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Micronutrient Status of Sugarcane as Affected by Sulphitation Press-mud with Nitrogen

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ABSTRACT

In a field experiment, 0, 10, 20 and 30 t ha0-10 sulphitation press-mud containing 80% moisture was applied with 0, 75, 100 and 150 kg N ha^{-1} to spring planted sugarcane cultivar Co 1148 in a clay loam soil. Zn, Fe, Mn and Cu in index tissue of different growth stages and their contents and uptake by crown at harvest increased with the increased addition of press-mud over control. Increasing levels of N however, did not have any significant effect. Uptake of Zn, Fe, Mn and Cu by sugarcane ranged from 0.29-0.71, 1.58-2.56, 0.57-1.46 and 0.11-0.34 kg ha^{-1}, respectively. Increased addition of press-mud alone from 10 to 30 t ha^{-1} increased the uptake of Zn, Fe, Mn and Cu by 10.3-106.9, 10.6-29.1, 29.8-59.7, and 36.4-145.4% over control that further reached to 144.8% at 100 kg N, 62.0 and 156.1% each at 150 kg N and 209.1% at 75 kg N each combined with 30 t Press-mud ha^{-1}, respectively.

INTRODUCTION

The use of high analysis fertilizers in intensive cultivation of high yielding crop varieties is resulting into more and more nutrient deficient soils. Consequently, deficiency of not only macro- but micro-nutrients as well is becoming widespread and alarming. The numerous reports contain the responses of different crops to micronutrients application (Yadav, 1987 ; Yadav *et al* 1987 a, b). Sugarcane is not an exception to this. Therefore, it is of importance to know the micronutrients requirement of sugarcane at different growth stage to meet the same for better utilization of nutrients and optimum crop yield. Secondly press-mud being a waste by-product of sugar industry, is cheap and easily available in plenty in sugarcane growing area. Further, being a store house of macro- and micro-nutrients, its effective use over fertilizers may reduce the cost of sugarcane production. Therefore, the effects of combined application of press-mud and nitrogen on micronutrients requirement of sugarcane are reported here.

MATERIALS AND METHODS

In a field experiment conducted during 1987 on a clay loam soil N at 0, 75, 100 and 150 kg ha^{-1} as urea in main plots was applied in combination with 0, 10, 20 and 30 tons sulphitation press-mud ha^{-1} in sub plots of a split plot design having three replications. The experimental soil had sand 51.6%, silt 18.8%, clay 30.3% pH (1 : 2) 7.8, EC (1 : 2) 0.936 ds m^{-1}, $CaCO_3$ 0.5%, available nitrogen 354 kg ha^{-1}, Olsen's P 32.5 mg kg^{-1} and DTPA extractable Zn, Fe, Mn and Cu as 2.96, 26.0, 16.0 and 2.5 mg kg^{-1} soil, respectively. Sulphitation press-mud (oven dry) had pH (1 : 10) 6.75, EC (1 : 10) 6.76, EC (1 : 10) 3.2 ds m^{-1}, total contents of N 1.7%, P 3.6%, K 1.44%, S 2.3%, Zn 248, Fe 2490, Cu 240 and Mn 150 mg kg^{-1} and traces of $CaCO_3$. Fresh press-mud containing 80% moisture was uniformly plough-mixed in soil 10 days before planting of cane cv Co 1148 at 57560 three budded setts per hectare of 6 March 1987. The

half doses of N and 75 kg ha^{-1} each of P_2O_5 and K_2O were applied below the setts at planting. Remaining nitrogen was applied as urea in two equal splits during tillering at an interval of 20 days. More details of the experiment are given elsewhere (Yaduvanshi *et al.*, 1988).

Surface soil (0-15 cm) before cropping and plant samples 115, 145, 215 and 350 days after planting commensurating with tillering, a month after tillering, grand growth and harvest of sugarcane were collected. Soil samples were air dried, ground and passed through 2 mm sieve for analysis. The sheaths of 3 to 6 leaves from plant top (index tissue) upto grand growth and crown (above ground whole plant) at harvest were digested in diacid mixture of HNO_3 and $CHIO_4$ in 4 : 1 ratio. Soil samples were extracted with DTPA solution (Lindsay & Norvell, 1978). Plant digests and soil extracts were analysed for micronutrients on atomic absorption spectrophotometer (AAS). Plant uptake of Zn, Fe, Mn and Cu was calculated by multiplying their contents in whole cane plant (above ground) with total oven dry matter produced.

The digests of press-mud in diacid mixture were analysed for micronutrients on AAS, potassium of flamephotometer and phosphorus by vanadomolybdophosphoric yellow colour method. pH and EC of 1 : 10 press-mud water suspension, $CaCO_3$, sulphur by turbidity and nitrogen by micro-kjeldahl methods were also estimated in press-mud (Jackson, 1967 ; Khanna & Yadav, 1979).

RESULTS AND DISCUSSION

Micronutrients content : Mean effects indicate that Zn (Table 1) and Fe (Table 2) contents in index tissue at different growth stages and whole plant at harvest increased significantly with increased addition of press-mud and non significantly with nitrogen over control. Zn in plant was maximum with the combined application of 100 kg N and 30 t press-mud ha0^{-1} 0at each stage of growth. Zinc (Zn) content in index tissues gradually decreased with plant growth due to possible dilution effect from 34-43 mg at tillering, 30-37 mg at one month after tillering, 20-25 mg at grand growth and finally to 12-23 mg kg^{-1} in whole plant at harvest. Fe content in plant was maximum with 75 kg N upto one month after tillering, 100 kg N at grand growth and 150 kg N ha^{-1} at harvest each combined with 30 t press-mud ha^{-1} . Like Zn, Fe decreased with plant growth from 227-283 mg at tillering to 208-259 mg at one month after tillering to 156-208 mg at grand growth and to 69-81 mg kg^{-1} at harvest. Mn content in sugarcane at each stage of growth increased significantly with an increased application of nitrogen and press-mud over control, being maximum with their combined application of 150 kg N and 30 t press-mud ha^{-1} (Table 3). However, it decreased with the growth of sugarcane from 76.9-94.7 mg at tillering, 60.2-72.8 mg at one month after tillering, 48.7-57.1 mg at grand growth to 31.5-40.9 mg kg^{-1} at harvest due to dilution effect.

Copper (Cu) in sugarcane increased significantly with increasing levels of press-mud at all growth stages and nitrogen at tillering and grand growth only (Table 4). It ranged from 18.2-20.0 mg at tillering, 18.3-20.1 mg at one month after tillering, 10.1-15.5 mg at grand growth and 5.4-10.3 mg kg^{-1} at harvest.

Table 1. Effect of sulphitation press-mud and nitrogen on Zn (mg kg^{-1}) in Leaf sheath upto grand growth and whole cane plant at harvest.

Nitrogen	Press-mud (t ha^{-1})					Press-mud (t ha^{-1})				
(kg ha^{-1})	0	10	20	30	Mean	0	10	20	30	Mean
	Tillering					One month after tillering				
0	32	32	34	38	34	25	29	35	37	32
75	36	37	39	39	38	30	34	34	37	34
100	33	34	43	46	39	32	34	35	39	35
150	33	43	45	46	42	33	34	35	34	34
Mean	34	37	40	43		30	33	35	37	
	Grand growth					Harvest				
0	18	20	21	24	21	13	16	21	23	18
75	21	23	24	23	23	13	21	22	23	20
100	20	27	26	28	25	11	21	22	23	19
150	20	23	24	24	23	12	18	21	22	18
Mean	20	23	24	25		12	19	22	23	

STATISTICAL SIGNIFICANCE

Stages	Nitrogen		Press-mud		N X Press-mud	
	SE	LSD (P=0.05)	SE	LSD (P=0.05)	SE	LSD (P=0.05)
Tillering	0.88	2.15	1.11	2.28	2.21	4.56
One month after tillering	1.57	NS	1.13	2.33	2.26	NS
Grand growth	0.44	NS	0.90	1.85	1.79	NS
Harvesting	1.11	NS	0.90	1.85	1.79	NS

The above discussion reveals that an addition of press-mud increased the concentration of Zn, Fe, Mn and Cu in sugarcane. This was owing to the increased availability of these nutrients to plant upon their release from decomposition of press-mud. Interaction effects of press-mud with nitrogen addition to increase the contents of these micronutrients in plant were not significant.

Removal of micronutrients : Zinc (Zn) uptake by sugarcane at harvest ranged from 0.29 to 0.71 kg ha^{-1}, being lowest in control and highest when 100 kg nitrogen was applied with 30 t press-mud ha^{-1} (Table 5). It increased by 10.3 to 106.9% over control with increasing addition of press-mud alone from 10 to 30 t ha^{-1}, which further increased to a maximum of 144.8% with combined application of 30 t press-mud and 100 kg N ha^{-1}.

Table 2. Effect of sulphitation press-mud and nitrogen on Fe (mg kg^{-1}) on leaf sheath upto grand growth and whole cane plant at harvest.

Nitrogen (kg ha^{-1})	Press-mud (t ha^{-1})					Press-mud (t ha^{-1})				
	0	10	20	30	Mean	0	10	20	30	Mean
	Tillering					One month after tillering				
0	210	239	268	298	254	186	212	216	229	211
75	233	250	278	304	266	205	210	240	277	233
100	249	254	260	263	257	222	237	243	264	242
150	216	220	241	265	236	217	228	260	264	242
Mean	227	241	262	283		208	222	240	259	
	Grand growth					Harvest				
0	138	156	158	202	164	69	80	80	80	77
75	141	168	170	200	170	70	80	80	81	78
100	171	187	188	222	192	69	79	78	80	77
150	175	184	187	207	188	69	80	81	82	78
Mean	156	174	176	208		69	80	80	81	

STATISTICAL SIGNIFICANCE

Stage	Nitrogen		Press-mud		N X Press-mud	
	SE	LSD (P=0.05)	SE	LSD (P=0.05)	SE	LSD (P=0.05)
Tillering	9.96	NS	11.63	24.01	23.26	NS
One month after tillering	11.88	NS	14.58	30.09	29.15	NS
Grand growth	5.84	14.29	12.17	25.12	24.34	NS
Harvest	0.44	NS	0.84	1.74	1.68	NS

Table 3. Effect of sulphitation press-mud and nitrogen on Mn (mg kg-1) in leaf sheath upto grand growth and whole cane plant at harvest.

Nitrogen (kg ha-1)	Press-mud (t ha-1)					Press-mud (t ha-1)				
	0	10	20	30	Mean	0	10	20	30	Mean
	Tillering					One month after tillering				
0.	72.4	73.6	75.5	77.1	74.7	58.4	62.1	63.1	69.5	63.3
75	73.0	74.7	78.4	81.7	77.0	59.1	62.8	63.3	69.9	63.8
100	74.5	75.9	85.9	88.5	81.2	60.6	69.0	70.9	75.5	69.0
150	87.8	93.0	98.1	99.8	94.7	62.5	65.3	66.8	76.3	67.7
Mean	76.9	79.3	84.5	86.8		60.2	64.8	66.0	72.8	
	Grand growth					Harvest				
0	45.9	47.5	49.1	52.3	48.7	25.3	32.0	33.3	35.3	31.5
75	48.5	49.1	51.2	53.6	50.6	24.0	33.3	33.3	38.7	32.3
100	51.7	52.8	54.9	57.1	54.1	22.7	38.7	41.3	42.7	36.4
150	52.3	57.1	58.9	60.0	57.1	24.7	41.3	44.7	46.7	39.4
Mean	49.6	51.6	53.5	55.8		24.2	36.3	38.2	40.9	

STATISTICAL SIGNIFICANCE

Stages	Nitrogen		Press-mud		N X Press-mud	
	SE	LSD (P=0.05)	SE	LSD(P=0.05)	SE	LSD (P=0.05)
Tillering	4.64	11.35	2.99	6.17	5.98	NS
One month after tillering	1.99	4.87	1.35	2.79	2.71	NS
Grand growth	1.56	3.82	1.04	2.15	2.08	NS
Harvest	1.19	2.91	2.17	4.49	4.35	NS

Table 4. Effect of sulphitation press-mud and nitrogen on Cu (mg kg^{-1}) in leaf sheath upto grand growth and whole cane plant at harvest.

Nitrogen (kg ha^{-1})	Press-mud (t ha^{-1})					Press-mud (t ha^{-1})				
	0	10	20	30	Mean	0	10	20	30	Mean
	Tillering					One month after tillering				
0	18.2	18.2	18.5	19.2	18.5	18.2	18.2	19.2	19.7	18.8
75	17.7	18.5	19.2	19.7	18.8	18.7	19.2	19.7	20.7	19.6
100	17.7	19.0	19.2	19.2	18.8	18.2	18.7	19.2	19.7	19.0
150	19.0	20.2	20.2	20.7	20.0	18.2	18.7	19.2	20.2	19.1
Mean	18.2	19.0	19.3	19.7		18.3	18.7	19.3	20.1	
	Grand growth					Harvest				
0	8.3	14.8	14.8	14.8	13.4	4.7	6.3	9.7	10.3	7.8
75	10.4	15.4	15.4	15.4	14.2	6.3	7.3	8.3	11.7	8.4
100	10.4	15.3	15.4	15.9	14.3	6.1	7.3	7.6	10.0	7.8
150	10.4	15.4	15.8	15.9	14.4	4.3	6.7	7.8	9.0	7.0
Mean	10.1	15.2	15.4	15.5		5.4	6.9	8.4	10.3	

STATISTICAL SIGNIFICANCE

Stages	Nitrogen		Press-mud		N X Press-mud	
	SE	LSD (P=0.05)	SE	LSD (P=0.05)	SE	LSD (P=0.05)
Tillering	0.59	1.44	0.47	0.97	1.17	NS
One month tillering after	0.53	NS	0.56	1.16	1.12	NS
Grand growth	0.25	0.62	0.19	0.38	0.37	NS
Harvest	0.56	NS	0.74	1.53	1.48	NS

Table 5. Effect of sulphitation press-mud and nitrogen on micronutrients uptake (kg ha^{-1}) by whole plant at harvest.

Nitrogen (kg ha-1)	Press-mud (t ha^{-1}) 0	10	20	30	Mean	Press-mud (t ha^{-1}) 0	10	20	30	Mean
			Zn					Fe		
0	0.29	0.32	0.53	0.60	0.44	1.58	1.84	2.04	2.04	1.88
75	0.34	0.56	0.53	0.66	0.52	1.82	2.09	2.26	2.34	2.13
100	0.29	0.62	0.66	0.71	0.57	1.91	2.41	2.40	2.47	2.30
150	0.33	0.55	0.65	0.69	0.56	1.95	2.39	2.48	2.56	2.35
Mean	0.31	0.51	0.59	0.67	1.82		2.18	2.30	2.35	
			Mn					Cu		
0	0.57	0.74	0.87	0.91	0.77	0.11	0.15	0.25	0.27	0.20
75	0.63	0.87	0.93	1.11	0.89	0.16	0.20	0.24	0.34	0.24
100	0.63	1.15	1.26	1.32	1.09	0.17	0.22	0.23	0.31	0.23
150	0.70	1.23	1.35	1.46	1.19	0.12	0.20	0.24	0.28	0.21
Mean	0.63	1.00	1.10	1.20		0.14	0.19	0.24	0.30	

STATISTICAL SIGNIFICANCE

Micronutrient	Nitrogen SE	Nitrogen LSD (P=0.05)	Press-mud SE	Press-mud LSD (P=0.05)	N X Press-mud SE	N X Press-mud LSD (P=0.05)
Zn	0.047	NS	0.039	0.079	0.077	NS
Fe	0.094	NS	0.091	0.187	0.181	NS
Mn	0.057	0.140	0.056	0.116	0.113	NS
Cu	0.019	NS	0.013	0.027	0.026	NS

Removal of iron by sugarcane varied from 1.58 to 2.56 kg ha^{-1}. Press-mud alone from 10 to 30 t ha^{-1} addition increased it by 10.6 to 29.1% over control which further increased to the maximum by 62% with combined addition of 150 kg N and 30 t press-mud ha^{-1}. Manganese (Mn) uptake increasing with increased addition of press-mud and nitrogen ranged from 0.57 to 1.46 kg ha^{-1}, being maximum increase by 156.1% over control at combined application of their maximum doses. Press-mud alone at 10 to 30 t ha^{-1} increased Mn uptake by 29.8 to 59.7% over control. With the application of 10,20 and 30 t press-mud ha^{-1} alone, sugarcane removed 36.4, 127.3 and 145.5% more Cu, respectively over control. Further combined application of 75 kg nitrogen and 30 t press-mud ha^{-1} gave the maximum removal of Cu, being 209.1% increase over control. However, Cu uptake ranged from 0.11 to 0.34 kg ha^{-1}.

The uptake of Zn, Fe, Mn and Cu was significant only with addition of press-mud and remained unaffected due to nitrogen addition or its interaction with press-mud. The increase in the uptake of these micronutrients was due to their increased content

as above and yield of sugarcane (Yaduvanshi *et al.*, 1988) upon addition of press-mud and nitrogen. Similar ranges of uptake of these micronutrients in sugarcane have been reported earlier (Yadav *et al.*, 1988).

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