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EFFECT OF INORGANIC AND ORGANIC SOURCES OF NUTRIENTS ON YIELD AND NUTRIENT UPTAKE BY WHEAT AND SOIL FERTILITY

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ABSTRACT

Field experiment was conducted during rabi seasons of 2011-12 and 2012-13 at Rasulpur village, Auraiya (U P) on farmer field to study the effect of organic and inorganic sources of nutrients on yield of and nutrient uptake by wheat and soil fertility. The results revealed significantly higher grain yield (49.7 q ha^{-1}) and total uptake of N, P and K by wheat (131.6, 22.9 and 39.0 kg ha^{-1}, respectivily) were recorded with application of 150% STR of N P K+ FYM as compared to the grain yield of 47.1 q ha^{-1} and total NPK uptake (119.5, 21.4 and 36.9 kg ha^{-1}, respectively) with 150% NPK alone . The yields of and nutrient uptake by wheat were significantly lower with the suboptimal doses of N, P, and K. The conjoint use of FYM with 150% NPK significantly improved the status of organic carbon and available N, P and K over the chemical fertilizer alone .The protein content in wheat grain and straw was also improved with the application of sources of nutrient over control. The combined use of inorganic and organic sources of nutrients maximized yield of wheat crop and improved the soil fertility.

Keywords: Inorganic, organic, nutrients, yield, nutrient uptake, wheat

INTRODUCTION

Wheat (*Triticum aestivum L.)* is an important cereal crop which contributes 40% in total food grain production in the country next to the rice. The productivity of wheat in U.P.(32.54 qha^{-1}) is low as compared to Panjab (45.31 qha^{-1}) and Haryana (40.66 qha^{-1}).Low fertilizer consumption, imbalanced fertilier use, removal of crop residue from field, severe soil degradation and prevalence of tropical, subtropical, arid and semiarid climate in the country have led to the low productivity . In addition nutrient imbalance due to continuous use of N alone or in combined with suboptimal rate of other nutrients (especially P and K) has been the primary reason for the non sustainable wheat yield in the state. Further farmers of this region do not pay any attention toward K apllication and it is almost negligible even in deficient soils because of the genral conviction that these soils are rich in K. This imbalanced and skewed application of N, P and K has not only stagnate/reduced crop yield but also impared nutrient use efficieny and crop yield.(Tiwari *et al.* 2006) Under these circumstances integration of chemical and organic sources and their management have shown promising result not only in sustaining the productivity but also proved to be effective in maintaining soil health and enhancing nutrient use efficiency (Selvi *et al.* 2005, Thakur *et al.*2011, Chandel *et al.* 2014).This increase in productivity may be due to the combined effect of nutrient supply and improvement in soil physical , chemical and biological properties (Singh *et al.* 2008). Information on the use of chemical fertilizers alougwith organic manure with the farmer is scanty. Therefore the present study was conducted using wheat as test crop.

MATERIALS AND METHODS

Field experiment was conducted for two consecutive rabi seasons (2011-12 to 2012-13) at Rasulpur village of district Auraiya (U P) on farmer field using wheat (U P 262) as the test crop .The experimental soil (0-15 cm) was sandy loam in texture having pH (1:2.5) 8.6, EC 0.3 dSm^{-1} , organic carbon 2.9 g kg^{-1} ,available nitrogen 164 kg ha-^{1}, available P 9.0 kg ha^{-1} and available K 180 kgha^{-1}. The 100% NPK recommended dose of fertilizer for wheat was 120kg N, 60kg P_2O_5 and 30kg K_2O, respectively and 100% FYM was 7.2 t ha^{-1}. The experiment consisted of ten treatments replicated four times in a randomized block design. Treatments were; T_1 control, T_2 N_{120}, T_3 $N_{120,}$ P_{60}, T_4 N_{120} $P_{60}K_{60}$, T_5 100% STR, T_6 100%STR+FYM, T_7 125%STR, T_8 125% STR+FYM, T_9 150%STR, and T_{10} 150% STR+FYM. The recommended FYM dose was incorporated in to soil one month before sowing as per treatment .Total N, P and K contents of the FYM were 0.43, 025 and 0.5%, respectively. Half of the N and entire doses of P and K were applied as basal in the form of urea, diammonium phosphate and muriate of potash, respectively. The remaining N was applied in two equal splits at tillering and flowering initiation stages. Usual crop husbandry operations were followed to raise a good crop. Grain and straw yields were recorded at maturity. The grain and straw samples were analysed for their N content by

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Kjeldahl method. In triacid mixture (HNO_3: H_2SO_4 : $HClO_4$,9:2:1), P and potassium were estimated as per standard procedures (Jacksen 1973). The uptake of nitrogen, phosphorus and potassium was computed by multiplying the yield with the respective nutrient content. pH, EC, organic carbon, available N, P and K in post harvest soil were determind as per standard procedures (Singh *et al.* 2005).

RESULTS AND DISCUSSION

Higher yield response in comparison to N, P and N alone was recorded with balanced application of N, P and K (Table 1.) Application of K along with N P significantly increased the grain yield of wheat over N P alone, emphasizing the essentiality of balanced fertilization to obtain higher productivity. The reduction in available P and K due to omission of these nutrients from the fertilizer schedule might have led to the improper root development, susceptible to lodging, pest diseases, frost etc. leading to deleterious effects on growth and yield of wheat (Verma *et al.*2005). Grain yield of wheat increased significantly with the graded doses of NPK over control with a yield responses of 105 and 94.1% with the application of $N_{120}P_{60}K_{60}$ and 100% STR NPK (120:60:30),respectively. Higher response to the applied N, P and K was expected on this N, P and K deficient soil. The yield of wheat increased significantly by different conbinations of FYM and inorganic fertilizers. Application of FYM based on STR along with 150%STR NPK recorded significantly highest yield response followed by 125% STR NPK+FYM (Table 1.) Highest grain (49.70 q ha^{-1}) and straw (77.52 q ha^{-1}) yields of wheat were obtained in treatment receiving 150%STR NPK along with 10.8 t FYM ha^{-1}. Benefits occurring from the integrated use of FYM with 150%STR NPK might be attributed to better supply of nutrients through incorporation of organic manure along the conductive physical environment leading to better root activities and higher nutrient absorption which resulted in better plant growth and superior yield attributes responsible for higher yield (Selvi *et al.* 2005; Mishra *et al.*2008; Thakur *et al.*, 2011, Singh *et al.* 2014).

Table 1: Effect of various treatments on yield attributes and yields of wheat (mean of 2 years)

Treatment	Tillers/ plant	Panicles/ plant	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Protein grain (%)	Protein straw (%)
Control	3.43	2.76	33.31	20.13	33.20	11.96	4.47
N_{120}	4.90	4.42	36.30	32.33	49.63	12.92	5.15
$N_{120}P_{60}$	5.36	4.54	37.14	38.31	55.56	13.43	5.33
$N_{120}P_{60}K_{60}$	5.75	5.18	41.77	41.62	59.71	14.21	5.44
100%STR	5.45	4.80	41.01	38.84	62.31	14.10	5.28
100%STR+ 7.2 t FYM ha^{-1}	6.50	5.43	43.26	45.12	70.86	15.00	5.57
125%STR	5.93	5.20	42.13	44.88	70.42	14.65	5.50
125%STR+ 9.0 t FYM ha^{-1}	6.88	5.63	45.56	48.70	77.33	15.42	5.88
150%STR	6.74	5.50	44.27	47.32	75.26	14.96	5.72
150%STR+ 10.8 t FYM ha^{-1}	7.62	6.35	44.71	49.70	77.52	15.60	5.96
CD (P = 0.05)	1.16	1.05	1.29	2.90	3.51	1.11	0.62

Protien

The various treatments significantly affected the protein content in grain and straw of wheat (Table 1). The protein content in grain and straw ranged from 11.96 to 15.60% and 4.47 to 5.96%, respectively. The significantly higher proient content in grain (15.60%) and straw (5.96%) was recorded with 150% STR NPK + 10.8t FYM ha^{-1}. The significantly lower protein content in wheat grain and straw was recorded in control. This increase in protein content might be due to the effect of increasing N, P and K content in soil which in turn led to higher root activity and it may increased the absorption and assimilation of nitrogen by plants and encouraged the translocation of nitrogen from vegetation to grain which might indirectly affect protein concentration. The results are in agreement with the findings of Mishra *et al.* (2008) and Chandal *et al.* (2014).

Nutrient Uptake

The uptake of N, P and K by wheat grain and straw increased significantly with different treatments over control (Table 2). Application of N and P either alone or in combination and graded doses of NPK recorded significantly higher N, P and K uptake in grain and straw over control. Application of balanced fertilization of N, P and K recorded significantly higher NPK uptake in comparison to N, P and N alone .The highest NPK uptake (in grain 132.1, 23.0, 39.2 and in straw 73.8, 11.6, 110.2 kg ha^{-1}) were recorded with incorporation of 150% STR + 10.8 t FYM ha^{-1} followed by 125% STR NPK + 9 t FYM

ha^{-1} (128.0, 22.0, 38.0 kg in grain and 74.8, 10.8, 105.1 kg ha^{-1} in straw, respectively). The increases in uptake of nutrients in organic manure treated plots may be due to increased crop yields that resulted in increased uptake. The increase in uptake was directly related to the crops yield. It can be explained on the basis that application of fertilizers alongwith manures improved initial process of plant growth such as cell division, number of root hairs etc., enabling the plant to have healthy root system that helped in better absorption of nutrients and moisture from soil. Similar positive influence of nutrients on crop yields and uptake has also been reported by Thind *et al.* (2007). The lower uptake of N, P and K by crop in control plot is due to the lowest yield obtained in these control plots.

Table 2: Effect of various treatments on nutrient uptake by wheat (mean of 2 years)

Treatment	Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
Control	38.6	23.3	6.4	2.5	17.1	28.3
N_{120}	22.2	40.8	10.1	4.3	24.2	47.4
$N_{120}P_{60}$	88.4	47.5	16.8	5.5	28.9	58.6
$N_{120}P_{60}K_{60}$	101.3	53.5	18.1	6.6	34.4	73.1
100%STR	94.0	51.6	17.0	6.3	29.9	69.4
100%STR+ 7.2 t FYM ha^{-1}	115.5	63.4	20.0	8.5	34.9	88.5
125%STR	116.5	62.0	20.0	8.2	34.8	86.0
125%STR+ 9.0 t FYM ha^{-1}	128.0	74.8	22.0	10.8	38.0	105.1
150%STR	121.1	69.0	21.4	9.8	36.4	97.3
150%STR+ 10.8 t FYM ha^{-1}	132.1	73.8	23.0	11.6	39.2	110.2
CD (P = 0.05)	7.46	4.4	1.32	0.85	5.24	4.37

Soil Properties

The soil p^H decreased from the initial level of 8.6 to 8.3 with the application of inorganic fertilizers alone and to 8.1 with organic manure combined with the inorganic fertilizer (Table 3). This could be due to the movement of Na to lower depths owing to its replacement by Ca, particularly as a result of beneficial effect of FYM. The **s**oil organic carbon of content of the soil increased significantly with the application of FYM along with graded doses of fertilizers (Table 3). Application 150%STR NPK alone showed positive significant effect on organic carbon content of soil. The highest build up of organic carbon content in the soil was recorded under 150% STR doses of NPK + FYM. The mean of organic carbon increased to 4.36g kg^{-1} in organic manure treated plots as compared to that of 2.45g kg^{-1} in inorganic fertilizer treated plots. In contrast, organic carbon declined by 44.8 and 31.0% in treatment receiving 100% STR + FYM and control ,respectively over the initial value. However, organic carbon in plots receiving 125% STR + FYM and 150% STR + FYM increased by 51.7% and 55.1%, respectively. The increase in organic carbon content in manorial treatment combination is attributed to direct addition of organic manure in the soil which is stimulated the growth and activity of micro organisms and also due to better root growth, resulting in the higher production of biomass, crop stubbles and residues (Singh *et al.*2011; Moharana *et al.* 2012).

Table 3: Effect of inorganic and organic sources of nutrients on soil fertility

Treatment	pH (1:2)	EC (dSm^{-1})	Org. C. (g kg^{-1})	Available nutrients (kg ha^{-1})		
				N	P	K
Control	8.4	0.23	2.0	91	7.6	161
N_{120}	8.4	0.22	2.1	142	6.2	156
$N_{120}P_{60}$	8.4	0.22	2.3	168	14.2	158
$N_{120}P_{60}K_{60}$	8.3	0.24	2.3	158	15.1	272
100%STR	8.4	0.23	2.5	146	10.7	227
100%STR+ 7.2 t FYM ha^{-1}	8.1	0.24	4.2	210	20.5	291
125%STR	8.3	0.24	2.6	160	18.8	295
125%STR+ 9.0 t FYM ha^{-1}	8.1	0.23	4.4	215	21.8	313
150%STR	8.4	0.23	2.9	172	19.6	299
150%STR+ 10.8 t FYM ha^{-1}	8.1	0.24	4.5	227	25.2	325
CD (P = 0.05)	0.09	NS	0.06	9.7	0.78	12.3

Available N, P and K

Available N also increased in treatments receiving FYM with 150% STR (Table 3). The results clearly indicate that the FYM helped to increase the available N content of the soil. Increased available N and P by combined use of inorganic and organic fertilizers was also reported by Thind *et al.* (2007). In plots treated with 120 kg N ha^{-1} alone, the available P decreased by 6.2kg ha^{-1} over the initial value (9.0 kg ha^{-1}). Compared to initial value (180 kg ha^{-1}), soil K decreased (158 $kgha^{-1}$) in treatment without the addition of K fertilizer. Available K increased in treatment receiving FYM with 150% STR. The build up of soil available K due to application of FYM may due to the additional K applied through it. Kumar *et al.*(2007) reported that K build up in soil increased due to addition of inorganic, organic manure and bio fertilizers treatments where as these value decreased when fertilizer K, organics and bio fertilizers were not used.

From our study, it can be concluded that there is a need to apply inorganic fertilizers along with FYM to achieve higher yield of wheat. Application of 125% STR NPK + 9 t FYM ha^{-1} can be adopted to sustain the optimum yield potential and enhanced the status of essential nutrients in the soil.

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