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Influence of farmyard manure, nitrogen and biofertilizers on growth, yield attributes and yield of wheat (*Triticum aestivum*) under limited water supply

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ABSTRACT

An experiment was conducted during the winter season (*rabi*) 1994–95 and 1995–96 at New Delhi, on integrated nitrogen management in wheat (*Triticum aestivum* L. emend. Fiori & Paol.) Application of farmyard manure (FYM) increased the growth, yield and water-use efficiency of wheat. Application of N up to 90 kg/ha also boosted the growth and yield of wheat. An application of FYM recorded the saving of 45 kg N/ha. Both biofertilizers, azospirillum and azotobacter proved effective in enhancing the growth and yield of wheat.

Key words : Wheat, Farmyard manure, N, Biofertilizers, Yield, Water

Nitrogen management is one of the major factors to attain higher productivity of wheat, particularly under limited water supply, where use of higher dose of inorganic fertilizers is restricted. Under such conditions, integration of various sources of nitrogenous fertilizers is more appropriate because this not only reduces the use of inorganic fertilizers but is also an environmental friendly approach. Hence an experiment was conducted to study the effect of FYM, doses of N and biofertilizers on growth, yield and water-use efficiency of wheat and to work out the economic optimum dose of N for wheat grown with limited water supply.

MATERIALS AND METHODS

An experiment was conducted during the winter season of 1994–95 and 1995–96 at New Delhi. Treatment combinations of 2 levels of FYM (no FYM and 10 tonnes FYM/ha) and 3 doses of N (0,45 and 90 kg/ha) formed the main plots and 4 combinations of biofertilizers (no biofertilizers, seed inoculation with azospirillium, azotobacter and azospirillium + azotobacter) were assigned to the sub-plots. The experiment was laid out in split-plot design with 3 replications. The soil

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was sandy loam having low organic carbon (0.33%) and medium available phosphorus (23.0 kg/ha) and potassium (285.0 kg/ha) with pH 7.1. Field capacity, permanent wilting point and apparent specific gravity up to 30 cm depth were 19.85%, 6.80% and 1.54 g/cc respectively. 'Kundan' wheat was sown on 6 December and 24 November in respective seasons at 25 cm distance in rows. A uniform dose of 30 kg/ha, each of phosphorus and potassium were incorporated into the soil before sowing through single superphosphate and muriate of potash respectively. Half of N was applied at the time of sowing and remaining after the first irrigation through urea. As per treatments, FYM was incorporated into the soil, 23 and 21 days before sowing in respective years. The *Azospirillum brasilense* and *Azotobacter chroococcum* strains specific to wheat were used to inoculate the seeds as per treatments. In 2 seasons crop was given 2 irrigations, one each at crown-root initiation and flowering stages. The crop was harvested on 16 and 18 April in respective seasons.

RESULTS AND DISCUSSION

Farmyard manure

Application of FYM resulted into taller plants and more number of tillers (Table 1). This might be due to improved fertility status and better utilization of nutrients by wheat. This caused to increase in yield-attributing characters (Table 1) and ultimately yield of wheat. On an average, FYM application resulted in 7.9 q/ha additional grain yield over the control (Table 2). Similar effect of FYM application was observed on straw yield and harvest index of wheat (Table 2). Our results corroborate the findings of Azad *et al.* (1998).

Nitrogen

Application of N significantly increased the plant height and tiller production in wheat. Significant increase in tillers were recorded up to 90 kg N/ha in both the years (Table 1). Nitrogen, being an important constituent of amino acids, proteins and protoplasts, directly influences plant growth and development through better utilization of photosynthates.

Application of N up to 90 kg/ha increased the grain yield (Table 2) significantly by increasing yield attributes, e.g. number of spikes, length of spike, grain weight/spike (Table 1). However, 1,000-grain weight of wheat was significantly increased up to 45 kg N/ha (Table 1). Increased number of ears/m with higher doses of N might be due to stimulatory effect of N on tillering through cytokinin synthesis resulting in more number of tillers. More accumulation of photosynthates in ears might have increased the length of spike. Adequate supply of N might have caused increase in grains/spike. Higher dose of N resulted in higher accumulation of photosynthates and also increased grains/spike. This resulted in relatively lesser accumulation of photosynthates in individual grain and thereby failed to increase the 1,000-grain weight at higher level of N.

Application of N up to 90 kg/ha also increased the straw yield and harvest index (Table 3). However, significant increase in straw yield in 1994–95 was recorded up to

Table 1. Effect of FYM, nitrogen and biofertilizers on growth and yield attributes of wheat

Treatment	Plant height (cm)		Total tillers/m		Spikes/m		Length of spike (cm)		Grains/spike		1,000-grain weight (g)	
	1994–95	1995–96	1994–95	1995–96	1994–95	1995–96	1994–95	1995–96	1994–95	1995–96	1994–96	1995–96
Farmyard manure												
No FYM	74.5	77.4	58.2	69.2	44.9	54.9	8.79	9.70	31.2	34.4	35.02	39.08
FYM	79.4	81.4	66.3	78.5	54.7	64.4	10.29	11.67	37.7	40.3	36.22	40.28
CD (P=0.05)	3.2	3.6	2.2	3.0	1.4	1.4	0.23	0.27	1.1	1.1	NS	0.95
Nitrogen (kg/ha)												
0	72.1	73.5	52.6	63.5	39.6	44.0	7.99	8.61	28.8	32.2	32.63	35.41
45	77.5	80.5	63.8	74.5	50.5	63.0	9.65	10.86	34.5	37.3	36.05	1.33
90	81.5	84.0	70.4	83.7	60.2	72.2	10.99	12.56	40.1	42.5	38.17	42.31
CD (P=0.05)	4.0	4.4	2.7	3.7	1.7	1.7	0.29	0.34	1.3	1.4	2.15	1.17
Biofertilizer												
Control	75.0	76.1	58.6	68.1	45.7	53.5	8.82	9.74	31.7	34.8	34.35	38.37
Azospirillum (Azos)	77.6	79.9	63.5	75.0	49.5	61.5	9.45	10.51	34.0	37.2	35.73	40.33
Azotobactor (Azot)	77.3	79.4	61.6	73.6	48.8	60.4	9.39	10.38	33.1	36.7	35.31	39.62
Azos + Azot	78.3	82.1	65.5	78.9	52.1	64.4	9.77	10.98	35.3	38.3	36.89	41.07
CD (P = 0.05)	NS	4.7	4.0	4.5	2.4	2.6	0.41	0.44	1.8	1.8	2.20	1.62

Table 2. Grain and straw yields and harvest index of wheat as affected by FYM, nitrogen and biofertilizers

Treatment	Grain yield (q/ha)			Straw yield (q/ha)			Harvest index	
	1994–95	1995–96	Pooled	1994–95	1995–96	Pooled	1994–95	1995–96
Farmyard manure								
No FYM	26.0	32.9	29.5	43.8	48.4	46.1	37.2	40.4
FYM	32.2	42.6	37.4	47.7	52.4	50.0	40.3	44.8
CD (P = 0.05)	1.8	2.2	2.1	2.9	3.4	3.1	1.2	1.4
Nitrogen (kg/ha)								
0	20.9	27.3	24.1	38.9	43.7	41.3	34.9	38.4
45	31.5	40.1	35.8	47.0	52.5	49.7	39.3	42.6
90	35.0	45.9	40.5	49.4	57.2	53.3	42.1	45.0
CD (P=0.05)	2.1	2.7	2.6	3.4	4.1	3.9	1.5	1.5
Biofertilizer								
Control	26.5	33.8	30.2	44.9	49.6	47.3	37.1	40.5
Azospirillum (Azos)	29.6	38.9	34.3	46.8	52.2	49.5	38.7	42.7
Azotobactor (Azot)	29.6	38.1	33.5	48.4	51.8	49.6	38.0	42.3
Azos+Azot	31.2	39.9	35.5	49.4	53.8	51.6	39.2	42.5
CD (P=0.05)	2.2	2.7	2.6	3.2	3.8	3.5	2.0	NS

45 kg N/ha only.

Biofertilizers

An application of biofertilizers significantly increased the plant height in 1995–96 and tillers/m length in both the years (Table 1). Among biofertilizers, azospirillum proved more effective as number of tillers in 1994–95 were not increased due to azotobacter. Biofertilizers also significantly increased the yield attributes (spikes/m, length of spike and grains/spike) in 2 years over the control (Table 1). Both the biofertilizers remained at par but their combined application significantly improved these parameters except length of spike in 1994–96. The 1,000-grain weight was also increased by biofertilizers but differences were significant due to combined application of both biofertilizers in 1994–95 and due to azospirillum in 1995–96 (Table 1).

Increase in the growth and yield attributes of wheat increased the grain and straw yields due to biofertilizers. Both the biofertilizers being at par significantly increased the grain yield (Table 2). Combined application of 2 biofertilizers did not bring further improvement in grain yield over their individual application. On an average, azospirillum and azotobacter increased the grain yield by 13.6 and 11.0% over untreated plots. Azotobacter increased the straw yield in 1994–95, whereas in 1995–96, only combined application of both the biofertilizers increased the straw yield significantly over the control (Table 3). However, this remained at par with their individual application. Biofertilizers failed to increase harvest index of wheat significantly over the control except in 1994–95 where combination of azospirillum and azotobacter produced significantly higher harvest index over the control. Increase in yield attributes and yield of wheat with biofertilizers might be due to increased supply of plant hormones (auxin, cytokinin, gibberillins) by the microorganizms or by roots as a result of reaction to microbial colonization as also reported by Avivi and Feldman (1982). Sushila (1998) also reported increase in microbial population in the rhizosphere of wheat with both biofertilizers inoculation.

Interaction

Interaction between FYM and nitrogen doses was also observed on grain yield (Table 3). The grain yield without FYM increased significantly up to 90 kg N/ha, whereas with FYM response was recorded up to 45 kg N/ha only as increase in yield

Table 3. Interaction effect of FYM and nitrogen on grain yield (q/ha) of wheat

Nitrogen (kg/ha)	1994–95		1995–96		Pooled	
	No FYM	FYM	No FYM	FYM	No FYM	FYM
0	16.8	24.9	20.9	33.5	18.9	29.3
45	28.1	34.9	34.7	45.3	32.2	40.2
90	33.1	37.1	42.9	48.7	37.3	42.9
CD (P = 0.05)	3.1		3.9		3.7	

due to 90 kg N/ha was not significant. The grain yield with FYM at 0 and 45 kg N/ha was statistically at par with that of 45 and 90 kg N/ha respectively without FYM.

Response and economic nitorgen dose

The relationship between levels of N and grain yield as influenced by FYM application indicated that wheat responded linearly to N without FYM whereas with FYM response was quadratic. The economic optimum dose of N for wheat with FYM was 75.9, 81.7 and 78.2 kg/ha in respective years and in pooled data. The return/rupee invested on N was worked out to be Rs 8.76, 10.16 and 9.49 in 2 years and pooled data respectively.

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