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EFFECT OF CONTINUOUS APPLICATION OF FYM AND NPK ON FERTILITY STATUS OF SOIL, YIELD AND NUTRIENT UPTAKE IN MAIZE

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ABSTRACT

FYM and NPK were continuously added for over 20 years in the cropping sequence of maize-cowpea-finger millet in a Typic Ustropept clay loam soil at Tamil Nadu Agricultural University, Coimbtore to study their effect on soil fertility and crop productivity. Among the ten treatments, FYM and NPK and increasing levels of NPK fertilization significantly increased the available N, P and K and organic carbon content in the soil and the biomass yield and uptake of major nutrients in maize being the 55th crop in this study. Continuous fertilization with N only resulted in depletion of available P and not much variation was observed for available K. Exclusion of S from fertilizer schedule had not resulted in adverse yield reduction.

KEY WORDS : Effect, FYM, Fertilizers, Available Nutrients, Biomass, Yield

Modern scientific agriculture envisages the use of multiple cropping and this imposes a heavier burden on the soil, not only by the number of crops it has to support in a given period but also by the quantum of fertilizers applied as well. Application of fertilizer plays an important role on the yield and uptake of nutrients. Use of organic manures along with fertilizers not only helps in maintaining physico-chemical characteristics and fertility of soils, but also increases the crop yields markedly over either of them. Hence, the present investigation was taken up to study the influence of fertilizers and manures on fertilifty status, uptake of major nutrients and yield of maize.

MATERIALS AND METHODS

The study was carried out under Long Term Fertilizer Experiments (LTFE) which is in progress since 1972 at the Tamil Nadu Agricultural University in a Typic Ustropept clay loam soil having pH 8.2 and EC 0.75 dSm^{-1}. The experiment was laid out in randomised block design comprising ten treatments replicated four times. Seven of the treatments involved NPK application at graded levels, one supplemented with zinc sulphate, one supplemented with FYM, one with hand weeding and one received sulphur free sources of NPK. A treatment without K application and another without P and K application and an absolute control formed the other three treatments. The recommended doses of N, P_2O_5 and K_2O to maize crop (Co.1) were 135, 67.5 and 35 kg/ha.

For examining the changes in the fertility status, soil samples were collected during knee high, tasseling and post-harvest stages of maize and were processed. Available N status of the soil was determined by alkaline permanganate method (Subbiah and Asija. 1956). The soils were also analysed for P (Olsen *et al.*, 1954) and K (Stanford and English, 1949) organic carbon (Walkely and Black, 1934). For plant analysis, the method proposed by Jackson (1973) was followed. The biomass yield was also recorded.

RESULTS AND DISCUSSION

The status of available N was found to be significantly influenced by the various treatments imposed and also by the stages of crop growth (Table 1). The available N content was increased with increase in the dose of fertilizer application. However, intensive cropping decreased the available N status in control treatment to a much lower value as compared to that of fertilized treatments (Bansal *et al.*, 1980). The increased N content with N fertilizers might be due to direct contribution towards the available N pool and enhancement of decomposition of the organic nitrogenous material. However, the FYM treated plot recorded the maximum value and surpassed all other treatments (Prasad *et al.*, 1983). This may be due to the continuous annual application of FYM at the rate of 10 t/ha for 20 years which would have brought an optimum environment of microbial population thus enabling quicker mineralization of

Table 1. Influence of treatments on Alk.$KMnO_4$-N and Olsen-P in soils at different stages of crop growth

Treatments	Alk.$KMnO_4$-N (kg ha^{-1})				Olsen-P (kg ha^{-1})			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
50% NPK	175	170	155	166	16.7	16.3	15.6	16.2
100% NPK	178	172	159	169	17.5	17.2	15.6	16.8
150% NPK	184	179	164	175	17.8	17.4	17.0	17.4
100% NPK + Hand weeding	180	175	160	171	16.6	16.6	15.9	16.4
100% NPK + $ZnSO_4$ (25 kg)	183	178	162	174	19.6	16.9	16.0	17.5
100% NP	177	172	156	168	17.3	16.4	15.3	16.3
100% N	176	170	153	166	6.9	5.6	5.2	5.9
100% NPK + FYM (10 t/ha)	191	186	171	183	18.6	17.6	16.9	18.6
100% NPK (S Free)	181	176	159	172	17.9	17.7	17.5	17.7
Control	166	161	145	157	6.5	5.6	5.0	5.7
Mean	179	174	158		15.5	14.7	14.0	
			CD (5%)				CD (5%)	
	Stage		3.26				0.34	
	Treatment		5.96				0.63	
	Treatment x Stage		NS				1.09	

S_1 - Knee high stage; S_2 - Tesseling stage; S_3 - Harvest stage

influenced the available N status of soil. Knee high stage had accounted higher available N and it decreased with advancement in age.

Available phosphorus

Singnificant increase in available P content was observed in the treatments involving phosphorus over control and N alone treatment (Table 1). This result further confirmed the beneficial effect of added P fertilizers on P availability (Muthuvel *et al.*, 1977). The superiority of added FYM in enhancing the P availability was also observed (Yaduvanshi *et al.*, 1985). Continuous application of N fertilizer alone without P addition had a marked deleterious effect on available P status of soil. It was due to crop removal and withholding of P fertilizer in the fertilizer schedule over several years. As in the case of available nitrogen, the soil available P declined with approach to maturity stage.

Available potassium

Regarding the soil available K, significant and strong variations could be observed only with treatments but it was non-significant with stages and its interaction (Table 2). A marked effect could be observed in the treatments receiving both organic and inorganic sources of nutrients. Decrease in available K was less in the treatments which received potassic fertilizer than those which did not receive it. Status of potassium was not significantly affected either with the use of N and P alone or in combination.

Organic carbon

Significant increase in the organic carbon content of soil was observed with treatments (Table 2). FYM involved treatment had registered maximum organic carbon content which was significantly higher than all other treatments. Among the other treatments, 150 per cent graded best and the rest of the treatments remained on par but yet significantly higher when compared to control. Enhanced organic carbon content could be observed with passage of time from knee high to harvest stage. This suggested the role of plant root exudates and microbial activities on organic carbon level in soil (Martin, 1977).

Biomass yield

Grain yield: The yield data (Table 3) involved that the yield differences among the various treatments attained the level of significance. Hundred per cent NPK + FYM treatment recorded its superiority over the rest of the treatments. Low yield was obtained from the unmanured treatments (Singh and Dubey, 1987). The successive increase in NPK levels reflected in corresponding siginficant rise in grain yield in relation to control and might be due to higher rate of assimilation

Table 2. Influence of treatments on NH_4OAc-K and organic carbon in soils at different stages of crop growth

Treatments	NH_4OAc-K (kg ha^{-1})				Organic Carbon (%)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
50% NPK	547	544	541	544	0.472	0.494	0.478	0.481
100% NPK	559	555	552	555	0.475	0.520	0.460	0.485
150% NPK	569	564	562	565	0.550	0.465	0.490	0.502
100% NPK + Hand weeding	562	557	550	556	0.460	0.486	0.485	0.477
100% NPK + $ZnSO_4$ (25 kg)	566	563	560	563	0.478	0.492	0.535	0.502
100% NP	543	540	538	540	0.467	0.580	0.487	0.511
100% N	538	535	534	536	0.542	0.491	0.497	0.510
100% NPK + FYM (10 t/ha)	590	587	585	587	0.493	0.455	0.596	0.515
100% NPK (S Free)	565	560	558	561	0.493	0.480	0.498	0.490
Control	537	535	532	535	0.475	0.490	0.445	0.470
Mean	558	554	551		0.490	0.495	0.497	
			CD (5%)				CD (5%)	
	Stage		NS				0.010	
	Treatment		16.23				0.018	
	Treatment x Stage		NS				1.032	

S_1 - Knee high stage; S_2 - Tesseling stage; S_3 - Harvest stage

(Patil *et al.*, 1984). There was no specific increase in biomass yield when K was added along with N and P in relation to NP treatment. It indicated the sufficiency of available K in the soil and the possibility of excluding fertilizer K for maize crop grown under similar situations (Anon., 1980). It is a noteworthy feature that exclusion of S from fertilizer schedule had not resulted in drastic yield reduction. This was due to the fact that the experimental soil is gypsiferous in nature and also the irrigation water contains a significant amount of S which could take care of the S requirements of crops being grown.

Straw yield: The effect of various treatments on the straw yield of maize was in consonance with the trend observed in the case of grain yields.

Uptake of major nutrients

The data on uptake of nutrients are given in Table 3.

N uptake

Fertilization with normal and enhanced doses of NPK significantly increased the N uptake in both grain and straw in relation to other treatments (Dahia *et al.*, 1980). The results showed that the application of FYM in combination with NPK removed maximum N as reported by Vageesh *et al* (1989). The least uptake was observed with control wherein not only the grain and straw yield was poor but also the N accumulation in grain and straw was less. This finding was in accordance with that of Patil *et al.* (1993).

Table 3. Influence of treatments on biomass yield and uptake of major nutrients in maize (kg ha^{-1}) (Mean values)

Treatments	Biomass yield		N uptake		P uptake		K uptake	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
50% NPK	2563	4343	42.5	32.3	7.9	4.5	13.8	79.4
100% NPK	2913	5426	52.0	42.2	9.9	6.3	17.3	100.7
150% NPK	3488	6513	64.4	54.2	12.7	8.3	23.6	127.2
100% NPK + Hand weeding	3250	5849	58.6	44.6	11.2	6.6	19.9	110.1
100% NPK + $ZnSO_4$ (25 kg)	3506	6598	64.0	53.1	13.6	6.9	23.5	125.9
100% NP	3231	5979	60.3	46.3	11.7	7.8	20.9	110.6
100% N	1563	2851	29.6	21.1	5.3	4.2	10.1	51.8
100% NPK + FYM (10 t/ha)	4775	8856	93.1	77.2	19.0	14.9	33.8	186.0
100% NPK (S Free)	3600	6670	62.8	53.5	12.5	8.5	21.9	123.9
Control	1263	2335	20.6	17.0	3.7	3.5	6.6	42.0
	63	2 6	2 2	22.2	4.7	3.2	7.4	50.8

P uptake

Uptake of phosphorus in maize grain and straw was significantly influenced by the different treatments. NPK in combination with FYM registered the highest uptake of phosphorus by both grain and straw. The addition of fertilizers along with FYM every year maintained the soil fertility at a fairly high level for sustained crop yields under Indian conditions (Chaudhary *et al.*, 1981). Avoiding the P sources resulted a significant reduction in the absorption of P by maize which was on par with control and hence the enhanced P in the medium was conducive for better uptake (Subehia and Minhas, 1993).

K uptake

The uptake of K by both grain and straw varied markedly in all the treatments. The absolute superiority of FYM in favouring greater uptake of K was well reflected in the result. It is in accordance with the findings of Savithri *et al.* (1977). Among the graded doses of NPK, maximum removal was recorded with the application of 150 per cent NPK which was so significantly higher over all other levels (Mathews and Jose, 1985). There was not much difference observed in the K uptake between NP and NPK treatments. The K fertilizer addition had not influenced the crop growth and subsequent uptake. The reason for this might be due to high available K status of the soil and hence, it could be concluded that good crop yields may be obtained without external source of K in the soil when the soil is very rich in K reserves.

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