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Effect of nitrogen, FYM and biofertilizer on dry matter accumulation, yield and NPK removal by cotton

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Abstract : An experiment was conducted during 2001 and 2002 at IARI, New Delhi, under irrigated condition to study the effect of nitrogen, Farm Yard Manure (FYM) and biofertilizers on dry matter accumulation, yield and NPK removal by cotton (*Gossypium hirsutum* L). The results indicated considerable improvement in dry matter accumulation, lint, seed cotton and stalk yield and NPK removal by cotton with addition of higher doses of fertilizer N. Individual application of *Azotobacter* and mahaagrozyme failed to influence the dry matter accumulation, yield and NPK removal significantly. The performance of cotton with FYM @ 12 t ha^{-1} was found to be intermediate between 30 and 60 kg N ha^{-1}. Highest dry matter accumulation, yield and NPK removal was observed with integrated application of 30 kg N and FYM @ 12 t ha^{-1} along with *Azotobacter* (M_4).

Key words : Cotton, Nitrogen, Azotobacter, Mahaagrozyme, Farm yard manure, NPK removal.

Introduction

Despite having the largest acreage under cotton (*Gossypium hirsutum* L) - 25 per cent of the global cotton area - India ranks third among the world's cotton producing countries, accounting for a mere 12.3 per cent of global cotton production. This compares poorly with China (22 per cent) and the U.S. (19.4 per cent). Indian cotton fields have the lowest yields - around 300 kg lint per hectare against the world average of 580 kg ha^{-1} (Smetacek, 2003). Imbalanced use of organic and inorganic fertilizer and poor agronomic practices besides other factors are mainly responsible for low productivity. A sound integrated nutrient management strategy is therefore, essential for achieving higher productivity on sustainable basis.

Dry matter accumulation is an important factor in crop husbandry in order to increase the aggregate productivity of crop. The vegetative growth of crop has a direct effect on the reproductive phase. Similarly nutrient needs of crop plant is essential for useful understanding and assessment of applied nutriet on total crop performance. Direct effect of nitrogen on dry matter production, yield and NPK removal by cotton was reported by a number of researchers (Mayilasamy and Iruthayaraj, 1980 and Prasad, 1998).

Mahaagrozyme is a multipurpose biotechnology product used as a biostimulant and biofertilizer marketed by Maharashtra Insecticides Ltd. It is not a substitute for fertilizers; however, it could be used for better utilization of available nutritional elements. It is needed to be experimented in the field conditions. Present experiment is aimed to study the effect of nitrogen, FYM and biofertilizers on the performance of cotton.

Materials and Methods

Field experiment was conducted at Indian Agricultural Research Institute, New Delhi during

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Table 1. Effect of nitrogen, FYM and biofertilizer on dry matter accumulation (g plant $^{-1}$) of cotton

Treatments	60 DAS		90 DAS		120 DAS		150 DAS	
	2001	2002	2001	2002	2001	2002	2001	2002
Control	44.7	46.6	88.8	89.1	136.9	141.6	154.6	169.7
30 Kg N ha $^{-1}$	48.2	51.4	100.2	102.1	151.4	157.8	173.2	189.2
60 Kg N ha $^{-1}$	52.6	56.7	108.7	112.6	163.0	170.8	189.8	205.7
Azotobacter (Az.) M_4	45.2	48.1	92.4	92.9	141.0	148.9	159.4	174.4
Azotobacter (Az.) M_5	44.7	47.7	90.9	91.2	138.9	146.8	158.4	172.2
FYM	47.8	51.2	101.5	107.9	153.3	162.7	178.8	193.0
30 Kg N ha $^{-1}$ Az.M_4	49.9	52.6	103.2	107.9	153.2	162.4	178.3	192.4
30 Kg N ha $^{-1}$ Az.M_5	49.6	52.4	102.3	106.6	153.0	161.1	176.5	192.1
30 Kg N ha $^{-1}$ FYM	51.9	56.8	112.5	118.7	167.4	174.8	195.5	212.6
30 Kg N ha $^{-1}$ + FYM Az.M_4	52.9	57.8	115.7	120.7	170.5	178.6	198.3	218.6
30 Kg N ha $^{-1}$ + FYM Az.M_5	52.2	57.9	113.4	119.8	168.8	176.8	196.8	215.8
Mahaagrozyme	45.6	49.4	96.2	97.0	145.3	151.8	170.6	181.6
Sem ±	1.1	1.4	3.3	3.5	3.9	4.4	5.3	4.8
CD (P=0.05)	3.3	4.0	9.8	10.2	11.6	12.8	15.6	14.1

DAS : days after sowing ; Az : Azotobacter; FYM : farm yard manure @ 12 t ha $^{-1}$

Table 2. Lint, Seed cotton and stalk yield of cotton as influenced by nitrogen, FYM and biofertilizer

Treatments	Lint yield (q ha^{-1})		Seed yield (q ha^{-1})		Seed cotton yield (q ha^{-1})		Stalk yield (q ha^{-1})	
	2001	2002	2001	2002	2001	2002	2001	2002
Control	5.10	5.89	9.6	11.0	14.6	16.8	47.9	49.4
30 Kg N ha $^{-1}$	6.15	6.97	11.6	13.2	17.7	20.2	51.9	54.2
60 Kg N ha $^{-1}$	6.95	7.89	13.3	15.1	20.2	22.9	55.8	58.8
Azotobacter (Az.) M_4	5.40	6.33	10.1	11.4	15.5	17.8	48.9	50.6
Azotobacter (Az.) M_5	5.34	6.29	9.9	11.2	15.3	17.5	48.7	50.4
FYM @ 12 t ha $^{-1}$	6.54	7.34	12.2	14.1	18.7	21.5	52.8	55.7
30 Kg N ha $^{-1}$ Az.M_4	6.49	7.09	12.1	14.1	18.6	21.2	52.5	55.4
30 Kg N ha $^{-1}$ Az.M_5	6.44	7.05	12.0	13.8	18.5	20.9	52.0	55.3
30 Kg N ha $^{-1}$ FYM	7.44	8.30	13.8	15.8	21.2	24.2	56.7	61.6
30 Kg N ha $^{-1}$ + FYM Az.M_4	7.64	8.95	14.1	16.0	21.7	24.9	57.4	62.7
30 Kg N ha $^{-1}$ + FYM Az.M_5	7.56	8.86	14.0	15.8	21.5	24.6	57.1	62.2
Mahaagrozyme	6.03	6.42	11.2	12.1	17.3	18.5	49.3	51.8
Sem ±	0.30	0.35	0.48	0.59	0.72	0.75	1.31	1.51
CD (P=0.05)	0.88	1.03	1.42	1.75	2.12	2.21	3.86	4.46

2001 and 2002 under irrigated condition. The experimental soil was sandy loam in texture, low in available nitrogen (230 kg ha^{-1}) and medium in available phosphorus (20.6 kg ha^{-1}) and potassium (228 kg ha^{-1}). The pH and organic carbon content of the soil were 7.9 and 0.43% respectively. The trial was laid out in randomized block design with 12 treatments viz., T_1 - control (no N), T_2 - 30 kg N ha^{-1}, T_3 - 60 kg N ha^{-1}, T_4 - *Azotobacter* (Az.) M4, T_5 - Az. W_5, T_6 - Farm yard manure (FYM) @ 12 t ha^{-1}, T_7 - 30 kg N ha^{-1} + Az. M_4, T_8 - 30 kg N ha^{-1} + Az. W_5, T_9 - 30 kg N ha^{-1} + Az. M_4 + FYM @ 12 t ha^{-1}, T_{10} - 30 kg N ha^{-1} + FYM @ 12 t ha^{-1} + Az. M_4, T_{11} - 30 kg N ha^{-1} + FYM @ 12 t ha^{-1} + Az. W_5 and T_{12} - Mahaagrozyme. The cotton cultivar 'Pusa 8-6' was sown by dibbling at a spacing of 75 cm x 30 cm. Each plot was applied with 40 kg P_2O_5 and 40 kg K_2O ha^{-1} as basal. *Azotobacter* (M_4 and W_5) were obtained from Microbiology Division, Indian Agricultural Research Institute and used for seed treatment @ 600 g ha^{-1}. FYM was manually incorporated into the ridges at planting. Three Mahaagrozyme spray @ 2 ml It^{-1} was given at vegetative (60 days after sowing), square initiation and full flowering stages.

Results and Discussion

Dry matter accumulation

Dry matter accumulation (Table 1) per plant increased with higher dose of nitrogen (60 kg ha^{-1}). Two strains of *Azotobacter* (M_4 or W_5) and Mahaagrozyme could not improve the dry matter accumulation significantly. Except at 60 DAS, at all other growth stages application of FYM @ 12 t ha^{-1} recorded dry matter accumulation significantly superior to control but remained at par with 30 kg N ha^{-1}. Combined application of 30 kg N and FYM @ 12 t ha^{-1} recorded dry matter accumulation significantly superior to the individual application of either 30 kg N ha^{-1} or FYM @ 12 t ha^{-1}. Highest dry matter accumulation per plant was observed with integrated application of 30 kg N and FYM @ 12 t ha^{-1} along with *Azotobacter* (M_4) followed by the same combination that involved 30 kg N ha^{-1} + FYM @ 12 t ha^{-1} + *Azotobacter* (W_4) and 60 kg N ha^{-1} alone. All these treatments were at par with each other. This could be ascribed to higher and continuous nutrient availability from combined source up to the maturity. Higher nutrient availability improved the growth attributes and photosynthetic activities of plant (Pagaria *et al.*, 1995, Padole, 1998).

Yield of cotton

The yield of cotton was appreciably influenced by the application of nitrogen, FYM and biofertilizers (Table 2). Successive doses of nitrogen increased the yield of cotton viz., seed, lint, seed cotton and stalk yield considerably. Prasad and Prasad (1994) also reported similar results. Biofertilizers viz., *Azotobacter* and Mahaagrozyme improved the yield of cotton marginally but was nonsignificant. Similar effect of Mahaagrozyme on cotton was reported by Prasad (2003). Yield values recorded with FYM @ 12 t ha^{-1} was found to be intermediate between 30 and 60 kg N ha^{-1}. Application of 30 kg N ha^{-1} along with *Azotobacter* produced yield comparable to 60 kg N/ha. This was in line with the findings of Ramamoorthy *et al.* (1991). Highest yield values were recorded with integrated application of 30 kg N and FYM 12 t ha^{-1} along with *Azotobacter* (M_4 or W_5) followed by the same combination but without *Azotobacter.* All these three were at par with application of 60 kg N ha^{-1}. This could be due to efficient utilization of nutrients from combined source compared to the single source. Availability of micronutrients from FYM, growth promoting substances and vitamins from *Azotobacter* might have helped in higher boll retention and improved yield. Muthuvel *et al.* (1989) and Katkar *et al.* (2002) reported similar findings.

Table 3. Nutrient content in seed and stalk of cotton as influenced by nitrogen, FYM and biofertilizer

Treatments	N content (%)				P content (%)				K content (%)			
	2001		2002		2001		2002		2001		2002	
	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk
Control	3.30	0.64	3.32	0.66	0.367	0.128	0.367	0.130	1.23	0.81	1.25	0.81
30 Kg N ha $^{-1}$	3.35	0.68	3.38	0.69	0.371	0.132	0.372	0.133	1.24	0.84	1.28	0.83
60 Kg N ha $^{-1}$	3.40	0.71	3.41	0.73	0.373	0.136	0.375	0.136	1.26	0.85	1.30	0.84
Azotobacter (Az.) M_4	3.32	0.66	3.34	0.68	0.368	0.130	0.369	0.131	1.24	0.83	1.26	0.82
Azotobacter (Az.) M_5	3.31	0.65	3.34	0.67	0.367	0.131	0.369	0.131	1.23	0.82	1.26	0.82
FYM @ 12 t ha $^{-1}$	3.39	0.69	3.39	0.73	0.373	0.137	0.377	0.139	1.25	0.85	1.29	0.86
30 Kg N ha $^{-1}$ Az.M_4	3.37	0.69	3.38	0.70	0.373	0.134	0.374	0.135	1.25	0.85	1.28	0.84
30 Kg N ha $^{-1}$ Az.M_5	3.36	0.68	3.38	0.69	0.372	0.133	0.373	0.133	1.24	0.84	1.29	0.83
30 Kg N ha $^{-1}$ FYM	3.44	0.72	3.43	0.75	0.375	0.140	0.380	0.143	1.28	0.87	1.31	0.88
30 Kg N ha $^{-1}$ + FYM Az.M_4	3.48	0.73	3.46	0.77	0.377	0.141	0.380	0.144	1.29	0.87	1.33	0.89
30 Kg N ha $^{-1}$ + FYM Az.M_5	3.46	0.72	3.45	0.77	0.375	0.140	0.381	0.144	1.29	0.87	1.32	0.89
Mahaagrozyme	3.32	0.65	3.35	0.68	0.370	0.130	0.373	0.131	1.24	0.83	1.27	0.83
Sem ±	0.08	0.03	0.07	0.03	0.30	0.004	0.011	0.004	0.04	0.02	0.03	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NPK content and their removal

Fertilizer nitrogen, FYM and biofertilizers did not bring about any marked change in NPK content of any plant parts (Table 3). However, their removal by plant increased considerably with corresponding increase in nitrogen levels (Table 4). Pandyan and Iruthayaraj (1991) concluded that higher rates of nitrogen application resulted in higher removal of N, P and K. Largest amount of N, P and K removal was noticed with integrated application of 30 kg N and FYM @ 12 t ha^{-1} along with *Azotobacter* (M_4), which was 31.7, 4.3 and 20.7 kg ha^{-1} higher over no nitrogen application, respectively. This was mainly due to higher dry matter accumulation. Close view on the data revealed that NPK removal by cotton followed the same trend as dry matter accumulation. This was in line with the Halevy (1976) and Pagaria *et al.* (1995).

Present findings showed that even with the lower dose fertilizer nitrogen (30 kg ha^{-1}) combined application of FYM and biofertilizer could increase the cotton yield profoundly. Nutrients are better utilized from combined sources and as a result higher yield of cotton was realized.

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