-1}	140.0	12.7	168.4	8.3	0.54
T_4 75 kg N + 10 t FYM ha^{-1}	137.0	12.5	165.0	9.0	0.55
T_5 150 kg N + 10 t FYM ha^{-1}	160.6	13.0	183.5	9.2	0.60
T_6 75 Kg N + 5 Kg Zn + 10 t FYM ha^{-1}	144.2	12.0	178.0	9.0	0.49
T_7 150 Kg N + 5 Kg Zn + 10 t FYM ha^{-1}	160.0	13.0	180.0	9.3	0.61
T_8 75 Kg N + 20 Kg S + 10 t FYM ha^{-1}	146.0	12.0	160.0	10.6	0.55
T_9 150 Kg N + 20 Kg S + 10 t FYM ha^{-1}	160.0	13.6	185.0	11.0	0.62
T_{10} 5 Kg Zn + 10 t FYM ha^{-1}	144.0	10.1	158.0	9.4	0.66
T_{11} 5 Kg Zn + 20 t FYM ha^{-1}	155.2	11.6	166.0	9.5	0.70
T_{12} 20 Kg S + 10 t FYM ha^{-1}	145.1	11.0	160.0	10.8	0.60
T_{13} 20 Kg S + 20 t FYM ha^{-1}	156.0	12.5	170.0	11.2	0.62
SEm+	1.29	0.17	1.32	0.82	0.005
CD (P=0.05)	3.79	0.50	3.88	2.41	0.014

Available S status in soil was significantly affected by all the treatments over control in both crop seasons (Table 2). The lowest value of available S was recorded in control. The reduction is available S status in without S may be ascribed to higher production of wheat which must have exhausted the soil S. Application of N levels + FYM significantly improved the status of available S in soil, which may be ascribed to the solublization effect of organic acids liberated during the decomposition of organic matter. These results are in close conformity with the findings of and Singh (2018). The combined application of FYM and Zn and S also improved the status of available S in soil. There was a significant increase in available S over control with increasing levels of NPK fertilizers and higher amount of available S were noted in N_{150} P_{60} K_{40} levels. The maximum values of S status were recorded under N_{150} S_{20} FYM_{10} treatment. The lowest value of available Zn in soil after harvest of the wheat crop was recorded in control treatment. The application of NPK levels slightly improved the status of available Zn in soil. The available Zn was further improved with Zn or S addition with NPK levels of FYM. Zinc proved superior over S in improving the status of available Zn in soil. Application of FYM with NPK levels significantly improved the status of available Zn in soil, which may be ascribed to the supply of These results are in close conformity with findings of Singh *et al.* (2018). Application of FYM and NPK fertilizers in combination resulted in higher build of available Zn in soil. Integrated use of organic and inorganic enhanced the available Zn and higher values of available Zn content were recorded with N_{150} Zn_5 FYM_{10} treatment indicating the beneficial effect of combined use of FYM, and NPK fertilizers.

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