irrigation water to a depth of 5 cm might be due to higher cultivation expenses because of higher cost of irrigation.

Higher grain yeild and net return from *Bhavani* were due to less cost of cultivation and reduced duration. Though *Ponni* and IR 20 registered higher grain yeild in the plant crop, the grain yield obtained from the ratoon crop of both the varieties was very low. Hence net return, per day production and net return per rupee were very low in these varieties. Increased net return per day production and net return per rupee invested were recorded with increasing N levels due to higher ratoon crop grain yield.

It is concluded that in single crop wetland area of Periyar-Vaigai command, allowing *Bhavani* to ratoon after the harvest would be desirable. Application of 125 kg.ha^{-1} N and irrigating the crop to a depth of 5 cm one day after the disappearance of ponded water would result in higher yield, greater water use efficiency and higher net return.

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EFFECT OF ORGANIC AMENDMENTS AND ZINC ON AVAILABILITY AND UPTAKE OF P, Ca AND Na BY SUGARCANE

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ABSTRACT

The efficacy of organic amendments (pressmud and zinc enriched pressmud) and zinc fertilisation was studied in paper factory effluent irrigated soil. The results showed that available phosphorus content in soil and its uptake in plant were increased due to the application of pressmud. Application of amendments and $ZnSO_4$ significantly increased exchangeable calcium, but decreased the exchangeable sodium. Total day matter production was significantly enhanced by the application of pressmud and soil application of $ZnSO_4$. Enrichment of pressmud with $ZnSO_4$ resulted in increased dry matter production. Foliar spray of zinc at 0.5 per centconcentration given at 90 and 110 days after planting significantly increased the dry matter production over soil application of zinc and control.

KEY WORDS : Zinc enriched pressmud -paper factory effluent - irrigated soil - nutrient availability and uptake - total dry matter production.

In recent years due to rapid industrilisation and urbanisation, it is not possible to bring more area under cultivation to step up the agricultural production. The only possible way is to increasee the production per unit area per unit time and to bring the degraded/polluted/ waste lands under cultivation by suitably reclaiming/managing them and using enriched organics. Keeping these points in view, this enrichment of amendment (pressmud) with micronutrient like zinc was designed to support the nutritional needs of plants.

MATERIALS AND METHODS

The field experiment was conducted at the farm of M/s. Ponni Sugars & Chemicals Ltd., Erode, to assess the favourable and adverse implications of effluent irrigation on soil

characters and plant growth, by employing organic amendment and zinc. The treatments consisted of the application of amendent (control, pressmud at 12.5 t/ha, enriched pressumed at 1 t/ha) and zinc application (control, soil application of $ZnSO_4$ at 25 t and 50 t/ha, foliar application at 0.5 per cent alone and in combination with soil application at 90 and 110 days after planting (DAP) in a factorial randomised block design with two replications. The enriched pressmud was prepared by mixing 2 kg $ZnSO_4$ for every 100 kg of sieved pressmud. The NPK fertilisers were applied uniformly to all the treatments at the recommended level of 220:62:120 kg/ha. Soil and plant samples were collected at 60, 90 and 120 DAP and analysed for pH, EC (Jackson, 1973), organic carbon (Warkley and Black, 1934), available N,P and K (Subbiah and Asija, 1956; Olsen *et al.*, 1954; Hanway and Hiedal, 1952, respectively), total NPK by acid digestion,available micronutrients by DTPA extraction (Jackson, 1973) and exchangeable cations (Hesse, 1971; Toth and Prince, 1949). The total dry matter production (TDMP) was recorded in the above stages and all the results are statistically scrutinised (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The initial characteristics of the soil and the amendments used are given in Table 1. The results indicate that available phosphorus status and uptake in plant were increased due to the application of presamud (Table 2, 3). The zinc addition either by soil application or foliar spray did not change the available P status and its uptake. Exchangeable calcium in soil and uptake in plant (Table 2,3) was increased due to the application of pressmud and zinc enriched pressmud. Individual application of $ZnSO_4$ as well as with foliar spray of $ZnSO_4$ were effective in increasing the exchangebale Ca content in soil and their uptake in plant. Incorporation of zinc enriched pressmud and $ZnSO_4$ at 50 kg ha^{-1} had profound influence in reducing the exchangeable sodium in soil and content and uptake at different stages of crop growth (Table 2,3). The magnitude of increase in TDMP was more at zinc enriched pressmud (10.77 t ha^{-1}) at 120 DAP and $ZnSO_4$ level at 25 kg ha^{-1} with 0.5 per cent foliar spray (10.98 t ha^{-1}). The interaction effect of amendments and zinc was highly significant (Table 4).

The additive effect of pressmud addition and effluent irrigation on available P and its uptake were observed in the present investigation. The favourable build up in the available P status in the soil could be attributed to the presence of organic matter, sulphides and phosphates coulped with the absence of free lime in sulphitation pressmud. The results from the present study were in agreement with the findings of Virendra Kumar and Mishra (1991). Zinc fertilisation at lower levels (25 kg $ZnSO_4$ ha^{-1}) increased significantly the P content and uptake because zinc plays an important role in

Table 1. Initial characteristics of soil, pressmud and enriched pressmud

Parameters	Soil	Pressmud	Enriched pressmud
pH	7.68	7.30	7.40
EC (dsm^{-1})	0.79	2.90	2.30
Organic carbon (%)	0.55	20.69	16.36
Alkaline $KMnO_4$ (kg ha^{-1})	262	-	-
Olsen's-P	19.6	-	-
NH_4 OAc-K	280	-	-
Total N (%)	-	1.10	1.15
Total P (%)	-	1.85	1.61
Total K (%)	-	1.25	1.28
Exch. Ca (C.mol (P^+) kg^{-1})	7.15	3.05	3.94
Exch. Mg (C.mol (P^+) kg^{-1})	1.52	1.50	1.86
DTPA-Zn (ppm)	0.95	150	225
DTPA-Cu (ppm)	1.35	35	153
DTPA-Fe (ppm)	14.60	1020	980
DTPA-Mn (ppm)	6.80	199	194

Table 2. Effects of organic amendments and $ZnSO_4$ on Olsens P, Exchangeable Ca and Na.

Treatments	Olsen's P kg ha^{-1}			Exchangeable Ca C.mol (P^+) kg^{-1}			Exchangeable Na. C.mol (P^+) kg^{-1}		
	60 DAP	90 DAP	120 DAP	60 DAP	90 DAP	120 DAP	60 DAP	90 DAP	120 DAP
O.A.									
1	22.1	19.8	10.8	7.43	7.19	6.63	20.9	20.6	20.2
2	26.0	22.3	20.2	8.92	8.35	8.02	19.1	18.7	18.9
3	25.1	22.0	29.7	9.28	8.60	8.45	18.9	18.2	18.0
CD	0.6	1.1	0.5	0.23	0.28	0.22	0.6	1.0	0.5
MNS									
1	23.9	21.4	19.1	8.13	7.77	7.23	20.9	19.3	19.4
2	24.9	22.1	18.8	8.63	8.15	7.80	19.6	19.3	19.0
3	24.4	21.0	18.5	8.87	8.32	8.07	19.2	18.9	18.7
4	24.0	21.3	19.3	8.20	7.63	7.30	20.1	19.3	19.4
5	24.9	21.4	28.9	8.60	8.15	7.77	19.6	19.2	19.0
6	24.3	21.2	18.6	8.83	8.27	8.03	19.1	18.9	18.7
CD	NS	NS	NS	0.32	0.39	0.31	0.8	NS	NS

O.A. - Organic amendments; MNS - Micronutrients; NS : Not-significant; DAP : Days after planting

the utilisation of native and applied P in soil. Similar results were reported earlier (Devarajan 1985).

The increased Ca availability and uptake was due to the beneficial effect of the pressmud and zinc enriched pressmud application in the removal of sodium ion from the clay complex by calcium ion and thereby improving the soil properties, besides increasing the exchangable calcium content of the soil. The increased uptake of calcium due to addition of zinc might be through the enzymatic effects in the matabolic process (Panda and Nayak, 1974). The beneficial effect of zinc enriched pressmud with $ZnSO_4$ in replacing the exchangeable Na from the clay complex by calcium was observed. The reason being that the calcium exchanged for Na might have improved the soil structure, facilitating better percolation, permeation and aeration. The results of the present study are in agreement with the findings of Manoharan *et al.* (1992). This would have reflected in the decreased Na content of plant. Zinc also played a prominent role in reducing the Na content by making the plant tolerant to salinity

Table 3. Effect of organic amendments and $ZnSO_4$ on P, Ca and Na uptake.

Treatments	P uptake (kg ha^{-1})			Ca uptake (kg ha^{-1})			Na uptake (kg ha^{-1})		
	60 DAP	90 DAP	120 DAP	60 DAP	90 DAP	120 DAP	60 DAP	90 DAP	120 DAP
O.A.									
1	3.81	5.39	9.61	31.2	44.3	177	2.29	3.02	11.02
2	4.35	6.41	11.79	40.2	57.5	234	1.66	2.00	10.79
3	4.20	6.13	10.84	39.7	57.4	265	1.34	1.56	10.86
CD	0.11	0.15	0.24	1.0	1.4	2	0.05	0.06	NS
MNS									
1	4.01	5.77	10.75	34.6	48.2	203	2.04	2.41	11.40
2	4.26	6.23	10.53	38.4	56.0	212	1.71	2.30	10.75
3	4.14	5.93	9.65	38.3	55.7	216	1.57	1.97	10.72
4	4.00	5.78	11.87	35.0	48.8	240	2.00	2.24	10.87
5	4.23	6.20	10.94	37.7	54.8	241	1.69	2.25	10.80
6	4.09	5.95	10.75	38.0	54.9	242	1.55	1.99	10.78
CD	0.15	0.21	0.34	1.3	2.0	3	0.07	0.09	0.33

O.A. - Organic amendments; MNS - Micronutrients; NS : Not-significant; DAP : Days after planting

Table 4. Effect of organic amendments and $ZnSO_4$ on dry matter production (t ha^{-1})

Treatments	60 DAP				90 DAP				120 DAP			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
NPK alone (T_1)	2.50	2.66	3.00	2.72	3.48	3.95	4.50	3.98	8.81	10.10	10.40	9.77
T_1 + 25 $ZnSO_4$ SA	2.63	2.90	2.74	2.76	3.88	4.40	4.11	4.13	9.40	10.20	10.25	9.95
T_1 + 50 $ZnSO_4$ SA	2.85	2.80	2.69	2.78	4.30	4.21	4.03	4.18	9.65	10.15	10.58	10.13
T_1 + 0.5% $ZnSO_4$ FS	2.59	2.65	2.97	2.74	3.53	3.94	4.47	3.98	10.52	10.74	11.50	10.92
T_1 + 25 $ZnSO_4$ SA + 0.5% $ZnSO_4$ FS	2.63	2.89	2.73	2.75	3.86	4.38	4.10	4.11	10.63	11.30	11.00	10.98
T_1 + 50 $ZnSO_4$ SA + 0.5% $ZnSO_4$ FS	2.84	2.80	2.69	2.78	4.28	4.20	4.02	4.17	11.11	10.82	10.90	10.94
Mean	2.67	2.78	2.80		3.89	4.18	4.21		10.02	10.55	10.77	
			CD				CD				CD	
			(P = 0.05)				(P = 0.05)				(P = 0.05)	
M			0.03				0.04				0.12	
Zn			0.04				0.06				0.18	
M x Zn			0.07				1.00				0.30	

SA : Soil application; FS : Foliar spray 0.5% Zn SO_4 on 90 and 100 DAS
DAS : Days after planting

which was evidenced by decreassed Na^+ content. Similar results were obtained by Saxena and Rewari (1990)

The role of zinc enriched pressmud in improving the dry matter yeild was quite expected. In addition, the use of enriched pressmud might have supplied the micronutrients especially zinc and enhanced their availability to crops. In the presence of pressmud, 25 kg $ZnSO_4$ ha^{-1} with 0.5 per cent $ZnSO_4$ foliar spray has increased the dry matter yield which is in agreement with the findings of Kumaresan *et al.* (1985),

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