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Integrated phosphorus nutrition system for blackgram - ragi sequence

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Abstract: Studies on the effect of phosphatic fertilizer alone and in combination with organics and inoculants on black gram-ragi sequence were conducted at the Agricultural Engineering College and Research Institute Farm, Kumulur, Trichirappalli during 1999-2000 and 2000-2001. The results revealed that there was a positive response for the application of phosphorous and the highest seed and haulm yields were recorded with 100 per cent P20s based on soil test value with pressmud and Phosphobacteria. Application of P fertilizer alone showed a depletion of available P with the advancement of stage of cropping but in combination with pressmud a positive balance was observed. Among the organics, the application of pressmud performed better than FYM. The residual effect of P was found to be higher while conjoint incorporation of inorganic P with pressmud and phosphobacteria than applying P alone.

Keywords: Blackgram, ragi, phosphorus, pressmud, FYM, Balance.

Introduction

Blackgram *(Vigna mungo)* is one of the major pulses being grown in our country. Due to lack of nutrient management especially phosphorous, the farmers are getting low yield. Being the legume, it can fix the N from the atmosphere but they need more P which would help in the root development resulting in higher N fixation.

It is estimated that 90 per cent of Indian soils contain low amounts of available P as it gets easily fixed with iron and aluminium oxides and form insoluble complexes (Tek Chand and Tomar, 1995). Besides with spiralling of cost of phosphatic fertilizers, there is a need to exploit the organic sources and inoculants inconjoint with the chemical fertilizers (Subramanian and Gopalswamy, 1991). These organic sources and biofertilizers not only supply P but also solublize the complex insoluble compounds and make them available to the crops. With this view, the present investigation was taken up to define an optimum P nutrition system by the inclusion of chemical P fertilizer, organics and ioculant for blackgram - ragi sequence.

Materials and methods

Filed experiments were conducted at Agricultural Engineering College and Research Institute Farm, Kumulur under irrigated condition during 1999-2000 and 2000-2001. The soil is classified taxonomically as Typic ustochrepts. The composite soil samples were collected and analysed for basic physico-chemical properties and depicted in Table 1. The experiment was laid out in factorial randomized block design with three replications. The treatments comprised inorganic phosphorus with 4 levels; M_0-control; M_1-100% P_2O_5, based on soil test value; M_2-75% dose P_2O_5 based on soil test value; M_3-50% P_2O_5 based on soil test value; organic sources: N_0-control; N_1-FYM @ 5 t ha^{-1}; N_2- pressmud @ 5 t ha^{-1}; N_3 - Phosphobacteria @ 2 Kg ha^{-1}; N_4-FYM @ 5 t ha^{-1}-phosphobacteria @ 2 kg ha^{-1} : N_5- pressmud @ 5 t ha^{-1} + phosphobacteria @ 2 kg ha^{-1}. The pressmud (N-2.1%, P-1.4%, K-1.98%) and FYM (N-0.5%, P-0.3%, K-0.7%) were applied 10 days

Table 1. Physico - chemical properties of the experimental soil.

Properties	1999-2000	2000-01
Mechanical analysis		
Sand	71.4	75.4
Silt	13.0	11.0
Clay	14.8	13.2
E.C.(dSm^{-1})	0.19	0.21
pH	7.24	7.18
CEC(c mol (p^+) kg^{-1})	8.0	9.2
Alkaline $KMnO_4$-N(kg ha^{-1})	152	162
Olsen P (kg ha^{-1})	4.4	4.8
NH_4OAc-K(kg ha^{-1})	225	236
Total N(%)	0.014	0.016
Total P (%)	0.020	0.022
Total K(%)	0.912	0.936
Organic Carbon (%)	0.25	0.28
P fixing capacity (ppm)	28.4	29.4

and 1 week prior to sowing of the blackgram (Variety T_9). The available P status of the experimental fields were 4.8 and 5.4 kg ha^{-1} for 1999-2000 and 2000-01, respectively. Accordingly, the fertilizer P was applied on soil test basis to the blackgram. Similarly, the N and K were applied on soil test basis as urea and muriate of potash. Treatment wise soil samples were collected on 30 DAS,60 DAS, and after harvest of the crop and analysed for available P by Olsen' s method (Olsen *et al.* 1954). Similarly plot wise plant samples were collected on 30 DAS, 60 DAS, and after harvest of the crop and analysed for P contents and its uptake was worked out. After the harvest of blackgram, the residual crop ragi (CO. 11) was sown in the same field. The P was not applied for the ragi crop. But N and K were applied on soil test basis. Plotwise ragi yields were recorded. The post harvest soil samples were analysed for available P by Olsen's method.

Results and Discussion

Effect of treatments on seed and haulms yield of blackgram

The blackgram seed and haulm yields were significantly influenced both by P levels and organic sources. The highest seed yield of 668 and 650 kg ha^{-1} and haulms yield of 884 and 896 kg ha^{-1} were registered during 1999-2000 and 2000-01, respectively (Table 2) in the treatments receiving 100 per cent P_2O_5 based of soil test value inconjoint with 5 tonnes of pressmud and 2 kg phosphobacteria ha^{-1}, followed by 100 per cent P_2O_5 based on soil test value with FYM @ 5 t ha^{-1} + phosphobacteria 2 kg ha^{-1}. It was also found that with the increase in P level, the seed and haulm yields were increased. Among the organics, the pressmud performed better as compared to the FYM, in recording seed and haulm yield. This might be due to the higher nutrient composition of pressmud than the FYM. It was observed

Table 2. Influence of treatments on blackgram seed and haulms yield (kg ha^{-1})

Treatments	1999-2000		2000-01	
	30 DAS	60 DAS	30 DAS	60 DAS
M_0N_0	304	410	318	424
M_0N_1	394	517	409	533
M_0N_2	445	572	454	590
M_0N_3	352	460	365	471
M_0N_4	418	560	425	560
M_0N_5	484	610	482	615
M_1N_0	520	666	531	680
M_1N_1	575	752	564	765
M_1N_2	605	842	616	850
M_1N_3	540	696	552	704
M_1N_4	638	860	594	872
M_1N_5	668	884	650	896
M_2N_0	486	618	494	626
M_2N_1	535	794	550	808
M_2N_2	570	818	576	824
M_2N_3	500	645	510	653
M_2N_4	575	828	586	833
M_2N_5	602	840	608	848
M_3N_0	420	574	428	583
M_3N_1	494	674	510	684
M_3N_2	526	752	536	762
M_3N_3	452	615	464	628
M_3N_4	516	720	522	733
M_3N_5	550	784	564	798
CD(P=0.05)				
M	11.4	12.6	11.6	12.2
N	15.2	15.4	14.9	15.6
MXN	29.8	31.1	29.6	30.6

that the application of P incombination with either pressmud or FYM recorded higher yield than applying P alone. As the P fixing capacity of the soil was found to be higher, incorporation of organics would have reduced the chelation of P by Fe and Al and also releases the $H_2PO_4^{2-}$ from these complexes (Vig *et al.* 1997: Bahl *et al.* 1998). The inoculant, phosphobacteria favoured better while incombination with organics like FYM and pressmud rather than applying alone. The result also indicated that incorporation of 5 tonnes of pressmud with 2 kg of phosphobacteria was on par with 50 per cent P_2O_5 based on soil test value in registering the seed and haulms yield.

Table 3. Influence of treatments on P uptake by the black gram (kg ha^{-1})

Treatments	1999-2000			2000-01		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
M_0N_0	3.8	4.6	5.4	4.0	4.8	5.8
M_0N_1	10.2	14.4	18.2	10.0	14.0	17.6
M_0N_2	11.4	15.8	20.2	11.8	16.2	20.8
M_0N_3	6.0	7.4	8.8	6.2	7.8	9.0
M_0N_4	11.8	15.2	21.0	12.2	15.6	21.4
M_0N_5	13.0	17.4	23.0	12.8	17.8	23.8
M_1N_0	14.8	18.4	22.8	15.2	18.8	23.0
M_1N_1	16.4	22.8	27.2	16.8	23.0	27.4
M_1N_2	17.6	23.4	28.6	18.0	23.8	29.2
M_1N_3	15.6	21.0	23.4	16.0	20.8	23.8
M_1N_4	17.8	24.0	28.0	18.2	24.4	28.4
M_1N_5	18.2	24.5	29.2	18.6	25.0	30.0
M_2N_0	13.2	16.4	19.0	13.4	16.8	19.2
M_2N_1	15.0	18.2	23.0	15.2	18.4	23.2
M_2N_2	17.4	21.2	24.8	18.0	21.8	25.2
M_2N_3	14.4	15.4	17.2	14.8	15.8	17.8
M_2N_4	16.2	19.8	23.8	16.0	20.4	24.2
M_2N_5	17.8	22.2	25.0	18.0	22.6	25.2
M_3N_0	10.8	14.2	17.4	11.2	14.8	17.8
M_3N_1	13.2	16.0	19.4	13.4	16.4	20.0
M_3N_2	15.8	18.2	21.4	16.2	18.4	21.8
M_3N_3	13.8	14.6	16.4	14.2	15.0	17.2
M_3N_4	16.4	19.0	21.0	16.8	19.4	21.8
M_3N_5	16.8	19.8	22.0	17.2	20.6	22.8
CD (P=0.05)						
M	0.11	0.20	0.24	0.11	0.22	0.26
N	0.13	0.27	0.30	0.14	0.27	0.30
MXN	0.26	0.55	0.60	0.27	0.57	0.59

Effect of treatments on the uptake of P

The data depicted in Table 3 revealed that the organic source and fertilizer P significantly influenced the P uptake by the crop. An increase in the uptake of P was observed with the advancement of stage of the crop. As indicated in the yield, the highest P uptake was registered with the addition of 100 per cent P_2O_5 based on the soil test value with pressmud and phosphobacteria followed by 100 per cent P_2O_5 based on soil test value with pressmud. While comparing the organic manures, higher uptake of P was noted with pressmud than FYM. This may be due to the higher P content of pressmud than FYM. In a P releasing pattern study, Mathan and Raj (1975) reported that the P released relatively faster while incubating it with pressmud than with FYM.

Effect of treatments on available P status of soil

Both positive and negative balance of available P were observed due to the influence of treatments (Table 4). A declining trend of available P was observed in control and the treatments receiving chemical P alone from 30 DAS to harvesting stage irrespective of its levels. Due to the enrichment of sesquioxide, $H_2PO_4^{2-}$ ions would have been adsorbed strongly over the Fe and Al oxides to satisfy their positive charges (Kaistha *et al.* 1997). While in combination with pressmud a progressive increase in available P was observed with the advancement of stage of cropping. This might be due to the organic ligands found in the pressmud would have chelated the Fe and Al and released the P in to the labile pool (Singh and Ram, 1977).

Residual effect of phosphorus

The residual organic and P sources significantly influenced the grain and straw yields of ragi (Table 5). The highest grain yield of 2684 and 2514 kg ha^{-1} and straw yield of 3623 and 3348 kg ha'[1] were recorded during 1999-2000 and 2000-01 respectively in the treatments receiving 100 per cent P20s based on soil test value in conjoint with 5 tonnes of pressmud and 2 kg phosphabacteria ha^{-1} followed by 100 per cent P_2O_5 based on soil test value with FYM @ 5 t ha^{-1} + phosphobacteria 2 kg ha^{-1}. On the contrary, the residual effect of P was found to be lesser in the treatments which received chemical P alone. Inclusion of organic sources with the fertilizer P favoured higher residual effect of P. The higher residual effect of P in the manured soils may be attributed to the release of P from the sorbed sites as it would have retained on the colloidal complexes by weaker electrostatic forces, while in unmanured soils, the $H_2PO_4^{2-}$ would be retained tenaciously with the colloidal constituents which would have caused for lesser rate of desorption to the labile pool. Such a higher residual effect of P while incorporating with pressmud was reported earlier by Srivastava *et al.* (1995). The P uptake by the ragi crop during harvest stage indicated that the application of fertilizer P also supplied lesser P as compared to the combination with organic manures. The highest P uptake of 11.26 and 11.40 kg ha"[1] during 1999-2000 and 2000-01 were recorded with treatment receiving triple combination of 100 per cent P_2O_5 based on soil test value and pressmud and phosphobacteria followed by 100 per cent P_2O_5 based on soil test value with pressmud.

Summary and conclusion

Blackgram responded positively to the P application. Application of fertilizer P alone showed the depletion of available P status. A conjoint incorporation of fertilizer P with organic manures particularly with pressmud, the P can be supplied to the crop continuously. Among the organics, the pressmud can be advocated in conjoint with the P fertilizer in order to increase the availability of P for the crop uptake. On an average 25-30 per cent of fertilizer *P* can be saved by including

Table 4. Influence of treatments on available P status of the soil (kg ha^{-1})

Treatments	1999-2000			2000-01		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
M_0N_0	4.0	3.2	2.5	4.2	3.4	3.0
M_0N_1	8.2	10.4	9.8	8.5	10.0	10.0
M_0N_2	11.0	11.2	12.6	11.4	13.6	14.8
M_0N_3	5.6	5.4	5.0	6.0	5.2	4.8
M_0N_4	9.4	11.8	12.6	9.8	11.4	12.4
M_0N_5	12.6	14.8	16.4	11.6	13.8	15.8
M_1N_0	12.6	9.8	8.8	12.0	10.2	9.0
M_1N_1	14.8	16.2	17.8	14.4	16.0	16.8
M_1N_2	15:2	16.8	18.2	15.2	17.0	18.4
M_1N_3	12.8	13.2	12.4	12..4	13.0	12.0
M_1N_4	14,8	16.4	17.8	15.6	17.0	18.2
M_1N_5	15.6	17.4	18.4	16.0	17.8	19.0
M_2N_0	10.0	8.5	7.0	9.8	8.4	6.8
M_2N_1	13.2	14.8	15.6	13.6	15,2	16.2
M_2N_2	14.0	15,4	16.0	14.2	15.6	16.8
M_2N_3	11.0	11.8	10.6	11.4	12.0	11.4
M_2N_4	13.8	15.6	16.0	13.8	15.4	16.2
M_2N_5	14.4	15.8	16.6	14.4	16.0	17.0
M_3N_0	8.5	6.8	6.0	8.2	6.8	6.0
M_3N_1	10.8	11.4	12.2	11.0	11.8	12.4
M_3N_2	11.6	12.8	13.8	11.8	13.0	14.2
M_3N_3	9.0	9.6	9.0	8.8	9.4	9.0
M_3N_4	11.2	12.0	12.8	11.8	12.6	13.2
M_3N_5	12.0	13.0	14.2	12.4	13.2	14.6
CD (P=0.05)						
M	0.09	0.07	0.10	0.09	0.07	0.11
N	0:12	0.09	0.12	0.11	0.09	0.12
MXN	0.24	0.19	0.22	0.22	0.19	0.22

Table 5. Effect of treatments on grain, straw yields and uptake of P by ragi (kg ha^{-1})

Treatments	1999-2000			2000-01		
	Grain	Straw	P uptake	Grain	Straw	P uptake
M_0N_0	1152	1498	2.64	1066	1392	2.74
M_0N_1	1864	2461	7.24	1668	2184	7.50
M_0N_2	2028	2738	8.88	1818	2384	8.92
M_0N_3	1264	1643	3.82	1166	1539	3.92
M_0N_4	1926	2564	7.98	1782	2371	8.04
M_0N_5	2210	2826	9.14	1968	2584	9.08
M_1N_0	1954	2579	4.74	1840	2466	4.80
M_1N_1	2486	3282	9.42	2328	3066	9.54
M_1N_2	2584	3360	10.84	2492	3218	10.90
M_1N_3	1988	2624	5.65	1912	2524	5.74
M_1N_4	2526	3411	9.84	2406	3178	9.90
M_1N_5	2684	3623	11.26	2514	3348	11.40
M_2N_0	1726	2244	4.20	1668	2224	4.34
M_2N_1	2254	2933	8.18	2052	2709	8.20
M_2N_2	2360	3118	8.84	2114	2812	8.80
M_2N_3	1820	2458	4.80	1728	2299	4.76
M_2N_4	2280	3072	9.02	2122	2844	9.14
M_2N_5	2392	3208	9.18	2264	3012	9.26
M_3N_0	1584	2091	4.06	1518	2038	4.10
M_3N_1	1982	2656	7.92	1888	2486	7.98
M_3N_2	2088	2819	8..14	2022	2664	8.20
M_3N_3	1624	2177	4.38	1564	2094	4.42
M_3N_4	2020	2729	8.06	1922	2597	8.14
M_3N_5	2138	2886	8.40	2082	2789	8.52
CD(P=0,05)						
M	44.2	51.8	0.11	42.6	53.2	0.12
N	53.2	60.4	0.13	51.4	63.4	0.14
MXN	104.4	119.2	0.25	102.6	125.2	0.27