



Growth, yield and nutrient uptake by wheat (*Triticum aestivum*) as affected by biofertilizers, FYM and nitrogen

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ABSTRACT

A field experiment was conducted during the winter (*rabi*) season of 2006–07 and 2007–08 to study the effect of biofertilizers, farmyard manure (FYM) and nitrogen levels on performance of wheat (*Triticum aestivum* L emend Fiori & Paol.) at Bichpuri, Agra. Seed inoculation with *Azotobacter* and *Azospirillum* significantly increased the plant height, dry matter, yield attributes and yield of wheat over no inoculation. However, both were at par with respect to above-mentioned parameters. Higher mean grain yield of 4.443 tonnes/ha was recorded with 10 tonnes FYM/ha, which was 9.1 and 26.3% more than 5 tonnes FYM/ha and control, respectively. Application of 120 kg N/ha increased the growth, yield attributes and yield of wheat. The mean grain yield increased by 8.1 and 22.4% with the application of 120 kg N/ha compared with 90 and 60 kg N/ha, respectively. The uptake of N, P and K by wheat grain and straw also showed increasing tendency due to the treatments. Addition of these inputs showed positive changes in available N content of the soil. Available P and K content also increased due to FYM and nitrogen application. Biofertilizers did not influence the available K status of the soil.

Key words: Biofertilizers, FYM, Growth, Nitrogen, Nutrient uptake, Yield, Wheat

Wheat (*Triticum aestivum* L emend Fiori & Paol.) is an exhaustive feeder and requires substantial amount of nutrients for higher productivity. Nitrogen is costly input and a major share of it is used for cereal cultivation. The cost of nitrogen fertilizers is increasing day by day. Under such a situation, suitable alternative nutrient combinations are to be evaluated. Biofertilizers are low cost and eco-friendly inputs and have tremendous potential for supplying nutrients, which can reduce the chemical fertilizer dose by 25-50% (Vance 1997 and Rana *et al.* 2012). FYM is a good source of nutrients and contributed towards build up of organic matter in soil (Das *et al.* 2008). Nitrogen is an indispensable element for optimum functioning of crops (Shivay 2007). The increase in eco-friendly production of wheat can be made possible by widespread adoption of improved technologies of which fertilizer management particularly that of nitrogen through bio-fertilizers and organic manure can play a key role. Hence, present investigation was carried out to study the growth, yield and nutrient uptake behavior of wheat to define optimum dose under integrated use of bio-fertilizers, FYM and nitrogen.

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MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) seasons of 2006–07 and 2007–08 on an Inceptisol at R B S College Farm, Bichpuri, Agra. The important soil properties of the field were: pH 7.8, organic carbon 3.4 g/kg soil, available N 190 kg/ha, available P 8.0 kg/ha and available K 175 kg/ha. Treatments consisted of no inoculation, *Azotobacter* and *Azospirillum*, three levels each of FYM (0, 5 and 10 tonnes/ha) and nitrogen (60, 90, and 120 kg/ha). These treatment combinations were replicated thrice in a split plot design having FYM and biofertilizers in main plots and nitrogen in sub-plots. The levels of nitrogen and FYM were applied as per treatments. Wheat seeds were inoculated with *Azotobacter* and *Azospirillum* culture as per treatments. Recommended doses of P and K were applied through single superphosphate and muriate of potash, respectively. The wheat variety PBW 343 was sown on 20 November in both the years using 100 kg seed/ha. Appropriate management practices were adopted to raise the crop. Grain and straw yields were recorded at harvest of the crop. Samples were analysed for N, P and K by adopting standard procedures (Prasad *et al.* 2006). The available N, P and K status of soil after harvest of the crop was estimated by standard methods (Jackson 1973).

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

Treatment	Plants Height (cm) at harvest	Number of tillers/m at harvest	Dry matter at harvest (g/plant)	Grain wt(g)/ plant	1 000-grains wt (g)	Yield (tonnes/ha)			
						2006-07		2007-08	
						Grain	Straw	Grain	Straw
<i>Biofertilizers</i>									
No inoculation	84.20	114.00	50.59	3.87	51.18	3.961	5.309	3.826	5.124
<i>Azotobacter</i>	86.90	119.40	51.93	4.45	52.18	4.099	5.607	4.056	5.699
<i>Azospirillum</i>	86.20	117.80	51.73	4.30	51.90	4.084	5.553	4.044	5.658
SEm±	0.31	0.89	0.34	0.15	0.11	0.031	0.042	0.075	0.101
CD (P=0.05)	0.88	2.46	0.97	0.42	0.33	0.086	0.117	0.210	0.282
<i>FYM (tonnes/ha)</i>									
0	82.60	109.00	46.93	3.42	49.72	3.549	4.879	3.490	4.806
5	85.00	117.60	48.68	3.97	51.89	4.120	5.635	4.025	5.469
10	89.70	118.50	58.64	5.23	53.64	4.475	6.088	4.411	5.995
SEm±	0.31	0.89	0.34	0.15	0.11	0.031	0.042	0.075	0.101
CD (P=0.05)	0.88	2.46	0.97	0.42	0.33	0.086	0.117	0.210	0.282
<i>Nitrogen (kg/ha)</i>									
60	81.30	106.00	45.11	2.89	44.86	3.623	5.005	3.572	4.854
90	85.60	118.10	49.28	4.13	52.29	4.140	5.586	4.009	5.449
120	90.40	126.90	59.87	5.60	58.11	4.464	6.011	4.345	5.904
SEm±	1.22	1.34	0.47	0.24	0.29	0.028	0.044	0.051	0.105
CD(P=0.05)	3.42	3.69	1.34	0.68	0.82	0.077	0.121	0.141	0.290

RESULTS AND DISCUSSION

Growth characters

Plant height, number of tillers and dry matter accumulation at harvest were significantly increased with application of *Azotobacter* and *Azospirillum* over no inoculation (Table 1). This might be partly owing to their additive effect of nitrogen fixed from the atmosphere and partly owing to synthesis of biologically active substances like vitamins, auxin and gibberellin etc, which in turn might have stimulated the plant growth parameters. These results are akin to the findings of Kachroo and Razdan (2006). The growth parameters such as plant height, number of tillers and dry matter production were significantly higher with FYM application. At harvest, 10 tonnes of FYM/ha recorded the higher value (89.7 cm) of plant height, which was 4.7 and 7.1 cm more than that recorded with the 5 tonnes of FYM/ha and control, respectively. Application of 10 tonnes FYM/ha produced more number of tillers (118.5/m) and dry matter (58.64 g/plant), which were 0.9 and 9.5 tillers/m and 9.96 and 11.71 g/plant dry matter higher than those obtained with 5 tonnes FYM/ha and control, respectively. Application of nitrogen significantly increased the growth parameters. Application of 120 kg N/ha produced significantly taller plants, more number of tillers and dry matter than all other levels of nitrogen. Similar results were reported by Singh and Yadav (2006).

Yield attributes

The yield attributes, viz. grain weight/plant and 1 000-grains weight was significantly increased with inoculation of *Azotobacter* and *Azospirillum* over no inoculation (Table 1). Similar results were reported by Kachroo and Razdan (2006). FYM application increased the yield attributes, viz. grain weight/plant and 1 000-grains weight (Table 1). The mean values of grain weight/plant were 31.7 and 52.9% and 1 000-grains weight were 3.4 and 7.9% higher with application of 10 tonnes FYM/ha than 5 tonnes FYM and no FYM treatment, respectively. These higher values might be due to increased leaf area index and better growth and development, where the plant got good opportunity for nutrients uptake which resulted in higher plant growth and development as well as yield attributes. Singh and Yadav (2006) also reported similar findings. Application of 120 kg N/ha produced 35.6 and 93.8% more grain weight/plant and 11.13 and 29.5% more 1 000-grains weight than that of 90 kg and 60 kg N/ha, respectively. Higher level of N improved the fertility level of soil and created congenial condition for better growth and development of plants, and thus improved the yield attributes. These results are in conformity with those reported by Singh and Yadav (2006).

Yield

Data showed that the grain and straw yields of wheat increased significantly with inoculation of bio-fertilizers and

maximum yield was recorded with *Azotobacter* inoculation (Table 1). The increases in grain yield due to *Azotobacter* inoculation were 0.138 and 0.230 tonnes/ha over no inoculation in first and second year, respectively. However, both the bio-fertilizers were at par with respect to grain and straw yield production in both the years. The increase in yield might have resulted from the growth regulating substances produced by biofertilizers besides fixation of additional nitrogen from atmosphere thereby, increasing nitrogen availability in the soil throughout the crop growth. Kachroo and Razdan (2006) also reported similar results. Application of FYM @ 5 and 10 tonnes/ha increased the grain and straw yield significantly by 16.1 and 15.5% and 26.1 and 24.8%, respectively over no FYM during 2006–07. The corresponding increases in grain and straw yield during 2007–08 were 15.3 and 13.8% and 26.4 and 24.7%. The improvement in grain and straw yield with the application of FYM was owing to the beneficial effect of FYM on nutrient uptake, crop growth rate and yield attributing components. Singh and Agarwal (2004) also reported higher yield of wheat with increasing dose of FYM. Application of 120 kg N/ha gave significantly higher grain and straw yield over that of 60 and 90 kg N/ha during both the years. The highest grain yield of 4.464 and 4.345 tonnes/ha was produced with 120 kg N/ha, showing an increase of 23.2 and 7.8% in 2006–07 and 21.6 and 8.4% in 2007–08 over 60 and 90 kg N/ha, respectively. Application of 120 kg N/ha gave straw yield of 6.011 and 5.904 tonnes/ha, registering an increase of 20.1

and 7.6% in 2006–07 and 21.6 and 8.4% in 2007–08 compared with those of 60 and 90 kg N/ha, respectively. The increase in grain and straw yields due to increase in level of N might be due to the fact that nitrogen fertilizer pushed up the removal of nutrients and water enhanced the photosynthesis and translocation of assimilates from source to sink. Singh and Yadav (2006) also reported an increase in grain and straw yields due to N application.

Uptake of nutrients

Inoculation of biofertilizers increased the N uptake by grain and straw yields significantly over no inoculation treatment, which might be because of better growth and development of the plant and adequate N availability in the soil (Table 2). However, higher values of N uptake by the crop were noted with *Azospirillum* inoculation than that of *Azotobacter*. Application of 5 and 10 tonnes of FYM/ha augmented nutrient uptake by grain by 10.9 and 33.0% N, 34.1 and 56.8% P and 25.3 and 44.4% K, respectively compared with no FYM. The corresponding increases in nutrient uptake by straw were 9.5 and 24.8% N, 29.1 and 51.5% P and 13.3 and 32.5% K. The increase in nutrient uptake with FYM was due to increased availability of nutrients to the plants. It also improved the soil environment, which encouraged profuse rooting system, resulting in better absorption of moisture and nutrient and thus resulting in higher biomass production. Similar results were reported by Singh and Agarwal (2004). Application of 120 kg N/ha

Table 2 Effect of various treatments on uptake of nutrients by the crop and status of available nutrients in soil after harvest (mean of two years)

Treatment	Nutrient uptake (kg/ha)						Available nutrients (kg/ha)		
	Nitrogen		Phosphorus		Potassium		N	P	K
	Grain	Straw	Grain	Straw	Grain	Straw			
<i>Biofertilizers</i>									
No inoculation	91.70	33.9	5.3	12.1	23.4	102.5	205.6	9.9	172.7
<i>Azotobacter</i>	103.20	37.8	5.9	13.6	24.6	111.9	212.7	10.2	173.2
<i>Azospirillum</i>	109.90	39.2	5.8	13.7	24.4	111.5	211.1	10.1	173.5
SEm±	1.28	0.68	0.24	0.22	0.44	1.39	1.70	0.14	0.95
CD (P=0.05)	3.60	1.90	NS	NS	NS	3.89	4.90	NS	NS
<i>FYM (tonnes/ha)</i>									
0	86.0	32.6	4.4	10.3	19.8	93.2	181.0	8.1	159.8
5	103.2	35.7	5.9	13.3	24.8	109.0	213.5	10.4	172.5
10	114.4	40.7	6.9	15.6	28.6	123.5	235.0	12.7	187.3
SEm±	1.28	0.68	0.20	0.22	0.44	1.39	1.70	0.14	0.95
CD (P=0.05)	3.60	1.90	0.68	0.61	1.23	3.89	4.90	0.39	5.30
<i>Nitrogen (kg/ha)</i>									
60	86.8	31.3	4.3	10.5	21.2	96.1	186.6	8.9	165.9
90	102.7	37.3	5.9	13.2	24.9	109.3	201.3	10.4	173.7
120	116.1	42.4	7.0	15.5	27.5	119.4	241.6	12.1	180.0
SEm±	0.90	0.43	0.24	0.21	0.38	1.30	2.50	0.18	2.20
CD (P=0.05)	2.49	1.20	0.66	0.58	1.05	3.61	7.10	0.51	6.30

recorded maximum nitrogen uptake by grain and straw, which increased by 33.8 and 35.5%, respectively over 60 kg N/ha. It might be because nitrogen uptake is directly correlated with yield. Increased yield ultimately resulted in higher uptake. The P and K uptake by grain and straw increased significantly with N application. The P and K uptake by grain increased by 62.8% and 29.7% with 120 kg N/ha over 60 kg N/ha, respectively. The corresponding increases in P and K uptake by straw were 47.6 and 24.2%. Improvement in P and K uptake with N levels was due to the increase in grain and straw yield and P and K content. Singh and Agrawal (2004) also observed increase in N, P and K uptake by N application.

Soil fertility

Significantly higher available nitrogen content was recorded in the soil when bio-fertilizers were applied as culture to wheat seed compared to no inoculation treatment. The increase was owing to enhanced nitrogen content in soil due to inoculation of biofertilizers. However, available P and K contents did not show significant variation due to bio-fertilizers. The data (Table 2) revealed significant increase in available N, P and K status of soil up to 10 tonnes of FYM/ha. The use of FYM for improving the fertility status of soil has been in practice for a long time. The FYM in addition to being a store house of almost all the nutrients required for plant growth improved the soil environment by way of improving the physio-chemical properties of soil. Thus, on addition of FYM, the available nutrient status of soil increased considerably due to mineralization of native as well as applied nutrient through fertilizers in addition to its own nutrient content. Similarly, at higher doses of nitrogen application, the available N content in the soil was observed to be higher than lower doses of nitrogen, which might be due to considerable gain of nitrogen content in the soil with its

addition. The available P and K contents in the soil were influenced significantly by the varying nitrogen doses. The maximum values of these nutrients were noted at 120 kg N/ha indicating beneficial effect of N on their availability.

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