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Effect of inorganic nitrogen, coirpith and biofertilizer on availability and uptake of phosphorus and potassium under maize preceded with sole and intercropped sorghum

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Abstract : Experiment was conducted in a mixed black soil to assess the impact of integrated nitrogen management on availability and uptake of phosphorus and potassium under maize preceded with sole and intercropped sorghum. The cropping system either sole or intercrop failed to influence the availability of P and K in the soil. However, the N levels and composted coirpith / coirpith + biofertilizer and their integration exerted favourable influence on the P and K status. Though the different modes of N aided in the buildup of P in the soil at harvest, depletion was noticed with respect of available K and the N sources reduced the depletion. The inorganic, organic and bio N sources again enhanced the uptake of P and K by maize. *(**Key Words** : Maize, Coirpith, Uptake, Availability).*

Application of major nutrients especially N plays a key role in determining the yield of crops. Shortage in fertilizers and escalating prices warrant the integrated use of inorganic, organic and bio nutrients to sustain productivity and to maintain soil fertility. Among the organics, coirpith which is accumulating in huge quantities causing pollution problem, could be profitably utilized after composting. Legumes are known to benefit the succeeding crop by way of biological N fixation and mobilization of lesser available forms of plant nutrients (Sharma *et al.* 1985). Fertilizers and organics not only act as a source of nutrients but also affect the availability of other nutrients in the soil. The present study aims at the impact assessment of various N modes on the availability and uptake of P and K under maize preceded with sole and intercropped sorghum.

Materials and Methods

Experiment was conducted in a mixed black soil (Vertic Ustropept), sandy clay loam in texture, pH 8.3, EC 0.39 dSm-1, low in available N (219 kg ha^{-1}) and P (10.64 kg ha^{-1}) and high in available K (665 kg ha^{-1}). The treatments included two cropping sequences (Cr) *viz.*, sole sorghum-maize (sole cropping) and sorghum + cowpea - maize (inter cropping) and inorganic N control (C), biofertilizer (BF), composted coirpith (CP) and both (CP + BF) in main plots and five levels of N *viz.*, 0, 30, 60, 90 and 120 kg ha^{-1} for sorghum and 0, 60, 120, 180 and 240 kg ha^{-1} for maize designated as N_0, N_1, N_2, N_3 and N_4 respectively in sub plots under split plot design in a fixed layout. Nitrogen in the form of urea was given in three splits, while P @ 45 and 62.5 kg P_2O_5 ha^{-1} for sorghum and maize, respectively was given basally. No potash was applied for both the crops. The CP @ 12.5 t ha^{-1} was incorporated in the soil before sowing and biofertilizer azospirillum @ 600 g ha^{-1} was given through seed treatment for both the crops. Soil and plant samples were collected at knee-high, tasseling and harvest stages of maize and anlaysed for available P (Watenabe and Olsen, 1965) and K (Hanway and Heidal, 1952) and plant samples for total P and K contents (Jackson, 1973) and uptake computed. The buildup / depletion of available P and K in the soil at harvest of maize was calculated.

Results and Discussion

Available phosphorus

Though the intercropping registered higher mean P availability (29.35, 26.01 and 19.96 kg ha^{-1}, respectively in the three stages) over sole cropping (27.12, 25.42 and 17.26 kg ha^{-1}), the differences did not attain the level of significance (Table 1). The N levels showed profound influence and N_3 level at knee-high and tasseling stages and N_4 at harvest registered higher values. However the applied levels were at par at the early stages of crop growth. Super imposing of organics rated better in enhancing the available P with higher values over inorganic N alone and this might be attributed to the release of CO_2 and organic acids produced during microbial decomposition which would have facilitated the solubility of P besides replacing a part of adsobed P. Further, the organic anions compete with phosphate ions and chelate/complex the Al^{3+}, Fe^{3+} and Ca^{2+}, thus decrease the phosphate precipitation process and

increase the P availability. This is in accordance with the findings of Dhakshinamoorthy (1991). Irrespective of the cropping, N levels and CP/BF, the available P decreased considerably with advancement of maize growth which might be due to crop removal.

Available potassium

The intercropping influenced the available K appreciably at knee-high stage only. Application of CP and CP+BF improved the available K over inorganic N alone at all but the harvesting stage of the crop. The N levels also showed positive influence on the buildup of K and the N_3 and N_4 recorded higher values over the other levels of N (Table 1) This might be due to the release of K^+ ions from the exchange sites by NH_4^+ ions through ion exchange and this corroborates with the earlier findings of Baskaran (1983) and Dhakshinamoorthy (1991). The highest available K of 774 kg ha^{-1} was in N_4 coupled with CP+BF at tasseling stage and this was comparable with same level of N with CP (744 kg ha^{-1}). As was the case with available P, the availability of K also decreased with time.

Buildup / depletion of P and K at harvest

The deviation in the P status over the initial level ranged from 0 to 24.36 kg ha^{-1} for various treatments. The intercropping exhibited higher buildup (+9.32 kg ha^{-1}) as compared to sole cropping (+6.62 kg ha^{-1}). The different N levels exhibited a buildup in P status and the values varied between 3.23 and 13.44 kg ha^{-1}. Super imposing of CP+BF followed by CP and BF exhibited higher buildup of +11.87, +9.42 and +6.83 kg ha^{-1}, respectively as compared to inorganic N alone (+3.77 kg ha^{-1}). The highest buildup of 19.18 kg ha^{-1} of available P was registered by the combination of 240 kg N ha^{-1} with CP+BF followed by the same level of N with CP (19.04 kg ha^{-1}) . In contrast to P, a depletion was noticed in available K under all the main effects. Both the cropping systems showed a depletion after maize and the values were - 90 and - 81 kg ha^{-1} under sole and intercropping, respectively (Table 2). The various levels of N showed a general depletion in K status and the values varied from - 48 to - 133 kg ha^{-1} and the applied levels reduced the depletion considerably. While the mineral fertilizer N revealed the depletion at higher magnitude (-137 kg ha^{-1}), super imposing of CP with N reduced the depletion to a greater extent (-39 kg ha^{-1}). The negative balance in available K might be substantiated by the increased removal of K from the soil by the crops under the situation of non supplementation of K through fertilizer. The effectiveness of chemical fertilizer, organics and biofertilizer in the buildup of P but not K was also reported by Presad and Rokima (1991).

Phosphorus uptake

Cropping systems either sole or intercropping in the preceding season did not show any appreciable variation in the total P uptake by succeeding maize in either of the three growth stages studied. Increase in levels of N showed a profound influence in enhancing the P uptake (Table 3). The applied N resulted in higher drymatter production without much dilution of P concentration and further, the N addition improved the root volume by favouring better root growth and absorption of native and applied P in turn promoting higher P uptake. This result corroborates with the findings of Baskaran (1983).

Use of organic and bio N sources with inorganic N exhibited their superiority over mineral fertilizer N in enhancing the P uptake. The enhanced uptake might have been contributed by better root growth, reduced P fixation besides chelating and complexing action of organic anions and hydroxy acids liberated from the decomposing organics (Dhakshinamoorthy, 1991). With advancement of crop growth, the P uptake also increased due to enhanced drymatter production. Higher P uptake was noted under N_3 and N_4 levels irrespective of integrating factor. Better P nutrition with coupled use of inorganics and organics was also earlier reported by Gangwar and Niranjan (1991).

Potassium uptake

The preceding crops either sole or intercropping exhibited only marginal effect. The N levels showed significant influence and N_4 registered higher uptake values and however this was at par with N_3 level (Table 3). Super imposing of CP with fertilizer N resulted in higher K uptake at knee-high and harvest stages while at tasseling stage, CP+BF exhibited higher uptake. Enhancement in the uptake of K by maize was reported for the addition of inorganic N (Baskaran, 1983), CP (Krishnan, 1986) and integration of fertilizer N with organics (Dahiya *et al.* 1987).

Thus it could be concluded that pulse intercropping with sorghum in the preceding season showed only marginal variation over sole cropping in enhancing the available P in the succeeding season under maize. However, the effect was positive in

Table 1. Available P and K status (kg ha^{-1}) at different stages of maize

Source	Available P						Available K					
	Knee-high		Tasseling		Harvest		Knee-high		Tasseling		Harvest	
	Sole	Inter	Sole	Inter	Sole	Inter	Sole	Inter	Sole	Inter	Sole	Inter
Organics / biofertilizer												
C	25.93	27.86	22.60	23.98	12.84	15.97	585	634	563	595	565	491
BF	26.96	23.49	20.67	30.81	15.68	19.26	605	671	613	632	575	559
CP	27.61	37.58	32.77	23.13	19.89	20.22	702	730	720	672	572	681
CP+BF	28.00	28.46	25.62	26.10	20.62	24.39	685	721	674	651	589	607
N levels												
N_0	21.56	24.15	18.08	20.76	13.94	13.80	613	667	612	573	520	546
N_1	29.08	24.74	24.64	21.34	16.19	15.42	634	681	610	608	559	585
N_2	29.19	29.02	25.50	27.09	16.45	19.48	672	697	627	638	573	580
N_3	30.31	32.20	33.65	29.61	16.62	26.04	669	705	657	664	596	538
N_4	25.48	36.63	25.21	31.23	23.10	25.06	636	694	709	705	627	573
Source	CD		CD		CD		CD		CD		CD	
Cr	NS		NS		NS		26.9		NS		NS	
O	NS		NS		3.97		38.1		66.2		NS	
N	4.84		4.16		3.37		27.9		23.0		42.2	
N x O	10.44		NS		NS		NS		54.6		NS	
Cr x O	NS		5.22		NS		NS		NS		NS	
Cr x N	7.11		NS		4.76		NS		NS		NS	

C : Control ; BF : Biofertilizer ; CP : Composted coirpith ; CD : (P = 0.05)

Table 3. P and K uptake (kg ha^{-1}) at different stages of maize

Source	Available P						Available K					
	Knee-high		Tasseling		Harvest		Knee-high		Tasseling		Harvest	
	Sole	Inter	Sole	Inter	Sole	Inter	Sole	Inter	Sole	Inter	Sole	Inter
Organics / biofertilizer												
C	1.84	1.81	7.90	8.56	15.1	15.0	34.3	37.1	157.0	161.1	176.0	183.7
BF	1.94	1.85	8.11	9.36	14.3	14.6	35.6	39.6	148.4	151.0	165.6	166.9
CP	2.11	2.17	10.40	8.11	16.4	17.7	42.8	41.1	180.6	149.2	190.3	208.2
CP+BF	2.07	2.01	10.19	9.01	18.2	17.5	39.7	32.4	191.7	154.0	199.0	195.9
N levels												
N_0	1.60	1.59	5.79	5.39	11.9	11.3	31.5	30.2	106.3	107.0	140.2	135.9
N_1	1.79	1.79	7.58	7.49	15.6	14.6	34.8	36.0	143.6	126.0	182.1	170.2
N_2	1.88	1.82	9.61	8.98	17.7	17.7	37.5	34.7	175.5	171.5	202.4	204.1
N_3	2.19	2.14	10.32	10.95	17.4	18.1	39.5	40.7	200.4	180.8	190.3	218.0
N_4	2.50	2.46	12.45	10.99	17.7	19.1	47.1	46.1	221.1	183.7	198.5	215.3

Source	CD	CD	CD	CD	CD	CD
Cr	NS	NS	NS	NS	NS	NS
O	0.13	NS	1.07	2.20	NS	20.0
N	0.09	0.69	1.71	1.36	14.7	18.2
N x O	0.17	1.52	1.47	2.83	NS	36.2
Cr x O	NS	NS	NS	3.11	NS	NS
Cr x N	NS	NS	1.04	2.00	21.9	23.1

C : Control ; BF : Biofertilizer ; CP : Composted coirpith ; CD : (P = 0.05)

Table 2. Buildup/depletion (kg ha^{-1}) of available P and K at harvest of maize

	Available P		Available K	
	Sole cropping	Intercropping	Sole cropping	Intercropping
Organics / biofertilizer				
C	+2.20	+ 5.53	-100	-174
BF	+5.04	+ 8.62	- 89	-105
CP	+9.25	+ 9.58	- 93	+ 16
CP+BF	+9.98	+13.75	- 76	- 58
N levels				
N_0	+ 3.30	+ 3.23	-146	-119
N_1	+ 5.55	+ 5.17	-105	- 80
N_2	+ 5.81	+ 7.33	- 92	- 85
N_3	+ 5.98	+10.69	- 68	- 27
N_4	+12.46	+13.44	- 38	- 92

respect of available K upto knee-high stage only. The inorganic N, CP and CP+BF also showed beneficial influence in the buildup of P, while they decrease the depletion of K considerably. The uptake of P and K was enhanced by the various N modes and their integration.

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