Comparative Efficiency of Oxalic Acid Industrial Waste Acidulated Rock Phosphate and Super Phosphate on Dry Matter Yield and Nutrition of Gram

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The results of a green house study conducted in chromustert clay soil of Jabalpur having pH 7.1, E.C. 0.24 ds m^{-1}, shows that application of 120 ppm rock phosphate (RP) acidulated with 13.2 g per pot oxalic acid industry waste (OAIW) gave highest dry matter yield of gram which was 14.67 g pot^{-1} whereas application of same amount of P_2O_5 through superphsophate (SP) produced 12.16 g pot^{-1} dry matter yield. Application of RP alone had no effect on dry matter yield; however, application of increasing levels of P_2O_5 through SP gave successive increase in dry matter yield. Application of waste acidulated RP and superphosphate alone not only improved the available nitrogen, phosphorus and sulphur content in the soil but it also improved the nutrition of the crop as judged from the uptake of these nutrients. The pH and EC of the soil was not affected by the use of OAIW. The results indicate that use of OAIW as an acidulator of rock phosphate will be beneficial.

INTRODUCTION

Phosphatic fertilizers, like other fertilizers, are becoming costlier. Search is on for use of alternate and cheap sources. One such source is rock phosphate. According to current estimate resources of phosphate in India are around 260 million tonnes including inferred, indicated and measured categories. However, 60% of these rock phosphates are unsuitable for fertilizer production. In Madhya Pradesh rock phosphate is mined in Damoh and Jhabua districts. Rock phosphate directly cannot be used as fertilizer as it contains water-insoluble phosphorus. Farmyard manure[1], pyrites[2] and organic manures and organic matter[3] are generally used as agents to increase water-soluble phosphorus content in rock phosphate. Since oxalic acid industry waste contains 12.5% free acidity, it was tested as an acidulator of rock phosphate and its effect was compared with that of superphosphate as regards its effect on dry matter yield and nutrient uptake by gram (*Cicer arietinum*).

EXPERIMENTAL

The study consisted of application of superphosphate (SP) and rock phosphate (RP) separately to provide 40, 80, 100 and 120 ppm P_2O_5 and in combination of oxalic acid industry waste (OAIW) with 6.6 and 13.2 g (1.5 and 3.0 tonne ha^{-1})

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per pot and a control. OAIW contained 12.5% free acidity, 45% organic matter, 13% total sulphur, 0.2% nitrogen, 0.1% P_2O_5, 0.4% K_2O, 250 ppm iron and negligible amount of Cu, Mn and Zn. In all there were seventeen treatments, which were replicated three times in complete randomised block design experiment. Ten kilograms of processed chromustert clay soil having pH 7.1, EC 0.24 ds m^{-1}, available N 196 kg ha^{-1}, available P 10.62 ha^{-1} and available S 4.68 kg ha^{-1} was filled in earthen pots having 18 cm lower, 36 cm upper diameter and 30 cm depth. A basal dose of 20 ppm N (urea) and 30 ppm K_2O (M.P.) was uniformly applied to each pot. Gram variety JG 315 was sown in each pot and six plants were allowed to grow up to floral initiation stage. Pots were irrigated as and when required. After harvesting plant samples were dried and dry matter yield was recorded. Processed plant samples were analysed for nitrogen[4], phosphorus[5], potassium[6] and sulphur[7]. Soil samples were also collected from each pot, dried in shade, processed and were analysed for available nitrogen, phosphorus[8], sulphur[9] and soil pH and electrical conductivity[6] were also determined in 1:2.5 soil-water ratio.

RESULTS AND DISCUSSION

Dry Matter Yield: Phosphorus applied through SP had resulted in significant increase in dry matter yield as compared to control. The marked response to applied P was expected in the soil as the soil had low amount of available P. These results are also in agreement with the findings of Paliyal *et al.*[10] When P was applied through rock phosphate, effect on dry matter yield was non-consistent and dry matter produced was similar to that obtained in control (Table-1). This is because RP contained negligible amount of water-soluble P. When 40 ppm P_2O_5 was applied through RP acidulated with 6.6 g pot^{-1} OAIW the dry matter yield was 7.02 g pot^{-1} as compared to 6.08 g pot^{-1} which was obtained with 40 ppm P_2O_5 applied through SP alone and 9.14 of pot^{-1} obtained with 40 ppm P_2O_5 RP + 13.2 g pot^{-1} OAIW application. The same trend was observed when higher levels of RP acidulated with higher levels of OAIW were used. The data indicated that 31.2 g pot^{-1} OAIW was required to acidulate RP so that the amount of P made available to plants was comparable with the dose of P applied through SP. Data also shows that maximum dry matter yield (14.16 g pot^{-1}) was obtained when 120 ppm P_2O_5 was given through RP + OAIW (13.2 g pot^{-1}). Increase in the dry matter production with the use of OAIW with RP could be due to an increase in the availability of P resulting from the solubilization of insoluble P contained in RP and also that present in soil. The fact that available P and S content in the soil were higher where OAIW was included (Table-2), further support this. Increase in solubilization could be due to the inherent acidity present in the oxalic acid industry waste. Khatik *et al.*[11] have also reported similar results.

Nutrients Uptake: Use of OAIW along with RP resulted in higher uptake of nitrogen as compared to SP and RP applied alone (Table-1). This might be due to synergistic effect of P on N. Pathak *et al.*[12] have also reported that application of RP with solubilizing agent such as easily decomposable organic matter resulted in higher uptake of N, P and K by wheat by their individual addition. Application of increasing levels of P had resulted in increased P uptake by the plant. Maximum P uptake was recorded in 120 ppm P_2O_5 supplied through acidulated rock phosphate (13.2 g pot^{-1} OAIW level). This could be due to high level of available P in the soil (Table-2) which could be due to increased solubilization of RP and soil P. Similar results have been reported by Sawarkar and Dikshit[13]. This is further supported by similarity in trend observed by uptake of K by the plants and amount of available K present in the soil. The data also shows that use of OAIW had resulted in significantly higher uptake of sulphur (Table-1) and higher amount of available sulphur in the soil (Table-2). Sulphur uptake, which was 7.46 mg pot^{-1} in 40 ppm P_2O_5 applied through SP had increased to 8.12 and 10.12 mg pot^{-1} when OAIW was included with this level @ 6.6 and 13.2 g pot^{-1} respectively. Similarly available S content in the soil had increased from 8.12 kg ha^{-1} to 9.14 and 14.21 ha^{-1} in these treatments respectively (Table-2). This increase in the uptake and available S content in the soil could be because of S contained in the OAIW. Dikshit and Paliwal[14] have reported that when S was applied to paddy grown in S- deficient soil its content in the soil and uptake by the crop was increased.

TABLE-1
EFFECT OF OAIW ACIDULATED ROCK PHOSPHATE AND SUPERPHOSPHATE ON YIELD AND NUTRITION OF GRAM

Treatment	Dry matter yield ($g\ pot^{-1}$)	Uptake ($mg\ pot^{-1}$)			
		N	P	K	S
SP— 0	4.01	26.7	9.28	15.29	5.56
40	7.02	42.18	12.43	19.16	7.46
80	9.12	50.6	16.95	24.8	9.12
100	9.11	52.1	21.68	32.2	12.13
120	12.46	82.5	23.43	35.8	15.04
RP— 40	3.96	12.14	4.56	22.1	3.12
80	4.12	14.15	7.12	27.2	5.21
100	3.87	21.21	6.68	35.6	10.14
120	4.53	19.28	9.74	34.2	8.36
6.6 g OAIW + RP 40	6.08	28.14	7.19	24.1	8.12
6.6 g OAIW + RP 80	8.12	39.40	11.18	28.5	11.34
6.6 g OAIW + RP 100	8.98	40.12	19.64	39.8	14.15
6.6 g OAIW + RP 120	11.02	43.68	23.56	37.6	18.12
13.2 g OAIW + RP 40	9.14	35.21	9.28	25.4	10.12
13.2 g OAIW + RP 80	12.16	50.12	14.16	32.1	12.42
13.2 g OAIW + RP 100	13.04	69.32	20.25	39.4	16.51
13.2 g OAIW + RP 120	14.67	84.21	24.93	42.7	18.31
SEm ±	0.55	3.54	1.29	2.29	1.06
CD 5%	1.12	6.12	2.62	4.62	2.14

TABLE-2
EFFECT OF OAIW ACIDULATED ROCK PHOSPHATE AND SUPER PHOSPHATE ON AVAILABLE NUTRIENT CONTENT, pH AND EC OF SOIL

Treatments	Available			(1:2.5)	nductivity dS m^{-1}
	Nitrogen kg ha^{-1}	Phosphorus kg ha^{-1}	Sulphur kg ha^{-1}		
SP— 0	160	7.18	5.23	7.3	0.32
40	185	14.6	8.12	7.2	0.38
80	225	16.2	10.18	7.2	0.37
100	258	21.3	14.13	7.0	0.35
120	271	23.7	13.91	7.1	0.35
RP— 40	80	2.14	2.56	7.1	0.32
80	96	3.99	3.12	7.0	0.34
100	108	5.42	4.36	7.1	0.33
120	97	4.48	4.14	7.3	0.33
6.6 g OAIW + RP 40	168	16.71	9.14	7.0	0.34
6.6 g OAIW + RP 80	172	24.32	13.15	7.1	0.35
6.6 g OAIW + RP 100	196	29,32	19.21	7.2	0.32
6.6 g OAIW + RP 120	208	29.12	18.54	7.0	0.31
13.2 g OAIW + RP 40	189	18.90	14.21	7.1	0.34
13.2 g OAIW + RP 80	224	24.12	16.28	7.0	0.33
13.2 g OAIW + RP 100	218	32.15	21.03	7.2	0.34
13.2 g OAIW + RP 120	256	30.16	20.35	7.2	0.36
SEm ±	11.41	1.53	1.13	0.201	0.151
CD 5%	22.94	3.08	2.28	NS	NS

The results show that oxalic acid industry waste can be safely used as an acidulator of rock phosphate to increase its efficient utilization in neutral soils as it helps in improving not only the availability of phosphorus but also that of sulphur. To obtain results comparable with SP, OAIW should be used @ 13.2 g pot^{-1} corresponding to 3 tons ha^{-1} application along with RP. Non-significant changes in pH and EC show that OAIW has no detrimental effect on these soil properties.

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