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Effect of nitrogen and FYM on yield, quality and uptake of nutrients in wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted at Bichpuri, Agra (U.P.) to study the effect of nitrogen and FYM on yield, quality and nutrient uptake by wheat (Triticum aestivum L.) (emend.Fiori & Paol) for two years (2012-14). The treatments consisted of four levels of each of nitrogen (0, 40, 80 and 120 kg ha^{-1}) and FYM (0, 2.5, 5.0 and 7.5 t ha^{-1}) were evaluated in randomized block design with three replications. Results pooled over two year revealed that yield of wheat increased significantly upto 120 kg N ha^{-1} and 7.5 t FYM ha^{-1} over their respective controls. The results indicated the superiority of integrated use of FYM and fertilizer nitrogen in increasing the productivity of wheat compared to application of fertilizer N alone. Wheat crop responded linearly upto 120 kg N ha^{-1} at FYM levels ranging from 0 to 7.5 t ha^{-1}. The grain and straw yields with the application of 120 kg N ha^{-1} were 5.52 and 7.51 t ha^{-1}, which were significantly higher than 31.1 and 29.9 % over control. The highest grain and straw yields were recorded with 7.5t FYM ha^{-1} followed by 5 t FYM ha^{-1}. Grain and straw yields of wheat were 24.2 and 23.4 % higher with 7.5 t FYM ha^{-1} over control. The content and yield of protein increased significantly with the addition of N upto 120 kg N ha^{-1} Application of 7.5 t FYM ha^{-1} recorded significantly higher content and yield of protein in wheat grain over control. The uptake of N, P, K, S and Cu in wheat crop increased significantly with increasing levels of nitrogen over control. Application of FYM also improved the uptake of nutrients significantly over no FYM. The interaction (N X FYM) had a singnificant beneficial effect on the utilization of nitrogen by wheat grain and straw.

Keywords: Nitrogen, FYM, quality, nutrient uptake, yield, wheat

INTRODUCTION

Wheat (*Triticum aestivum)* is the most important staple food grain crop in Indian diet and main source of protein and calories for a large section of population. There is a stagnation or decline in productivity of wheat as a result of degradation of the soil and water resources and inadequate nutrient management. Nitrogen is one of the major deficient plant nutrients particularly in sandy loam soil of semi-arid region of western Uttar Pradesh. An optimum supply of nitrogen is important for vigorous vegetative growth, chlorophyll formation and carbohydrate utilization. But N use efficiency in cereals is quite low. Conjoint use of inorganic and organic sources of N is recommended to maintain soil and crop productivity. The integrated N management also increased organic carbon content and availability of plant nutrients in soil. Integration of chemical and organic sources and their efficient management have shown promising results not only in sustaining the production but also in maintaining soil health (Singh and Singh 2012). Jat *et al.* (2014) suggested that further improvement in nutrient use efficiency will become possible by balanced use of N, P and K fertilizers and by rational use of organic manures in wheat systems.The role of organic matter is well established in governing the nutrient fluxes, microbial biomass and improvement in soil physical chemical and biological properties. Extra mining of nutrients will have to be resisted in order to maintain the soil health. Maintaining soil health is of utmost important to ensure food and nutritional security of the country. For most efficient use of fertilizers, all nutrients must be used in balance proportion. However, there is a lack of information regarding the performance of FYM and nitrogen in relation to productivity and fertility of soil under wheat cultivation in Agra region of Uttar Pradesh. The present study was undertaken with objective to assess the effect of FYM and nitrogen on wheat crop.

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MATERIAL AND METHODS

A field experiment was conducted during rabi seasons of 2012-13 to 2013-14 at the farmer field of Bichpuri, Agra. At the time of starting the experiment, the sandy loam soil had pH 7.9, organic carbon 3.1 g kg^{-1}, available N 150 kg ha^{-1}, P 10 kg ha^{-1}, K 110 kg ha^{-1}, DTPA Zn 0.54 mg kg^{-1} and Cu 0.22 mg kg^{-1}.The treatments consisted of four levels each of N (0, 40, 80 and 120 kg ha^{-1}) and FYM (0, 2.5, 5.0 and 7.5 t ha^{-1}) were replicated three times in randomized block design wheat was taken as test crop. A basal dose of 60 kg P_2O_5 and 60 kg K_2O ha^{-1} was applied at sowing time through single superphosphate and muriate of potash, respectively. Nitrogen was applied as per treatments through urea. Half dose of nitrogen was applied as basal at the time of sowing and remaining half at two splits. Well decomposed FYM (0.60% N, 0.25% P and 0.54% K) was added to plots as per treatments one week before sowing. The wheat (var. PBW 343) was sown during both the years in first week of November using a seed rate of 100 kg ha^{-1}. The grain and straw yield of wheat was recorded at the time of harvest. Grain and straw samples of wheat were analysed for nitrogen content by Kjeldahl method. The samples were digested with di acid mixture (HNO_3 $HClO_4$) for determming other nutrients. Phosphorus was determined by vanadomolybdate yellow colour method (Jackson 1973), K by flame photometer, S by tubidimetry (Chesnin and yien 1951) and Cu by atomic absorption spectrophotometer. Nutrients uptake by grain and straw was computed as the product of grain and straw yield and their nutrient concentration.

RESULTS AND DISCUSCUSSION

Yield

Wheat yield was significantly affected by nitrogen fertilizer, FYM and their interaction (Table 1). Different levels of N application produced significantly higher wheat grain yield, which increased progressively upto 120kg N ha^{-1}. Application of 120 kg N ha^{-1} recorded higher yield which was significantly higher over other N levels. Stover yield increased under different N levels was significantly higher over control. Straw production showed trend similar to grain yield with higher values recorded with 12.0 kg N ha^{-1}.Grain and straw yield of wheat increased significantly with the application of FYM. The increase in wheat grain yield was 24.2% with application of 7.5 t FYM ha^{-1} over the control. The corresponding increase in straw yield was 23.4%. Increase in yield of wheat was due to steady decomposition of FYM and release of nutrients through out the crop growth period coupled with better assimilation of nutrients (Kumar *et al.* 2015, Singh *et al.* 2016).

Table 1: Effect of nitrogen and FYM levels on yield and quality of wheat crop (mean of two years)

Treatments	Grain yield (t ha^{-1})	% response	Straw yield (t ha^{-1})	Protein content (%)		Protein yield (kg ha^{-1})
				Grain	Yield	
Nitrogen (kg ha^{-1})						
0	4.21	-	5.78	13.00	3.50	547.3
40	4.59	9.0	6.27	13.31	3.68	611.0
80	5.13	21.8	7.00	13.50	3.87	692.5
120	5.52	31.1	7.51	13.62	4.06	751.8
SEm±	0.15		0.21	0.08	0.03	8.13
CD (P=0.05)	0.41		0.57	0.22	0.08	23.85
FYM (t ha^{-1})						
0.0	4.29	-	5.88	13.18	3.62	565.4
2.5	4.70	9.5	6.43	13.31	3.75	625.0
5.0	5.08	18.4	6.98	13.50	3.81	685.2
7.5	5.33	24.2	7.26	13.62	3.94	726.0
SEm±	0.15		0.21	0.08	0.03	8.13
CD (P=0.05)	0.41		0.57	0.22	0.08	23.85

The beneficial effect of FYM on yield was also reported by Singh *et al.* (2013). The significant interaction effect between N and FYM revealed that the application of FYM increased the grain and straw yield of wheat at all the levels of nitrogen (Table 2). However, the effect

of FYM was more effective in increasing the yields at low levels of nitrogen (0 to 40 kg ha^{-1}). Further application of 80 kg N ha^{-1} alongwith 5 t FYM ha^{-1} produced the wheat yields similar to 120 kg N ha^{-1} without FYM, suggesting that FYM supplied 40 kg N ha^{-1} to wheat. Consistent with our results, Singh *et al.* (2013) have also reported a saving of 40 kg N ha^{-1} in wheat with FYM.

Quality

The higher protein content in grain (13.62 %) and straw (4.06%)was obtained with 120 kg N/ha, which was significantly higher than those of 40 and 80 Kg N ha^{-1}. Significant increase in grain nitrogen content with the increase in nitrogen levels could be attributed to more nitrogen uptake by the plant and more translocation of nitrogen to grain. Nitrogen being the precursor of protein increased grain protein content accordingly. Similar results were reported by Singh *et al.* (2016).The protein content in grain and straw significantly improved with FYM application over control. Kumar and Singh (2013) also reported similar results. Increasing levels of N from 0 to 120 kg ha^{-1} increased the protein production significantly over control. The maximum protein yield (751.8 kg ha^{-1}) was accrued with 120 kg N ha^{-1}. The increase in protein yield may be attributed to increased grain yield and improvement in protein content due to N application. Similar results were reported by Singh *et al.* (2016). The protein production in wheat grain also increased significantly with FYM application over control. The protein yield ranged from 565.4 kg ha^{-1} at control to 726.0 kg ha^{-1} with 7.5 t FYM ha^{-1}.Kumar and Singh also reported similar results.

Table 2: Interaction effect of FYM and nitrogen on grain and straw yield of wheat (mean of two years)

FYM (t ha^{-1})	Nitrogen (kg ha^{-1})			
	0	40	80	120
Grain yield (t ha^{-1})				
0.0	3.61	3.97	4.58	5.00
2.5	4.03	4.45	4.95	5.38
5.0	4.47	4.87	5.39	5.75
7.5	4.71	5.06	5.60	5.97
SEm±		0.30		
CD (P=0.05)		0.82		
Straw yield (t ha^{-1})				
0.0	4.98	5.44	6.26	6.85
2.5	5.56	6.14	6.73	7.31
5.0	6.15	6.62	7.33	7.82
7.5	6.45	6.88	7.67	8.06
SEm±		0.42		
CD (P=0.05)		1.14		

Nutrient uptake

Nitrogen application had a significant beneficial effect on nitrogen uptake by wheat crop (Table 3). With the successive increase in N levels from 0 to 120 kg N ha^{-1}, the uptake of nitrogen in grain and straw increased significantly. Application of 120 kg N ha^{-1} registered 38.5 and 51.0 % higher uptake of nitrogen in grain and straw, respectively over control (Singh *et al.* 2013).Nitrogen uptake by wheat grain and straw increased significantly with the application of FYM from 0 to 7.5 t ha^{-1}. The increase in N uptake may be due to mineralization of N from FYM which sufficiently meet the nutrient requirement of the crop. Similar results were reported by Kumar and Singh (2013) in wheat and Singh *et al.* (2016) in oat.The significant interaction between FYM and nitrogen levels (Table 4) indicated that the maximum uptake of nitrogen by wheat grain and straw was recorded under 7.5 t FYM x 120 kg N ha^{-1}. The minimum value of N uptake by wheat crop was recorded under no FYM and no nitrogen treatment. Similar results were reported by Singh *et al.* (2013).

Table 3: Effect of nitrogen and FYM on uptake of N, P, K, S (kg ha^{-1}) and Cu (g ha^{-1}) by wheat crop (mean of 2 years)

Treatment	Nitrogen		Phosphorus		Potassium		Sulphur		Copper	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Nitrogen (kg ha^{-1})										
0	87.6	32.3	7.6	5.2	20.2	109.8	6.7	5.2	43.7	35.2
40	97.7	37.0	9.2	6.3	23.0	120.3	7.8	6.2	48.6	39.5
80	111.3	43.4	10.7	8.4	27.1	136.5	9.7	8.4	54.8	45.5
120	121.4	48.8	12.6	9.7	30.3	148.0	11.5	9.7	58.0	48.0
SEm±	3.10	1.50	0.45	0.30	1.06	3.65	0.24	0.25	1.45	1.11
CD (P=0.05)	8.90	4.30	1.20	0.82	2.90	9.96	0.65	0.68	3.96	3.03
FYM (t ha^{-1})										
0.0	90.5	34.1	8.1	5.9	21.4	112.3	7.7	5.9	45.0	36.4
2.5	100.1	38.5	9.4	7.1	24.0	124.0	8.9	7.0	49.8	41.1
5.0	109.7	42.2	10.6	7.7	26.4	136.1	10.1	8.4	50.2	45.4
7.5	116.2	45.3	11.7	8.7	28.7	142.2	11.2	8.7	57.0	47.2
SEm ±	3.10	1.50	0.45	0.30	1.06	3.65	0.24	0.25	1.45	1.11
CD (P=0.05)	8.90	4.30	1.20	0.82	2.90	4.96	0.65	0.68	3.96	3.03

The P uptake by grain and straw of wheat increased significantly with nitrogen application over control. Improvement in P uptake by wheat crop with N levels may be due to the increase in grain and straw yield and P content. Similar results were reported by Jaga *et al.* (2017). Application of 7.5t FYM ha^{-1} increased the P uptake by grain and straw significantly over control. The increase in P uptake with FYM application might be due to mineralization of organic P contained in FYM resulting in its increased availability to the crop. Increased availability of P encouraged proliferation of roots resulting in more absorption of water and nutrients from larger area and soil depth. Singh *et al.* (2016) also reported similar results in oat.

Significant improvement in K uptake by grain and straw of wheat was observed with each increment of N applied upto 120 kg N ha^{-1}. The K uptake by grain and straw increased from 20.2 to 30.3 kg ha^{-1} and from 109.8 to 148.0 kg ha^{-1}, respectively due to the application of 120 kg N ha^{-1}. The increase in K uptake by the crop may be attributed to the improvement in available K status in soil due to N application. (Singh *et al.* 2013).The uptake of K by wheat crop improved significantly with FYM addition over control. The uptake of K by wheat grain and straw ranged from 21.4 to 28.7 kg ha^{-1} and 112.3 to 142.2 kg ha^{-1} with 7.5t FYM application. Application of FYM to soil might increase the availability of K to crop by improving K nutrition either by supplying K directly or by mobilizing strongly held K in soil. Singh *et al.* (2013) and Singh *et al.* (2016) also reported a beneficial effect of FYM addition on the utilization of K by wheat and oat crop, respectively.

Table 4: Interaction effect of FYM and nitrogen on uptake of N by grain and straw of wheat (mean of 2 years)

FYM (t ha^{-1})	Nitrogen (kg ha^{-1})			
	0	40	80	120
N uptake by grain (kg ha^{-1})				
0.0	74.0	82.9	98.0	108.0
2.5	83.4	94.3	106.9	117.8
5.0	92.9	104.7	118.0	127.6
7.5	99.8	109.8	123.2	133.7
SEm±		6.20		
CD (P=0.05)		17.80		
N uptake by straw (kg ha^{-1})				
0.0	26.8	30.4	36.9	42.4
2.5	31.1	35.6	41.0	46.7
5.0	35.0	39.7	46.1	51.6
7.5	37.4	41.9	49.8	54.8
SEm±		3.00		
CD (P=0.05)		8.60		

Application of nitrogen from 0 to 120 kg ha^{-1} increased the S and Cu uptake by wheat grain from 6.7 to 11.5 kg ha^{-1} and 43.7 to 58.0 g ha^{-1} respectively. The corresponding increases in S and Cu uptake by wheat straw were from 5.2 to 9.7 kg ha^{-1} and 35.2 to 48.0 g ha^{-1} (Table 3). This might be due to the increase in yield as well as S and Cu content in wheat grain and straw.Successive increase in FYM level from 0 to 7.5 t ha^{-1} increased the S uptake from 7.7 to 11.2 kg ha^{-1} in grain and from 5.9 to 8.7 kg ha^{-1}

in straw. The corresponding increases in copper uptake by grain and straw were from 45.0 to 57.0 g ha^{-1} and 36.4 to 47.2 g ha^{-1}.This increase might be due to the fact that FYM supply S and Cu to soil. Similar results were reported by Kumar and Singh (2013).

From the results of present investigation, it may be concluded that the application of FYM and nitrogen increased the grain and straw yield and protein content in wheat crop. Application of 7.5 t FYM and 120 kg N ha^{-1} gave the maximum values of yield, protein content and utilization of nutrients in wheat under agro-climatic conditions of Agra region.

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