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Effect of integrated nitrogen-management practices on the growth and yield of rainfed winter maize (*Zea mays*)

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ABSTRACT

A field experiment was conducted during the winter seasons (*rabi*) of 1995–96 and 1996–97 at Coimbatore, to study the effect of different organic N sources and *Azospirillum* along with 4 levels of nitrogen on the growth and yield of maize (*Zea mays* L.) under rainfed condition. The results revealed that application of enriched farmyard manure @ 750 kg/ha significantly increased the growth and yield attributes, N uptake and grain yield of maize in both the years. Nitrogen levels were also significantly influenced the crop growth and yield favourably. Application of 60 kg N/ha gave the maximum grain yield in both the years.

Key words : Winter or *rabi* maize, Integrated nutrient management, *Azospirillum*, Enriched FYM, Composted coir pith

Maize is gaining importance particularly in rainfed tracts of north–western, western and southern zones of Tamil Nadu because of its increasing demand as poultry and animal feed. The 2 major constraints of crop production in drylands are the inadequancy of moisture and poor fertility status of the soil. There is every possibility of increasing the soil-fertility status of drylands by applying organic N sources which also helps in improving the water-holding capacity of the soil. However, limitations in the availability of conventional organic manures like farmyard manure (FYM), compost etc., in large quantities proved to be a bottleneck for their winder application. An integrated approach with optimum combination of organics, inorganics and biofertilizers will be more useful to increase the crop productivity. Hence the present study was undertaken to study the influence of different organic N sources and *Azospirillum* along with varied N levels on the growth and yield of rainfed maize.

MATERIALS AND METHODS

A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore, during winter (*rabi*) seasons of 1995–96 and 1996–97. The experiment was conducted in 2 different fields and the soils were sandy clay loam with pH 7.60 (1995–96) and 7.90 (1996–97). The soil had 0.56 and 0.28% organic carbon, 148.25 and 169.00 kg available N, 14.58 and 18.00 kg

available P_2O_5 and 578.00 and 501.00 kg available K_2O during 1995–96 and 1996–97 respectively. The treatments consisted of 4 different sources of organic N, viz. composted coir pith @6.25 tonnes/ha, enriched farmyard manure at 750 kg/ha, *Azospirillum* (ASPM) as seed and soil inoculation and no organic nitrogen (NON) in main plots and 4 levels of nitrogen (0, 20, 40 and 60 kg N/ha) in subplots. The experiment was laid out in split-plot design with 3 replications. Maize 'Co. 1' variety was sown on 18 September during 1995 and 27 September in 1996 and harvested on 1 January 1996 and 18 January 1997 respectively. Composted coir pith was prepared by taking 100 kg raw coir pith which was uniformly spread over an area of 5 m long and 3 m wide and to a height of 5 cm, and over this a layer of 300 g spawn (*Pleurotus sajor-caju)* was applied uniformly. Above this layer, 100 kg raw coir pith was spread uniformly and on this 1 kg urea was applied. This process was repeated by sandwiching the spawn and urea alternatively to a height of 0.5 m. Sprinkling of water was done twice a week for 30 days. Enriched FYM was prepared by taking 750 kg well-decomposed and sieved farmyard manure and mixed thoroughly with 30 kg P_2O_5 and heaped. The heap was then plastered with red earth and kept for 30 days with periodic plastering of the cracks developed, so as to facilitate anaerobic decomposition. The calculated quantities of composted coir pith (CCP) and enriched farmyard manure (EFYM) were applied before sowing and incorporated into the soil. It is estimated that through the application of EFYM and CCP about 22.5 and 30.0 kg/ha N is supplied to the soil. For biofertilizer treatment, maize seeds were treated with *Azospirillum* culture just before sowing and also applied mixing with sand as soil application. A total rainfall of 269.9 mm and 409.1 mm was reached in 19 and 22 rainy days during 1995–96 and 1996–97 respectively.

RESULTS AND DISCUSSION

Effect of sources of nitrogen on maize growth and yield

Application of organic sources (CCP and EFYM) and biofertilizer (*Azospirillum*) enhanced the growth and yield attributes of maize in both years (Table 1). The increase in plant height due to the application of organic N sources over no organic N application was 1.3–20.0 cm at 90 days after sowing. The increase was maximum with the application of EFYM, followed by CCP and *Azospirillum* in both the years. Application of different organic sources of N increased leaf-area index to the level of 0.05–0.44 over the no organic N. An application of EFYM at 750 kg/ha recorded a maximum leaf-area index (LAI) of 5.22 and 5.23 during 1995–96 and 1996–97 respectively. This might be due to better contribution of N for the growth and development of maize (Veerabadran and Rajendran 1993; Balasubramanian *et al.*, 1995). In both the years, the cob length, cob girth and cob weight were significantly higher with EFYM, followed by CCP and *Azospirillum* treatments. During 1995–96 significantly higher test grain weight was recorded with the application of EFYM than the other sources. However, during

Table 1. Effect of nitrogen resources and levels on the growth and yield attributes of maize

Treatment	Plant height (cm) at 90 DAS		Leaf-area index		Cob length (cm)		Cob girth (cm)		Cob weight (g)		100-grain weight (g)	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1997–98
N source												
Composted coir pith	198.5	229.3	5.16	5.18	14.8	17.8	13.4	13.6	85.1	111.1	22.9	23.6
Enriched farmyard manure	202.3	237.5	5.22	5.23	14.9	18.4	13.6	13.7	90.0	114.2	23.5	23.9
Azospirillum as seed and soil inoculation	194.7	224.2	4.88	5.09	14.6	17.1	13.2	13.5	84.7	105.4	22.8	23.4
No organic nitrogen	193.5	218.8	4.78	5.04	14.5	16.5	13.0	13.3	78.5	96.5	22.6	23.0
CD (P=0.05)	1.9	3.9	0.13	0.04	0.1	0.3	0.2	0.2	1.2	3.8	0.2	0.5
N (kg/ha)												
N_0	167.9	213.5	4.68	4.76	14.0	16.4	12.7	12.9	73.8	99.3	22.0	22.6
N_{20}	189.8	225.5	4.96	5.12	14.6	17.3	13.1	13.2	80.3	104.7	22.8	23.2
N_{40}	205.6	231.0	5.14	5.29	15.1	17.8	13.5	13.8	92.0	109.4	23.5	23.8
N_{60}	225.6	239.9	5.26	5.37	15.1	18.3	13.9	14.0	92.3	113.8	23.5	24.3
CD (P=0.05)	1.7	2.1	0.06	0.03	0.2	0.3	0.1	0.2	2.5	1.5	0.1	0.6

1996–96, EFYM registered significantly higher test grain weight over no organic N and was on a par with CCP and *Azospirillum* treatments. The test weight was least with no organic N in both the years. The greater accumulation of dry matter with different organic sources caused improvement in various yield attributes. Application of EFYM at 750 kg/ha significantly increased the DMP over other sources and the extent of increase was 4–27% over no organic N in the both years.

Greater accumulation of dry matter due to better crop growth with different organic sources resulted in increased grain yield of maize (Anabayen and Palaniappan, 1991). The increase in grain yield was 38–446 kg/ha for different organic N sources over no organic N source which recorded the least grain yield of 1,046 and 1,736 kg/ha during 1995–96 and 1996–97 respectively. The EFYM application at 750 kg/ha resulted in the maximum grain yield of 1,295 and 2,182 kg/ha during 1995–96 and 1996–97, respectively, and the increase was 20–26% higher over no organic N application. This might be owing to the beneficial effects of EFYM on influencing the yield attributes favourably (Singh and Arya, 1993; Balasubramanian *et al.*, 1995). Application of EFYM at 750 kg/ha resulted in maximum straw yield of 3,625 and 4,466 kg/ha during 1995–96 and 1996–97 respectively over the application of CCP and *Azospirillum*, while no organic N application recorded the least straw yield of 3,218 and 3,810 kg/ha in the corresponding years.

Application of organic N sources significantly improved the uptake of N over no organic N. Among the N sources, EFYM recorded higher N uptake over other sources. The EFYM application might have led to the sustained availability of applied N to the crop.

Effect of nitrogen levels on growth and yield of maize

Increasing the nitrogen levels from 0 to 60 kg/ha significantly increased the plant height, leaf-area index (LAI) and dry matter (DM) of maize (Table 1). The increase in LAI was probably due to better crop growth with higher N availability. The results also confirm the findings of Singh and Sharma (1994). Application of N at different levels significantly increased the cob length, cob girth, cob weight and test grain weight of maize. Better crop growth at higher N levels might have influenced favourably yield attributes (Ranjodh Singh, 1983; Narayanasamy *et al.*, 1994).

Application of 60 kg N/ha recorded significantly higher grain yield of 1,402 and 2,477 kg/ha during 1995–96 and 1996–97 respectively (Table 2), whereas the control treatment (0 kg N/ha) registered the lowest grain yield (911 and 1,477 kg/ha). The grain yield was increased by 151–1,000 kg N/ha in both years due to N over the control. The highest grain yield obtained with of 60 kg N/ha might be due to efficient utilization of N and soil moisture by crop (Balasubramanian *et al.*, 1995; Narayanaswamy *et al.*, 1994).

Application of different levels of N significantly improved the N uptake of maize in both the years. The increase in N uptake was in the range of 3.6 to 14.8% over 0 kg N/ha. This might be due to higher dry-matter yield and more concentration of N in plants (Gangwar and Niranjan, 1991) at higher N levels.

Table 2. Effect of nitrogen source and level on the growth and yield attributes of maize

Treatment	Dry-matter production (kg/ha)		Grain yield (kg/ha)		Straw yield (kg/ha)		Cob girth (cm)	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97
N source								
Composted coir pith	3,653	5,094	1,178	2,082	3,499	4,290	166.5	169.5
Enriched farm-yard manure	3,839	5,346	1,295	2,182	3,625	4,446	171.6	176.4
Azospirillum as seed and soil inoculation	3,526	4,659	1,084	1,964	3,367	4,054	160.1	163.3
No organic manure	3,428	4,252	1,046	17,36	3,218	3,810	152.1	157.4
CD (P=0.05)	32	123	25	42	82	158	1.3	1.9
N (kg/ha)								
N_0	2,693	3,619	911	1,477	2,632	3,448	145.9	165.4
N_{20}	3,312	4,455	1,062	1,822	2,987	3,864	152.4	170.2
N_{40}	3,916	5,226	1,197	2,128	3,758	4,397	159.6	174.3
N_{60}	4,524	6,951	1,402	2,477	4,333	4,891	167.5	180.2
CD (P=0.05)	54	100	22	58	69	86	0.4	2.9

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