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Effect of Integrated Nutrient Management on Nutrient Balance Sheet and Yield of Maize in Southern Transitional Zone of Karnataka

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Abstract

Higher nitrogen uptake (139 kg/ha), phosphorus uptake (58 kg/ha) and potassium uptake (131 kg/ha) were observed in T_8 which received 75 kg N through inorganic fertilizer, 25 kg N through compost, *Azospirillum*, recommended P and K with French bean intercrop. Integrated nutrient management using compost, French bean green manure and *Azospirillum* favored higher fertilizer use efficiency, thus leading to higher nutrient uptake and higher grain and stover yield of maize (4,689 kg/ha and 6.68 t/ha, respectively). Soil nitrogen balance increased had the proportion of nitrogen sources increased. In T_1 and T_8 loss of nitrogen was minimum (–10.27 and –6.38 kg N/ha respectively). Residual phosphorus increased with proportion of inorganic sources, minimum loss of 5.31 kg P/ha was recorded in T_2. With the increase in proportion of organic sources there was increase in net gain of potassium, higher net gain of P was noticed in T_6 and T_8 (12.48 and 9.95 kg P/ha respectively).

Key words : Integrated nutrient management, Nutrient balance sheet, Organic sources of nutrients, Maize yield.

Maize (*Zea mays* L.) is an important cereal because of its production potential and adaptability to wide range of environment. In recent years maize is occupying vast area of southern transitional zone of Karnataka due to well distributed rainfall and better soil condition, which helps to harvest bumper yield under rainfed condition. In Karnataka, it is cultivated over an area of 9.61 lakh ha with annual production of 26.42 lakh tonnes (1). Maize crop requires large quantities of nitrogen, the deficiency of which limits growth, yield and quality of the crop. The importance of organic manures has been demonstrated by number of studies all over the world. Organic manures are known to successfully maintain and improve soil fertility and productivity. Manures not only supplies major and micro nutrients, but also improve soil physico-chemical characters, which help to maintain soil productivity. There is ample scope to grow green manure crops like cowpea, French bean and sunhemp owing to wider row spacing of the crop. When these green manure crops are used in combination with biofertilizers like *Azospirillum, Azotobacter, Phosphobacterium,* availability of nutrients increases in the soil. To meet the nutritional requirement of the crop one cannot depend only on chemical fertilizers, though it supplies nutrients in readily available form. Therefore, to maintain soil productivity on a sustainable basis and to obtain sustainable yield integrated use of chemical fertilizers, organic and biological sources of nutrients area essential. In view of using more quantity of fertilizers it is required to know the balance sheet of nutrients so that the cost of cultivation is minimized along with increase in net returns to the farmers. The present investigation was initiated to study the effect of integrated nutrient management on nutrient balance sheet and yield of maize in southern transitional zone of Karnataka at Zonal Agricultural Research Station, Navile, Shimoga during 2003.

Methods

The field experiment was initiated with ten treatments in randomized complete block design with three

Table 1. Effect of integrated nitrogen sources on available soil nutrient status and nutrient uptake (kg/ha) after harvest of maize crop.

Treatments	Details	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	Nutrient uptake (kg/ha)		
T_1	Rec. practice 7.5 ton compost/ha + 100:50:25 kg NPK/ha	280	205	271	N	P	K
T_2	125 kg N through inorganic source (I_0) + rec. P & K	224	155	224	134	57	127
T_3	100 kg N (I_0) + 25 kg N though compost (N_c) + rec. P & K	235	183	243	90	48	85
T_4	75 kg N (I_0) + 50 kg N though compost (N_c) + rec. P & K	24	196	252	97	49	96
T_5	75 kg N (I_0) + 25 kg N though compost (N_c) + rec. P & K + *Azospirillum*	239	175	232	103	50	102
T_6	100 kg N (I_0) + frenchbean intercrop + rec. P & K + *Azospirillum*	306	181	263	108	51	105
T_7	75 kg N (I_0) + 50 kg N though compost (N_c) + rec. P & K + *Azospirillum*	275	180	235	120	53	116
T_8	75 kg N (I_0) + frenchbean intercrop + 25 kg N (N_c) + rec. P & K + *Azospirillum*	312	187	272	122	54	119
T_9	100 kg N (N_c) + rec. P & K	225	211	266	139	58	131
T_{10}	125 kg N (N_c) + rec. P & K	234	217	281	111	51	108
Initial status of soil		210	158	290	116	52	110
SE ±		–	–	–	1.1	0.9	1.3
CD 5%		–	–	–	3.4	2.8	3.8

replications. The initial fertility level of the experimental site was analyzed before initiation of the experiment (pH 6.5, EC 0.25 dS/m, OC 0.53%, avail N 210 kg/ha, avail. P_2O_5 150.4 kg/ha, avail K_2O 290 kg/ha). Land preparation was done based on the regular practice and experimental layout was prepared as per the plan. The organic manure (compost) was incorporated following the treatments before sowing. The recommended dose of 50 kg/ha P and 25 kg/ha K was applied as basal dose. Nitrogen was applied in two equal splits, one as basal and the other as top dressing on 35 days after sowing. Urea, super phosphate and murite of potash were used as sources of N, P and K respectively. For the fertilizer treatment (T_5, T_6, T_7 and T_8), *Azospirillum* and *Phosphobacterium* each at 2 kg/ha (10 pockets) were used of which 400 g each was used for seed inoculation and remaining was (1,600 kg) was applied after germination. Intercrop of French bean in T_6 and T_8 was sown on the day of sowing of main crop and incorporated at 30 days after sowing. Seeds of Deccan 103, hybrid maize were used at the rate of 15 kg/ha for sowing by opening shallow furrows of 5 cm deep and 60 cm apart and 2—3 seeds were dibbled at 30 cm distance in the furrows. Regular intercultural operations and plant protection was followed till harvesting crop yield were recorded in all the treatments. Yields data on maize crop has been considered for the statistical analysis. Soil samples were collected after the harvest of maize crop

Table 2. Balance sheet of available nitrogen (kg/ha) as influenced by integrated nitrogen sources after harvest of maize crop.

Treatments	Initial status of available N	Addition of nutrients	Total nutrient status	Removal of nutrient by crop	Expected balance	Actual balance	Net loss(-) gain (+)
T_1	210	212	422	134	228.47	280.20	-10.27
T_2	210	125	335	90	244.75	224.08	-20.67
T_3	210	125	335	97	237.93	235.30	-2.63
T_4	210	125	335	103	232.18	240.10	7.92
T_5	210	140	350	108	242.19	238.90	-3.29
T_6	210	248	458	120	337.57	305.50	-32.07
T_7	210	165	375	122	253.31	275.10	21.79
T_8	210	248	458	139	318.63	312.25	-6.38
T_9	210	100	310	111	199.24	225.04	25.80
T_{10}	210	125	335	116	218.64	233.50	14.86

Table 3. Balance sheet of available phosphorus (kg/ha) as influenced by integrated nitrogen sources after harvest of maize crop.

Treatments	Initial status of available P	Addition of nutrients	Total nutrient status	Removal of nutrient by crop	Expected balance	Actual balance	Net loss (-) gain (+)
T_1	158	114	272	57	215.61	205.03	-10.58
T_2	158	50	208	48	160.31	155.00	-5.32
T_3	158	65	223	49	174.54	183.00	8.46
T_4	158	80	238	50	188.47	196.26	7.79
T_5	158	65	223	51	172.90	175.00	2.10
T_6	158	62	220	53	168.02	180.50	12.48
T_7	158	80	238	54	184.03	180.25	6.22
T_8	158	77	235	59	176.61	186.56	9.95
T_9	158	110	268	51	217.55	210.60	-6.95
T_{10}	158	125	283	52	231.20	217.00	-14.20

and analyzed for different parameters like pH, electrical conductivity, organic carbon, available phosphorus and available potash content by following the standard methods to study the changes in the soil fertility levels. The plant samples (grain and straw samples separately) were collected after the harvest of crop and analyzed for uptake of nitrogen, phosphorus and potassium content by following standard methods and plant uptake of nutrients was calibrated using grain and straw yields data. The balance sheet for nitrogen, phosphorus and potassium was worked out using the derived data. All the results were then analyzed statistically for drawing conclusion using standard statistical analysis tools.

Results and Discussion

Available Soil Nutrient Status

Higher available N was observed in T_8 (312.25 kg/ha) followed by T_6 (305.50) and T_1 (280.200 which could be due to addition of both organic and inorganic sources which helps in release of nutrients throughout the crop growth period (Table 1). Lowest available N was recorded in T_2 (224.08 kg/ha) which received only inorganic sources as nutrients are released at faster rate leading to leaching losses. Available phosphorus and potassium was highest in T_{10} (217 and 281 kg/ha, respectively) in treatment receiving 125 kg N through organic sources and recommended P and K through inorganic sources with least in T_2 (155 and 224 kg/ha, respectively). The higher NPK, could be attributed to increased population of beneficial micro organisms as result of application of organic manures as observed by Bhatnagar et al. (2).

Uptake of Nutrients

The results of plant analysis are shown in Table 2. Application of 75 kg N through inorganic + French bean intercrop + 25 kg N through compost + recommended P and K + *Azospirillum* (T_8) recorded higher N uptake (139 kg/ha) followed by T_1 (134 kg/ha) with least in T_2 (90 kg/ha). The higher N uptake in T_8 may be attributed to legume crop association along with *Azospirillum* which helps in buildup of N facilitating higher uptake similar to the studies of Sharma and Choubey (3). Phosphorus uptake also followed similar trend with highest P uptake in T_8 (58 kg/ha) followed by T_1 (57 kg/ha) and least in T_2 (48 kg/ha). The results are in accordance with the observations made by Chopra and Ganguly (4). The potassium uptake was highest in T_8 (131 kg/ha) followed by T_1 (127 kg/ha) with least in T_2 (85 kg/ha).

The combined application of organic manure, legume crops, bio-fertilizer and inorganic fertilizer has favored in higher biomass production resulting in higher uptake of all the three major nutrients.

Nitrogen Balance in Soil

Soil nitrogen balance increased has the proportion of nitrogen sources increased (Table 3). Net loss reduced from 32.07 kg N / ha in treatment T_6 to 2.63 kg N/ha in treatment T_3, while there was net gain of 25.8 kg N/ha in T_9. Higher nitrogen uptake was noticed in T_8 (139.37 kg N/ha) while lowest nitrogen uptake was noticed in T_2 (90.25 kg N/ha). Similarly residual moisture in the soil followed the same trend with that of net balance and increased from 224.08 kg N/ha in T_2 to 312.25 kg N/ha in T_8. The increase in residual soil nitrogen and net nitrogen balance with increase in quantity of nitrogen sources may be attributed to addition of more nitrogen to the soil through integrated nitrogen sources and its slow release throughout the crop growth period, which might have mini-

Table 4. Balance sheet of available potash (kg/ha) as influenced by integrated nitrogen sources after harvest of maize crop.

Treatments	Initial status of available K	Addition of nutrients	Total nutrient status	Removal of nutrient by crop	Expected balance	Actual balance	Net loss (-) gain (+)
T_1	290	100.00	390.00	126.50	263.50	271.74	7.54
T_2	290	25.00	315.00	85.20	229.83	224.21	-5.83
T_3	290	42.50	332.50	95.80	236.71	243.00	6.29
T_4	290	60.00	350.00	101.50	248.48	251.00	3.02
T_5	290	42.50	332.50	105.20	227.32	232.00	4.68
T_6	290	85.00	375.00	116.40	258.58	263.20	4.62
T_7	290	60.00	350.00	119.00	230.99	234.70	3.71
T_8	290	102.50	392.50	130.80	261.75	272.00	10.25
T_9	290	70.00	360.00	108.10	251.88	265.00	13.72
T_{10}	290	87.50	377.50	109.60	267.90	281.20	13.33

mized nitrogen loss (5, 6).

Highest nitrogen loss of 32.07 kg N/ha and 20.67 kg N/ha was observed in T_6 and T_2 respectively which may be attributed to inorganic nitrogen source used which was liable to transformation into gaseous nitrogen forms. Further, the higher content of carbonaceous material used in T_6 might have enhanced transformation into gaseous form. However, with T_1 and T_8 loss of nitrogen was minimum (-10.27 and -6.38 kg N/ha respectively) which may be attributed maximum uptake by the crop. Maximum nitrogen gain in T_9 and T_{10} may be attributed higher proportion of organic carbon.

Phosphorus Balance in Soil

Residual phosphorus increased with proportion of inorganic sources (Table 3) minimum loss of 5.31 kg P/ha was recorded in T_2 and crop uptake of P was also minimum in the same treatment (48.09 kg P/ha) which may be attributed to addition of les phosphorus to soil which was applied only inorganic form. Increase in residual phosphorus in T_{10}, T_9 and T_1 (217,210.60 and 215.61 kg P/ha) can be ascribed to contribution of P present in compost which was added to the soil. Higher net gain of P was noticed in T_6 and T_8 (12.48 and 9.95 kg P/ha respectively) with integration of organic and inorganic sources of nutrients. Organic acids and carbon dioxide released during decomposition might have acted on native insoluble iron and aluminum phosphate resulting in release of insoluble phosphorus as observed by Sharma and Saksena (7).

Potassium Balance in Soil

With the increase in proportion of organic sources there was increase in net gain of potassium, which was highest in T_9 (13.72 kg K/ha), followed by T_{10} and T_8 which may be due to addition of more potassium to the soil through the organic manures (Table 4). Maximum residual K of 281.20, 272 and 271.74 kg/ha was recorded in T_{10}, T_8 and T_1 respectively. Potassium depletion of 5.83 kg/ha was recorded in T_2 which may be because of non-addition of organic manures in this treatment similar to the studies of Toor and Bishnoi (5).

Thus integrated nutrient management helps in maintaining soil fertility, improving crop productivity and showing positive balance in nutrient after harvest of the crop.

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