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[U]se of Jhabua rock phosphate as a phosphatic fertilizer to cotton (cv. MCU 12)

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Abstract: A field experiment was carried out at Cotton Breeding Station, Coimbatore with cotton var. MCU 12 as test crop with various combinations of Jhabua Rock Phosphate (JRP), Single Super Phosphate (SSP), compost and phosphobacteria (PB), to study the effect of JRP alone and with SSP, compost and PB on the yield and quality parameters of the crop. The results revealed that the yield parameters and ginning percentage were the highest in the treatment which received 50 per cent SSP + 50 per cent JRP along with compost and PB, which was significantly different from treatment with 100 per cent SSP alone. Other quality parameters *viz.* span length, micronaire value, bundle strength and uniformity ratio were not significantly correlated with the P availability. The study revealed that the indigenous source of phosphorus as JRP in combination with SSP, compost and PB, besides curtailing the input cost can effectively and profitably be used to improve yield and quality parameters of cotton crop. The kapas yield, lint yield and seed yield were significantly influenced by 50 per cent JRP + 50 per cent SSP with PB and compost. The highest available P content in soil was registered by 100 per cent SSP treatment followed by 50 per cent SSP plus 50 per cent JRP with PB and compost, whereas the later recorded the highest P uptake by crop on 160 DAS.

Key words : Rock phosphate, Cotton yield, Quality, Available P, P uptake.

Introduction

Cotton is the only agricultural commodity in the world which has exercised such a profound influence on men and matters from time immemorial. With regard to its production, India produces about 135 lakh bales of lint occupying the third position in the world. To achieve the production target of 10 lakh bales for Tamil Nadu and 230 to 250 lakh bales for India in 2020 A.D., the scientists, extension officers, farmers as well as private and public sector enterprises should integrate their efforts to bring about a total change in the scenario (Abdul Kareem and Ramasamy, 2000). Phosphorus is the back bone of any fertilizer management programme for intensive cropping system. However, fertilizer P is a costly input. Soil fertility map of India based on more than 8 million soil tests conducted in 363 districts for P indicates that soils of about 46 per cent districts are in low fertility class, 52 per cent in medium fertility category and only 2 per cent high in available P status. Thus, there is an imminent need for application of P to achieve higher yields from crops in nearly 98 per cent of Kamath,1999). Large quantities of low grade Rock Phosphate (RP) have been located in some parts of India. The total economically viable deposits occur in Mussoorie, Syncline (U.P.), Jhabua district (M.P.), Singhbum district (Bihar), Kasipatnam (A.P.) and Purulia district (W.B.). The RP deposits occurring at Jhabua are exclusively of sedimentary origin and more reactive than other deposits occurring in India. They contain loosely consolidated aggregates of micro crystalline structure with large internal surface area which account for their higher reactivity. In order to make economic use of these materials, they have to be directly used as fertilizer. In the light of above facts, the present study has been taken to elicit information on the availability and uptake pattern of P as influenced by application of Jhabua Rock Phosphate (JRP) alone and in combination with organic manures and biofertilizers to cotton crop cv. MCU 12.

Materials and Methods

A field experiment was carried out at Cotton Breeding Station, Coimbatore with cotton

Table 1. Effect of treatments on yield parameters of cotton (MCU 12) (kg ha^{-1})

Treatments		Kapas Yield	Per cent increase over control	Lint Yield	Per cent increase over control	Seed Yield	Per cent increase over control
T_1	Control	1470	-	366	-	1097	-
T_2	100% SSP	1762	19.8	466	27.3	1302	18.6
T_3	100% JRP	1502	2.1	369	0.8	1106	0.8
T_4	T_3+Phosphobacteria	1551	5.5	375	2.4	1113	1.4
T_5	T_3+compost	1594	8.4	384	4.9	1124	2.4
T_6	T_5+Phosphobacteria	1573	7.0	393	7.3	1202	9.5
T_7	25% SSP + 75% JRP	1526	3.8	411	12.2	1197	9.1
T_8	T_7+Phosphobacteria	1642	11.7	417	13.9	1236	12.6
T_9	T_7+compost	1618	10.0	427	16.6	1253	14.2
T_{10}	T_9+Phosphobacteria	1667	13.4	437	19.3	1277	16.4
T_{11}	50% SSP + 50% JRP	1689	14.8	453	23.7	1293	17.8
T_{12}	T_{11}+Phosphobacteria	1739	18.2	464	26.7	1315	19.8
T_{13}	T_{11}+compost	1713	16.5	471	28.6	1337	21.8
T_{14}	T_{13}+Phosphobacteria	1780	21.0	483	31.9	135	23.6
SEd			27		6		8
CD (P=0.05)			55		11		6

under Pallathur series (Typic Haplustalf) and sandy clay in texture. Sowing was taken during the month of August, 2000 and harvested during February, 2001. Fourteen treatments were replicated thrice, using randomised block design. The treatment details are given below.

Treatments

T_1 - Control

T_2 - 100% P_2O_5 as SSP (40 kg P_2O_5 ha^{-1})

T_3 - 100% P_2O_5 as JRP (40 kg P_2O_5 ha^{-1})

T_4 - T_3 + Phosphobacteria (seed treatment as well as soil application)

T_5 - T_3 + Compost

T_6 - T_5 + Phosphobacteria (seed treatment as well as soil application)

T_7 - 75% JRP + 25% SSP

T_8 - T_7 + Phosphobacteria (seed treatment as well as soil application)

T_9 - T_7 + Compost

T_{10} - T_9 + Phosphobacteria (seed treatment as well as soil application)

T_{11} - 50% JRP + 50% SSP

T_{12} - T_{11} + Phosphobacteria (seed treatment as well as soil application)

T_{13} - T_{11} + Compost

T_{14} - T_{13} + Phosphobacteria (seed treatment as well as soil application)

Initial soil sample was collected and analysed for physico-chemical properties. The texture of the soil was sandy clay with a pH of 8.2 and the EC of 0.91 dSm^{-1}. The organic carbon content was 7.2 g kg^{-1}. The available N,P and K contents were 148.4 (low), 13.0 (medium) and 360 (high) kg ha^{-1} respectively. The compost application was done first at the rate of 12.5 t ha^{-1} for the plots as per treatment schedule and incorporated. The entire dose of P and K as per the treatment details was applied in two equal splits to all the plots at the time of sowing and at 40 days after sowing respectively. Phosphobacteria at the rate of 2 kg ha^{-1} was applied to the soil and 600 g for seed treatment.

Soil samples were collected at periodic intervals *viz.* 40,80,120 DAS and at post harvest

(Non replicated sample analysis)

	Treatments	Ginning %	2.5% span length	Uniformity Ratio	Micronaire value	Bundle Strength (g.t^{-1})	Predicted CSP 1/8" g.t^{-1}	Elongation %
T_1	Control	34.46	28.9	44	3.20	19.5	2140	6.0
T_2	100% SSP	39.40	34.0	45	3.30	25.9	2294	6.5
T_3	100% JRP	37.79	29.9	41	3.50	20.8	2206	5.9
T_4	T_3+Phosphobacteria	38.83	31.0	45	3.10	24.0	2305	5.8
T_5	T_3+compost	39.11	30.1	43	3.30	23.4	2222	5.9
T_6	T_5+Phosphobacteria	39.35	31.1	45	3.60	23.2	2232	5.4
T_7	25% SSP + 75% JRP	39.27	29.7	45	3.40	22.3	2239	5.8
T_8	T_7+Phosphobacteria	39.22	31.0	43	3.50	21.5	2179	6.0
T_9	T_7+compost	38.78	29.9	45	3.80	24.2	2225	6.0
T_{10}	T_9+Phosphobacteria	39.11	30.3	44	3.00	22.8	2256	5.9
T_{11}	50% SSP + 50% JRP	39.64	30.0	45	3.60	21.8	2191	5.6
T_{12}	T_{11}+Phosphobacteria	39.75	30.8	42	3.50	23.2	2252	5.5
T_{13}	T_{11}+compost	39.61	31.0	44	3.50	22.3	2280	5.7
T_{14}	T_{13}+Phosphobacteria	39.21	31.7	44	3.50	22.8	2236	5.1

stage and were analysed for available P employing Olsen method. Plant samples were collected at periodic intervals *viz.* 40,80,120 DAS and at the time of harvest and were oven dried at 60-70°C for 8 hours, powdered and P uptake was estimated by using vanadomolybdate yellow colour in $HClO_4$ system (Triple acid extraction HNO_3: H_2SO_4: $HClO_4$=9:2:1). Healthy delinted cotton seeds (MCU 12) were sown. The seed cotton harvested from five plant samples were pooled, cleaned, ginned and fibre quality parameters were analysed as non replicated sample analysis in High Volume Instrument. Ginning percentage was calculated as the ratio of weight of lint to weight of seed cotton. The experimental data were subjected to statistical scrutiny to determine the effect due to treatments and inferences drawn based on the statistical results.

Results and Discussion

Kapas yield

The kapas yield of cotton ranged from 1470 (T_1) to 1780 (T_{14}) kg ha^{-1}. The kapas yield was highest in the treatment that received 50 per cent JRP + 50 per cent SSP with PB and compost (Table 1). A positive and significant correlation existed between available P and kapas yield substantiating the positive role of P. The solubility of RP is also enhanced by the compost and PB which enabled the availability of P in the later stages also, thus favouring the enhanced uptake of nutrients and improved the kapas yield. The favourable influence of higher doses of P for increasing the cotton kapas yield was reported by Viera *et al.* (1997)

Lint yield

The cotton lint yield ranged from 366 (T_1) to 483 (T_{14}) kg ha^{-1}. The plots that received 50 per cent SSP + 50 per cent JRP with PB and compost recorded the highest lint yield of cotton, while control recorded the lowest lint yield (Table 1). A positive and significant correlation of Bray 1-P was obtained with lint yield at 40,80,120 and 160 DAS whereas, in

Table 3. Effect of treatments on soil available phosphorus and P uptake at different stages of growth (kg ha^{-1})

	Treatments	available P					P uptake				
		40 DAS	80 DAS	120 DAS	160 DAS	Mean	40 DAS	80 DAS	120 DAS	160 DAS	Mean
T_1	Control	13.33	11.83	10.83	10.66	11.66	2.13	8.23	18.03	20.50	12.27
T_2	100% SSP	30.33	28.53	27.33	26.07	28.06	3.34	14.96	27.53	30.68	19.13
T_3	100% JRP	13.83	12.33	11.33	20.03	14.38	2.23	9.16	20.26	26.81	14.62
T_4	T_3+Phosphobacteria	14.33	13.83	13.16	19.66	15.24	2.33	9.46	20.93	26.33	14.76
T_5	T_3+compost	14.50	14.16	13.66	20.03	15.58	2.36	10.13	22.46	26.53	15.37
T_6	T_5+Phosphobacteria	14.66	12.51	12.09	21.07	15.08	2.46	10.37	22.11	24.83	14.94
T_7	25% SSP + 75% JRP	15.16	13.08	12.33	21.66	15.55	2.56	11.28	21.16	26.51	15.38
T_8	T_7+Phosphobacteria	15.55	14.53	14.09	22.33	16.62	2.75	10.46	21.93	27.66	15.70
T_9	T_7+compost	16.16	15.83	15.55	23.34	17.72	2.61	10.83	22.33	27.03	15.70
T_{10}	T_9+Phosphobacteria	15.33	14.53	14.50	23.83	17.04	2.83	11.53	22.66	27.33	16.09
T_{11}	50% SSP+50% JRP	16.09	15.66	15.33	24.66	17.93	2.71	11.26	25.31	27.53	16.70
T_{12}	T_{11}+Phosphobacteria	16.16	16.16	15.16	25.33	18.20	2.83	12.63	27.33	28.33	17.78
T_{13}	T_{11}+compost	16.66	15.16	14.08	26.04	17.98	279	13.81	27.35	28.57	18.13
T_{14}	T_{13}+Phosphobacteria	19.07	18.33	17.53	26.16	20.27	3.48	14.53	28.80	30.76	19.39
	Mean	16.51	15.46	14.78	22.20		2.67	11.33	23.44	27.10	
		SEd		CD (P=0.05)			SEd		CD (P=0.05)		
S		0.23		0.45			0.27		0.54		
T		0.43		0.85			0.51		1.02		

Olsen P, it was positive but a non significant correlation at 40,80,120 DAS. Increased lint yield, owing to the increasing application of P corroborated the findings of Sharma *et al.* (1988).

Seed yield

The seed yield of cotton crop ranged from 1097 (T_1) to 1436 kg ha^{-1} (T_{14}). A trend akin to that of lint yield and kapas yield was found in seed yield (Table 1). A significant positive correlation between seed yield and available P existed at different growth stages was evident. In general, P application at different levels increased the number of bolls per plant in cotton. This was in line with the findings of Gomaa (1991) and Sabino *et al.* (1991).

The yield attributes such as kapas yield, lint yield and seed yield recorded were the highet in the treatment that received 50 per cent JRP + 50 per cent SSP with PB and compost.

Quality parameters

The values of ginning percentage ranged from 34.46 to 39.75. Among the different treatments tried, treatment that received 50 per cent SSP + 50 per cent JRP along with PB recorded the highest ginning percentage (39.75). The lowest value (34.46) was registered in control (Table 2).

Rabey and Tamner (1981) who reported on higher rates of P in reflecting higher fibre length. Lower doses of SSP and combination of SSP

JRP reduced fibre length (Table 2). The ɪatment which received 50 per cent SSP + per cent JRP with PB and compost excelled ɪr others in putting the fibre under extra ɪg category (2.5 per cent span length> 32.5) ɪt can very well be used in making shirts, ɪets and other fine goods besides commanding better price in the market.

Fibre obtained from treated plots had ɪher fibre strength (Bundle strength = 23.1 26.9). Bundle strength is related to strength the manufactured yarn and cloth. Silva *et* (1990). Application of 50 per cent JRP 50 per cent SSP along with PB and compost s effective in increasing the quality parameters . span length, micronaire value, 2.5 per cent ɪn length, ginning percentage and bundle strength cotton var. (SVPR 2) (Ragunath, 2000).

In general, phosphatic fertilizers (SSP JRP or their combination to get the full ɪplement of P) have no explicit effect in ɪroving the fibre properties as well as ginning cent as evidenced from the meagre differences ɪerved between the treatments. The reports Mukundan *et al.* (1990) lend support to above findings.

l available phosphorus

Variations in the available P content was re pronounced among the treatments. The ɪtmetns that received 100 per cent SSP registered highest available P content obviously due ɪ its more readily available water soluble P ɪ compared to RP and the findings are in ɪgreement with Kabeerathumma and Mohankumar, ɪ990) (Table 3). Higher P availability at the ɪarlier stages associated with the treatments ɪvolving 50 per cent SSP and 50 per cent RP along with compost and PB.

The P availability was low at the initial ɪrowth stage followed by a gradual increase ɪwards harvest stage. This might possibly be ɪue to the slow rate of dissolution and release ɪ P and the findings are inline with Bolland ɪnd Gilkes (1990). This trend was noticed in ɪll the treatments except for control and 100 ɪer cent SSP, in which a declining trend upto ɪarvest stage was found.

Phosphorus uptake

The nutrient uptake is governed by both dry matter production and nutrient concentration in plant. Application of 50 per cent SSP plus 50 per cent JRP with PB and compost recorded highest P uptake (Table 3). In this study, P uptake increased with increasing P availability and increased uptake to added P. Subehia and Minhas (1993) reported that application of inorganic P along with organic manures and their combination increased the P uptake over inorganic P alone. This was ascribed to the solubilization of insoluble P from RP by organic acids produced during decomposition of organic manure leading to the increased availability of P, higher P content of the plant and higher yield of both dry matter and grain and this lend support to the present finding.

Integrated use of inorganic P, organics and biofertilizers registered higher P uptake because plant use more P from insoluble phosphatic fertilizer in the presence of phosphate dissolving organisms (Vaisha *et al.* 1996) due to maximum solubilization of phosphate by microorganism and more utilisation of added P and the findings are in line with the present findings as evidenced from the significant and positive correlation with DMP (r=0.629**).

The investigation with Jhabua rock phosphate as a source of phosphorus for cotton, indicated that, application of 50 per cent SSP + 50 per cent JRP along with PB and compost is effective in increasing, yield attributes, quality parameters of cotton, enhanced P availability and P uptake.

In the current context of escalating cost of fertilizers, especially that of P, there is an imminent need to go in for a cheaper and effective alternate phosphatic source. The study has vividly revealed that, indigenously available Jhabua rock phosphate can be effectively and economically used as phosphorus source to cotton crop in combination with SSP, compost and PB for increasing the production of cotton.

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