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SOIL FERTILITY AND YIELD OF SUGARCANE *AS INFLUENCED* BY PHOSPHORUS MANAGEMENT IN *KHARIF* RICE-AUTUMN SUGARCANE RAISED WITH OR WITHOUT INTERCROP OF GREENGRAM CV. CO-4

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ABSTRACT

Field experiment was conducted during 2004-05 and 2005-06 on deep black soil. Results revealed that the application of 40 tonnes pressmud biocompost ha^{-1} to preceding rice recorded significantly higher millable cane yield, intercrop yield, sugarcane equivalent yield, total nutrient uptake and available P_2O_5 status of soil after harvest of sugarcane during both the years of study. Available N, K_2O and S status of soil after harvest of sugarcane were also improved with application of pressmud biocompost but not up to significant level. Application of recommended dose of P/ha (54.59 kg/ha) to sugarcane raised without and with intercrop of greengram recorded significantly higher millable cane yield, sugarcane equivalent yield, total nutrient uptake and available nitrogen and phosphorus status of soil after harvest of sugarcane over the other levels of phosphorus. The available potassium and sulphur content of soil reduced and increased, respectively with increased level of phosphorus. However, it failed to attain the levels of significance during both the years.

Key words: Sugarcane, Rice, Pressmud biocompost, Available phosphorus, Intercrop.

INTRODUCTION

Organic matter, the backbone of soil fertility and productivity is generally low in vertisol of south Gujarat. Therefore, use of chemical fertilizer alone may not keep pace with time in maintenance of soil health for sustaining the productivity. Rice-sugarcane cropping system is one of the dominant sequences under vertisol of south Gujarat. Under rice-sugarcane cropping system, both crops are nutrient exhaustive and may deplete the soil fertility and this may also decline the soil productivity. Therefore, adequate and balanced use of manures and fertilizer is essential. Application of 12-15 t/ha seasoned pressmud in sugarcane save 50 to 75 per cent phosphorus needs of crop (Anonymous, 2000). However, most of the farmer applied their pressmud to rice crop. Further the sugar factories in south Gujarat started production of biocompost from pressmud. Therefore, it becomes imperative to test the role of biocompost as sources of phosphorus in rice-sugarcane cropping system. With this background information the present experiment was planed at Regional Sugarcane Research Station, N.A.U., Navsari.

MATERIALS AND METHODS

Field experiment was conducted during 2004-05 and 2005-06 on deep black soil of plot number G-19 and G-25 of Regional Sugarcane Research Station, Navsari, Gujarat, respectively. The soil of plot number G-19 and G-25 were contained 0.53 and 0.48 % total nitrogen, 28.0 and 18.0 kg/ha available phosphorus and 320.0 and 315.0 kg/ha available potassium, respectively. The experiment on preceding kharif rice crop was laid out in randomized block design (RBD) with four treatments consisting two levels of pressmud biocompost (PB) (T_2:20 and T_3:40 t/ha) and one level of inorganic phosphorus (SSP: single super phosphate) (T_4:13.2 kg P/ha) along with control (T_1:no phosphorus) replicated four times. The experiment on autumn

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sugarcane was superimposed on the same site without changing the randomization of treatments during both the years to assess the residual effect of phosphorus management in preceding *kharif* rice on succeeding autumn sugarcane raise with or without intercrop of greengram 'Co-4' under three phosphorus (in form of SSP) levels in split plot design (SPD) with four replications. Thus, in sugarcane there were 24 treatment combinations consisting of four treatments i.e. residual treatments of *kharif* rice as main plots and three levels of phosphorus applied to sugarcane raise with or without intercrop of greengram 'Co-4' *viz.*, zero kg P/ha without (S_1) and with (S_2) intercrop, 50% recommended dose of P/ha without (S_3) and with (S_4) intercrop and 100% recommended dose of P/ha without (S_5) and with (S_6) intercrop as sub plots. The recommended dose of P for sugarcane is 54.59 kg/ha. The experiment was started during *kharif* season of 2004 with sowing of rice 'Jaya'. Rice seedlings (30 days old) were transplanted at 20 cm x 15 cm spacing in R.B.D. with four replications. Transplanting of rice seedling was done during first fortnight of July and planting of sugarcane 'CoN-03131' during second fortnight of November in furrows of 100 cm apart. In rice, different levels of PB and phosphorus were applied at time of puddling, while in sugarcane various levels of phosphorus were applied at time of planting. Nitrogen (100 and 250 kg/ha to rice and sugarcane, respectively) in form of ammonium sulphate in rice and in form of urea in sugarcane and potassium (125 kg/ha to sugarcane) in form of muriate of potash were applied to both crops as per recommendation. Greengram 'Co-4' as intercrop sown 3 to 4 days after sugarcane planting at 30-40-30 cm spacing in between two rows of sugarcane. All the necessary cultural practices were done as and when required for *kharif* rice, autumn sugarcane and greengram. The crops were harvested at their maturity *viz.* rice at 90 days after transplanting, greengram at 120 days after sowing (before the earthing-up) and sugarcane at 12 month of planting. The weather during crop period was normal.

RESULTS AND DISCUSSION

Residual effect of P management in preceding crop : The highest Millable cane yield was noted with application of 40 tonnes pressmud biocompost ha^{-1} to preceding *kharif* rice (T_3) during both the years as well as in pooled data (Table 1). The mean increased in millable cane yield recorded under treatment T_3 over T_1 were 17.14, 22.74 and 19.86 during 2004-05, 2005-06 and in pooled data, respectively. The increase in millable cane yield due to application of pressmud biocompost to preceding rice may be accounted for improvement in yield attributes like number of millable canes ha^{-1} and millable cane weight. Patil and Kale (1983) also reported the beneficial residual effect of pressmud cake over inorganic fertilizers for cane yield.

Similarly the highest seed yield of greengram sown as intercrop in sugarcane was recorded the highest under treatment T_3 (40 tonnes pressmud biocompost ha^{-1}). These may be attributed to better utilization of nutrients left in soil applied to rice crop resulted in profuse growth of intercrops leads to higher yields. The seed yield of rice was converted to sugarcane equivalent yield and added to sugarcane yield. The residual effect of phosphorus management in preceding *kharif* rice on sugarcane equivalent yield was significant during both the years as well as in the pooled analysis. Sugarcane grown after *kharif* rice receiving 40 tonnes pressmud biocompost ha^{-1} recorded significantly the highest sugarcane equivalent yield as compared to other treatments and the increase was to the tune of 18.20, 21.66 and 19.91 per cent during 2004-05, 2005-06 and pooled data, respectively over treatment T_1 (no phosphorus application). The increased sugarcane equivalent yield might be due to higher intercrop as well as millable cane yield under this treatment (T_3). The addition of large quantity of pressmud biocompost left the beneficial residual effect which might have enhanced the intercrop as well as millable cane yield.

The application of 40 tonnes pressmud biocompost ha^{-1} to preceding *kharif* rice remained *at par* with 20 tonnes pressmud biocompost ha^{-1} recorded significantly higher total uptake of nitrogen, phosphorus and sulphur by sugarcane over rest of the treatments during both the years of experimentation (Table 2). The increased uptake of nutrients by sugarcane due to residual effect of pressmud biocompost applied to preceding rice was due to higher content of nutrients and higher cane dry matter production of crop under these treatments boosted the nutrient uptake.

TABLE 1. Millable cane yield (t/ha), seed yield of Intercrop and sugarcane equivalent yield (t/ha) of sugarcane as influenced by phosphors managements.

Treatment	Millable cane yield (t/ha)			Seed yield of Intercrop (kg/ha)		Sugarcane equivalent yield (t/ha)		
	2004-05	2005-06	Pooled	2004-05	2005-06	2004-05	2005-06	Pooled
Residual effect of P management in preceding *kharif* rice								
T_1	92.71	87.83	90.27	604.16	980.55	96.91	94.81	95.86
T_2	101.46	101.20	101.33	802.08	1022.22	107.03	108.48	107.76
T_3	108.60	107.80	108.20	857.64	1055.55	114.55	115.35	114.95
T_4	96.63	94.58	95.61	798.61	1013.88	102.17	101.80	101.99
S.Em. ±	2.21	1.95	1.47	-	-	2.29	2.09	1.55
CD at 5%	7.05	6.24	4.37	-	-	7.31	6.68	4.60
CV %	10.82	9.76	10.32	-	-	10.65	9.74	10.20
Phosphorus levels with and without intercrop applied to succeeding autumn sugarcane								
S_1	91.44	86.63	89.04	-	-	91.44	86.63	89.04
S_2	86.00	79.38	82.69	669.27	943.75	95.30	92.81	94.06
S_3	103.48	102.10	102.79	-	-	103.48	102.13	102.81
S_4	95.84	94.44	95.14	726.56	1027.08	105.93	109.10	107.52
S_5	115.35	116.80	116.08	-	-	115.35	116.75	116.05
S_6	106.98	107.90	107.44	901.04	1083.33	119.49	123.30	121.40
S.Em. ±	2.46	1.71	1.22	-	-	2.47	1.68	1.22
CD at 5%	6.95	4.84	3.42	-	-	6.98	4.75	3.41
CV %	9.84	6.99	8.56	-	-	9.39	6.40	8.03
Interaction								
S.Em. ±	4.91	3.42	2.99	-	-	4.94	3.36	2.99
CD at 5%	NS	NS	NS	-	-	NS	NS	NS
General mean	99.85	97.86	98.86	1881.94	2122.56	105.16	105.11	105.14

The available nitrogen, potassium and sulphur content in the soil after harvest of sugarcane were remained non significant due to residual effect of phosphorus management in rice crop during both the years (Table 3). Although there was a slight improvement in nutrient status of soil under treatment of pressmud biocompost as compared to other treatments. Pressmud cake is a rich source of organic matter and also content good amount of major and micro nutrients. Patil and Kale (1983) reported that pressmud cake is effective for maintaining soil fertility. The status of available P_2O_5 in soil after harvest of sugarcane was significantly influenced by residual effect of phosphorus management in *kharif* rice during both the years. Application of 40 tonnes pressmud biocompost ha^{-1} (T_3) to preceding rice resulted in the highest available P_2O_5 content in soil after harvest of sugarcane during both the years but it was remained *at par* with treatment T_2 during first year (2004-05). The increase in available P_2O_5 content of soil under treatment of pressmud biocompost may be due to huge quantity of P_2O_5 added in the soil through pressmud biocompost being a good source of P_2O_5. Further, the rate of decomposition of pressmud cake is slow due to its wax content (Kale, 1981), some of the nutrients may be remains in the soil and benefited to succeeding crop. Bawasakar *et al.* (1981) also noticed increase in availability of P_2O_5 due to incorporation of pressmud cake.

Effect of phosphorus levels with and without intercrop : Application of 100 per cent recommended dose of P/ha (54.59 kg P/ha) to sugarcane raise without intercrop of greengram (S_5) increased the millable cane yield significantly over the other treatments during both the years as well as when the data were pooled over years. On the basis of pooled data, cane yield was increased to the tune of 40.38 and 36.53 per cent under treatment S_5 over no phosphorus application to sugarcane raise with (S_2) and without (S_1) intercrop of greengram. These results are in conformity with those reported by Patel *et al.* (2004). When sugarcane raise without intercrop of greengram recorded significantly higher millable

TABLE 2. Total nutrient uptake (kg ha^{-1}) by sugarcane as influenced by phosphorus management.

Treatments	N uptake (kg ha^{-1})		P_2O_5 uptake (kg ha^{-1})		K_2O uptake (kg ha^{-1})		S uptake (kg ha^{-1})	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Residual effect of P management in preceding *kharif* rice								
T_1	154.80	170.33	77.97	68.92	206.27	201.92	30.57	34.41
T_2	172.80	184.40	92.29	82.17	226.01	216.55	33.47	37.02
T_3	180.80	192.46	97.54	87.14	234.25	225.37	35.06	38.69
T_4	165.20	176.67	84.94	76.97	216.08	208.19	32.18	35.43
S.Em. ±	4.43	3.10	2.73	1.62	4.93	3.19	0.65	0.56
CD at 5%	14.17	9.92	8.74	5.18	15.77	10.22	2.08	1.79
CV %	12.89	8.39	15.18	10.06	10.95	7.34	9.69	7.52
Phosphorus levels with and without intercrop applied to succeeding autumn sugarcane								
S_1	138.22	154.81	54.38	50.09	200.36	198.30	29.97	33.85
S_2	142.60	156.66	66.56	56.57	191.51	187.49	28.45	31.70
S_3	166.97	179.88	83.84	73.80	226.99	217.34	33.50	37.34
S_4	166.71	182.61	89.70	80.52	206.85	205.68	30.97	35.03
S_5	194.50	207.06	112.20	101.96	255.40	244.10	37.94	42.15
S_6	201.30	205.47	122.42	109.84	242.85	225.12	36.08	38.26
S.Em. ±	5.17	5.79	2.93	2.71	7.63	7.05	1.02	1.29
CD at 5%	14.62	16.38	8.29	7.66	21.60	19.96	2.88	3.64
CV %	12.28	12.79	13.29	13.74	13.84	13.25	12.42	14.15
Interaction								
S.Em. ±	10.34	11.58	5.86	5.42	15.27	14.11	2.04	2.57
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
General mean	168.39	101.07	88.19	78.80	220.65	213.00	32.82	36.39

cane yield as compared to sugarcane raise with intercrop at same level of phosphorus applied to sugarcane during both the years and pooled data. The low cane yield under intercropping system may be due to shadding effect of intercrop. These results are in accordance with Kumar and Srivastava (1994) and Sinha *et al.* (1994).

Seed yield of greengram sown as intercrop in sugarcane was noted higher under higher level of phosphorus (54.59 kg P/ha) applied to sugarcane over other levels of phosphorus. The sugarcane equivalent yield was found significantly higher under treatment S_6 (100 per cent recommended dose of P/ha with intercrop) during both the years as well as in pooled data. But it was remained *at par* with treatment S_5 (100 per cent recommended dose of P/ha without intercrop) during year 2004-05. Further, the successive increase in the levels of phosphorus significantly increased the sugarcane equivalent yield during both the years and in pooled data. Application of higher level of phosphorus to sugarcane not only increased the millable cane yield but also increased the seed yield of intercrop of greengram which lead to higher sugarcane equivalent yield under sugarcane-greengram intercropping system. At the same level of phosphorus, sugarcane raise with intercrop of greengram recorded higher sugarcane equivalent yield than sugarcane raise without intercrop of greengram during both the years and in pooled data. It clearly indicated that intercropping of greengram very well compensated the reduction in the sugarcane yield. Higher sugarcane equivalent yield of intercropping system might be due to additional yield from intercrop with good market price. These results are in accordance with the findings of Patel (2003).

There was a progressive increase in total nutrient (nitrogen, phosphorus, potassium and sulphur) uptake by sugarcane raise with and without intercrop of greengram with every increase in the level of phosphorus applied to sugarcane during both the years. Application of 100 per cent recommended dose of P/ha without intercrop noted the highest total nitrogen, potassium and sulphur uptake by sugarcane, being *at par* with application of 100 per cent recommended dose of P/ha with inter crop

TABLE 3. Available nutrient status of soil after the harvest of sugarcane as influenced by phosphors managements.

Treatments	Available nutrients in soil							
	2004-05				2005-06			
	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	S (ppm)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	S (ppm)
Residual effect of P management in preceding *kharif* rice								
T_1	206.88	23.25	321.83	11.67	212.92	16.92	316.83	13.67
T_2	216.25	29.75	327.12	12.46	222.29	19.50	326.96	14.46
T_3	224.33	32.46	339.92	13.29	224.29	21.83	327.33	15.29
T_4	210.25	25.25	319.96	12.25	215.54	18.58	314.96	14.25
S.Em. ±	4.02	0.86	6.16	0.45	2.95	0.48	3.35	0.45
CD at 5%	NS	2.76	NS	NS	NS	1.52	NS	NS
CV %	9.18	15.29	9.29	17.91	6.61	12.14	5.10	15.42
Phosphorus levels with and without intercrop applied to succeeding autumn sugarcane								
S_1	208.75	23.13	332.88	11.63	210.88	14.88	329.50	13.63
S_2	209.50	25.63	327.25	11.63	215.63	16.69	325.69	13.63
S_3	213.00	27.25	324.19	12.56	216.56	17.50	323.25	14.56
S_4	215.06	29.38	321.31	12.44	222.88	20.75	320.56	14.44
S_5	218.50	28.94	323.15	13.13	221.31	21.38	315.61	15.13
S_6	221.75	31.75	319.50	13.13	225.31	24.06	314.50	15.13
S.Em. ±	2.24	0.90	4.40	0.48	3.30	0.73	4.90	0.48
CD at 5%	6.34	2.55	NS	NS	9.35	2.06	NS	NS
CV %	4.17	13.02	5.42	15.55	6.04	15.14	6.10	13.39
Interaction								
S.Em. ±	4.48	1.80	8.80	0.97	6.61	1.45	9.81	0.97
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
General mean	214.43	27.68	324.71	12.42	218.78	19.21	321.52	14.42

during both the years of experimentation. While incase of total phosphorus uptake by sugarcane, it was observed significantly higher with application of 100 per cent recommended dose of P/ha with intercrop as compared to other treatments during both the years of study. The increased uptake of these nutrients by sugarcane with increase levels of phosphorus might be due to better development of crop resulted in higher content of these nutrients. These results are similar to those reported by Bangar *et al.* (1995).

The highest value of available nitrogen and available P_2O_5 in soil after harvest of sugarcane was obtained with application of 100 per cent recommended dose of P/ha with (S_6) intercrop during both the years over other treatments, but it was statistically *at par* with treatment S_5 (100 per cent recommended dose of P/ha with out intercrop) for available nitrogen and with treatment S_4 (50 per cent recommended dose of P/ha with intercrop) for available P_2O_5 in soil after harvest of sugarcane. The improvement in status of available P_2O_5 could be ascribed to addition of phosphorus through fertilizer. Further, intercrop greengram also helped to increase the availability of P_2O_5 in soil by converting unavailable form of P_2O_5 into available form by producing organic acid with decomposition of its (greengram) residue. This result is in consonance with those of Kumar and Verma (1999). The available K_2O and S status of soil after harvest of sugarcane was not altered significantly due to different levels of phosphorus applied to sugarcane raise with and without intercrop during both the year (Table 3).

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