Indian Journal of Agronomy 46 (4) : 698–701 (December 2001)

Effect of integrated nutrient management on yield and nutrient balance in maize (*Zea mays*)

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Received : October 2000

ABSTRACT

A field study was conducted during the rainy (*kharif*) seasons of 1997 and 1998 on sandy-loam soil at the Main Research Station, University of Agricultural Sciences, Bangalore, to study the effect of integrated nutrient management on yield and nutrient balance in maize (*Zea mays* L.). The study comprised 7 treatments, consisting of recommended dose of inorganic fertilizer, combination of 50 and 75% recommended dose with FYM and vermicompost and only FYM and vermicompost. Combined application of 50 or 75% recommended dose of fertilizer with 12 tonnes/ha FYM or 2.7 tonnes/ha vermicompost caused higher productivity of maize compared with the application of either only inorganic fertilizer or organic sources. Integrated nutrient management resulted in better uptake and less loss of nutrients from the soil.

Key words : Maize, FYM, Compost, Integrated nutrient management, Nutrient balance

Maize has higher production potential in Karnataka, specially under irrigated conditions. It is well known that maize is heavy feeder of nitrogen and demands 150 kg N/ha (Prasad *et al.*, 1987). In order to sustain soil fertility and to reap rich harvest of maize, it is important that FYM or vermicompost have to be applied in adequate quantity. Due to the ever-increasing cost of inorganic chemical fertilizers, their use in combination with organic manures and crop residues has become imperative for sustained crop production and maintenance of soil health. With these points in view, a field experiment was conducted at the Main Research Station, Hebbal, Bangalore, during the rainy (*kharif*) seasons of 1997 and 1998 to study the effect of integrated nutrient management on yield and nutrient balance in maize.

MATERIALS AND METHODS

The study was carried out on sandy-loam soil at the Agronomy Field Unit, Main Research Station, Hebbal. The soil was near neutral with pH 6.5 and electrical conductivity 2.21 dS/m. The soil was low in organic carbon (0.38%) and the available

nitrogen (147.2 kg/ha) and available K_2O (147.4 kg/ha) and medium in available P_2O_5 (37.7 kg/ha). All together 7 treatments comprising combinations of inorganic and organic sources and also in isolation (Table 1) were tried in randomized block design with 3 replications. Maize hybrid 'Deccan 103' and 'Pioneer 3015' were used during 1997 and 1998 respectively. Both FYM and vermicompost samples were analysed for available N, P_2O_5 and K_2O contents and the composition was 0.62, 1.38 and 0.18, 0.36 and 0.48 and 0.71% in FYM and vermicompost respectively.

The quantity of vermicompost and FYM required for each plot was calculated based on their composition of NPK and as per the treatments and were incorporated into soil 2 weeks before sowing. Urea, single superphosphate and muriate of potash were used as source of N, P and K respectively. The entire dose of phosphorus and potassium and 50% of nitrogen were placed 5 cm deep and 5 cm away from the seed row as a basal dose. The remaining N was top-dressed 30 days after sowing. The seeds were sown in July in 60 cm rows at 30 cm apart. Irrigations were given, depending on the dry spell. Nutrient analysis in soil and plant was done as per prescribed methods. The yield and yield components were recorded and nutrient balance for the second year data was worked out after converting to N, P_2O_5 and K_2O.

RESULTS AND DISCUSSION

Grain yield

Application of 50% recommended NPK + 12 tonnes/ha FYM registered the maximum grain yield in 1997, followed by 75% recommended NPK + 2.7 tonnes/ha vermicompost which were at par with each other (Table 1). Application of vermicompost (2.57 tonnes/ha) or FYM (3.03 tonnes/ha) alone significantly lowered the yield compared to combination of both inorganic and organic fertilizers. Similar trend was observed in test weight and grains/row. During 1998, the highest grain yield was recorded with 75% recommended dose of fertilizer + vermicompost 2.7 tonnes/ha which was on par with 75% recommended dose of fertilizer + FYM 6 tonnes/ha, 100% recommended dose of fertilizer, 50% recommended dose of fertilizer + vermicompost 5.4 tonnes/ha and 50% recommended dose of fertilizer + FYM 12 tonnes/ha, recording 6.05, 5.99, 5.65 and 5.64 tonnes/ha grain respectively. Kale *et al.* (1991) suggested that quantity of chemical fertilizers could be reduced by 25–50% when applied with vermicompost. In the present study, higher grain yield with 75% recommended dose of fertilizer along with either 2.7 tonnes/ha vermicompost or 6 tonnes/ha FYM was attributed to more grains/row, grain yield/plant and test weight. The vermicompost besides having higher available N, P_2O_5 and K_2O status has rich population of microbes might have degraded and mobilized the nutrients to available form. The exudates of earthworms would also support the growth of micro-organisms which secrete plant growth hormones. These micro-organisms are also found to fix atmospheric N into available form. Further several enzymes and hormones present in the vermicompost might have stimulated the growth and development of maize. The higher yield

Table 1. Yield and yield components of maize as influenced by integrated nutrient management

Treatment	Grains/ row		Grain weight/ plant (g)	Test weight (g)		Grain yield (tonnes/ha)		Straw yield (tonnes/ha)	
	1997	1998	1998	1997	1998	1997	1998	1997	1998
T_1, RDF (150:75:40 kg N, P_2O_5 and K_2O kg/ha)	33.5	35.2	140.92	38.00	21.86	3.17	5.99	22.50	9.45
T_2, 75% RDF + FYM 6 tonnes/ha	31.5	36.5	144.13	38.75	21.96	3.23	6.05	21.07	9.76
T_3, 50% RDF + FYM 12 tonnes/ha	31.8	32.4	129.50	40.01	21.76	3.48	5.64	20.59	8.95
T_4, 75% RDF + VC 2.7 tonnes/ha	33.2	37.3	147.63	38.90	22.30	3.38	6.12	21.54	9.97
T_5, 50% RDF + VC 2.4 tonnes/ha	32.6	32.7	132.10	37.86	21.96	3.07	5.65	20.59	9.04
T_6, FYM 24 tonnes/ha	25.2	25.4	123.54	37.40	18.26	3.04	3.72	18.20	6.83
T_7, VC 10.8 tonnes/ha	25.5	27.0	127.53	36.00	18.63	2.98	3.85	16.04	7.06
CD (P=0.05)	5.5	3.1	5.85	NS	8.13	0.21	0.50	4.11	1.67

RDF, Recommended dose of fertilizer; FYM, farmyard manure; VC, Vermicompost

Table 2. Nutrient balance (kg/ha) after maize as influenced by integrated nutrient management (1998)

Treatment	Initial status of available			Nutrients added by the treatments			Nutrients removed by the crop			Expected balance			Actual balance			Net loss or gain		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
T_1	240.8	38.4	143.4	150	75	40	132.5	33.8	126.6	257.3	79.5	56.8	244.1	43.9	152.7	–13.57	–35.9	+95.9
T_2	240.6	39.2	145.2	150	75	40	136.5	36.0	131.3	254.1	78.1	53.9	251.8	44.2	153.6	–2.3	–33.9	+99.7
T_3	239.4	39.2	145.0	150	75	40	122.6	30.5	116.8	267.2	83.6	68.1	260.0	48.0	156.9	– 7.2	– 35.6	+88.8
T_4	240.4	39.1	145.2	150	75	40	139.1	37.3	135.0	251.3	81.8	50.2	258.2	51.8	154.7	+ 7.0	–30.0	+104.5
T_5	241.3	38.6	146.2	150	75	40	123.9	31.2	118.9	267.4	82.4	67.2	265.3	53.3	159.7	– 2.1	– 29.1	+92.5
T_6	240.0	39.3	144.6	150	75	40	83.9	21.4	82.1	306.0	92.8	99.5	261.9	55.4	160.2	– 44.1	–37.4	+60.7
T_7	241.1	39.2	144.3	150	75	40	87.0	22.2	87.9	304.1	91.9	96.3	266.9	57.4	162.9	–37.1	–34.6	+66.6

Treatment details are given in Table 1

with 75% recommended dose of fertilizer + FYM 6 tonnes/ha was due to the added FYM which acts as store- house of several macro- and micro-nutrients, apart from improving the soil physical conditions.

Nutrient balance

The combined application of organic and inorganic chemical fertilizers not only increased the availability of nutrients but also their uptake by the crop (Table 2). The uptake of N, P and K by maize was higher due to application of 75% recommended dose of fertilizer + 2.7 tonnes/ha vermicompost. However, the application of either 24 tonnes/ha FYM or 10.8 tonnes/ha vermicompost registered the lower nutrient uptake.

In general, loss of N and P was more where either only chemical fertilizers or organic fertilizers were applied. This was mainly because of slow release of nutrients for the first crop from the organic sources. However, the loss was less when inorganic and organic sources were applied in combination. Among the different treatments, the removal of N by crop was higher with 75% recommended dose of fertilizer + vermicompost 2.7 tonnes/ha. The actual balance of N was higher with vermicompost 10.8 tonnes/ha. The loss of N was more with 24 tonnes/ha FYM (–44.1 kg/ha) and less with 50% recommended dose of fertilizer + vermicompost 5.40 tonnes/ha (–2.1 kg/ha). This might be due to slow mineralization of nutrients in the organic source to the first crop (Sabey, 1980). The removal of available P_2O_5 was higher with only vermicompost 10.8 tonnes/ha (57.3 kg/ha). The loss of P_2O_5 was observed in all the treatments might be due to fixation of available P_2O_5. There was a gain of K_2O in all the treatments, might be due to decrease in shifting equilibrium of K_2O in the soil and also reduced leaching losses.

Thus, it can be concluded that the combined application of 50 or 75% recommended dose of fertilizer + 12 tonnes/ha FYM or 2.7 tonnes/ha vermicompost would enhance the productivity of maize apart from reducing the loss of nutrients in the soil.

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