This investigation revealed the importance of both additive and non-additive gene action for the characters studied. Similar results were reported by Valdia *et al.*, (1980) in their studies with *Gossypium arboreum*. Improvement in the characters is possible by simultaneous exploitation of both additive and non additive genetic components. This can be achieved by adopting biparental mating in F2 among selected crosses or following selection procedures such as diallel selective mating (Jensen, 1970).

The trial conducted showed that most of the characters are controlled by additive and predominantly non-additive gene action. The best general combiners in the parents were 138F, 83 for earliness, MCU 6 for earliness and for 50 per cent boll bursting and 133F for higher boll weight. So these parents can be used in the crossing programme to get the better hybrid. The hybrid 108F x MCU 6 was considered as the best cross because it recorded significant positive sca effect for yield of seed cotton and boll weight.

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PHOSPHORUS MANAGEMENT FOR LOW LAND TRANSPLANTED RICE: A TEST VERIFICATION TRIAL WITH 2% DAP SPRAY

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ABSTRACT

An experiment was conducted during June 1993 to February 1994 to study the effect of phosphorus levels and 2% DAP spray on lowland rice (*Oryza sativa* L.). Application of P at recommended dose (38 kg P_2O_5/ha) with 2% DAP spray given thrice at boot leaf, 50% flowering and post-milk stages would result in higher rice grain productivity and profitability. Considering soil health and increase in P fertilizer price, the farmer may choose to apply P at 50% of recommended dose (19 kg P_2O_5/ha) with 2% DAP spray twice at boot leaf stage and 50% flowering or at post milk stages if capital is constraint for the farmer. Based on the previous season result, test verification trial was conducted in the Rabi season with I.R.20 as test variety. Similar trend was also observed in the test verification trial. The effect on P uptake at different stages of crop growth and economics were also discussed.

KEY WORDS : Rice, Phosphorus, Management, Verification, DAP Spray

Rice (*Oryza sativa* L.) is the staple food of more than 60 per cent of the world's population and is grown in an area of about 145 million ha. Though India has the largest area under rice, its production per unit area of the farm is, by world standards, very low. Low level of fertilizer application is an important reason for low productivity in major parts of the rice growing belt. Among the fertilizer elements, phosphorus plays a key role in promoting root growth and proliferation, tillering, early maturity and ripening. Because of withdrawal of subsidy and higher cost, farmers are applying low quantities of phosphorus. The quantity applied is not sufficient to meet the crop requirement. Work done in India and abroad has shown that a single crop uses only about 20 per cent of applied P and the rest is retained in the soil, irrespective of the fact whether the soil is relatively low or high in P content (Tandon, 1987). Due to increase in fertilizer price and considering the soil health, it is

Table 1. Effect of P levels and DAP spray on rice yield (IR 50) June-September, 1993

Treatments	Productive tillers (No./ panicle)	Panicle length (cm)	Grains (No./ panicle)	Filled grains (No./ panicle)	Un filled grains (No./ panicle)	1000 grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
o spray (S_0)	10.50	18.33	60.89	46.30	14.58	20.07	4.1	6.6
% DAP spray at boot leaf age and 50% flowering (S_1)	10.75	18.43	62.67	48.26	14.33	20.41	4.5	7.1
% DAP spray at boot leaf age and post milk stage (S_2)	9.75	18.87	67.31	56.38	11.11	21.45	4.5	7.0
% DAP spray at boot leaf age and 50% flowering and post-milk stages (S_3)	11.00	18.73	71.76	62.78	8.98	21.50	4.7	7.3
SD (P=0.05)	0.8028	NS	6.548	5.49	4.1961	0.0798	0.4	0.4
o P (P)	8.50	18.61	64.64	50.13	14.52	20.63	3.8	6.1
% of recommended P (P_1)	9.75	18.12	65.70	53.29	12.56	20.92	4.3	7.0
% of recommended P (P_2)	11.00	18.49	65.80	54.78	11.02	20.93	4.8	7.4
0% recommended P (P_3)	12.75	19.16	66.48	55.51	10.90	20.95	5.0	7.5
SD (P=0.05)	0.8854	NS	NS	NS	NS	0.0709	0.5	0.8

e : Interactions not significant except for 1000 grains weight.

challenge to the agronomists to find the best ategies for P fertilizer management without any duction in crop yield.

ATERIALS AND METHODS

A field experiment was conducted to study the ffect of P levels and diammonium phosphate DAP) spray on filling capacity and grain yield of a hort duration (105 days) rice variety I.R.50 in the outh west monsoon season (June-Sept.) 1993, at he Tamil Nadu Agricultural University, oimbatore. The experiment was laid out in a plit-plot design, replicated thrice, with graded evels of P (0, 9.5, 19 and 38 kg P_2O_5/ha) in the nain plot and foliar spray of in the sub-plots (No DAP spray; 2% DAP spray at boot leaf stage and 50% flowering; 2% DAP spray at boot leaf stage and post-milk stages; 2% DAP spray at boot leaf stage and 50% flowering and at post milk stages). The experimental field soil was moderately drained, deep clayloam classified as typic Haplustalf with a pH of 8.1. It was low in available N (264 kg/ha), high in P (Bray P - 23.5 Kg/ha) and high in K (ammonium acetate K-705 Kg/ha). A fertilizer dose of 120: 38 kg N, K_2O/ha was applied in 3 splits *viz.*, 50 per cent basal, 25% per cent at active tillering and 25% at panicle initiation. Phosphorus was applied as per the treatment schedule. DAP 2% solution was prepared previous day and the solution was used for spray. The spray

Table 2. Effect of P levels and DAP spray on P untake at different growth stages, and post-harvest soil available P (kg/ha)

Treatments	P uptake				Post harvest soil available P
	Active tillering	Panicle initiation	Flowering	Harvest	
No spray (S_0)	4.01	7.87	27.40	29.74	14.21
2% DAP spray at boot leaf stage and 50% flowering (S_1)	3.99	7.86	32.08	33.99	14.41
2% DAP spray at boot leaf stage and post milk stage (S_2)	3.94	7.87	32.11	33.78	14.02
2% DAP spray at boot leaf stage and 50% flowering and at post-milk stages (S_3)	3.96	7.91	32.17	34.85	15.23
LSD (P=0.05)	0.0480	NS	0.2528	1.5478	0.1324
No P (P_0)	3.24	7.12	28.75	30.43	11.12
25% of recommended P (P_1)	3.72	7.69	29.40	31.75	12.74
50% of recommended P (P_2)	4.19	8.00	31.44	33.63	16.44
100% of recommended P (P_3)	4.75	8.68	34.18	36.55	17.57
LSD (P=0.05)	0.0489	0.1348	0.5219	2916	0.2654

Table 3. Economics of P application and DAP spray in rice (IR 50)

Treatments		Gross return (Rs/ha)	Cost of cultivation (excluding P Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B/C ratio
S_1	P_0	14118.16	7024.41	7024.41	7093.75	2.01
	P_1	15950.33	7024.41	7196.61	8753.72	2.22
	P_2	16625.20	7024.41	7368.76	9256.44	2.26
	P_3	17066.35	7024.61	7713.16	9353.19	2.21
S_2	P_0	14687.24	7024.61	7290.21	7397.03	2.01
	P_1	16784.25	7024.61	7462.41	9321.04	2.25
	P_2	19177.33	7024.61	7634.56	11542.77	2.51
	P_3	19574.34	7024.61	7678.96	11895.38	2.55
S_3	P_0	14848.63	7024.61	7290.21	7556.42	2.04
	P_1	16762.77	7024.61	7462.41	9300.36	2.25
	P_2	19191.77	7024.61	7634.56	11557.21	2.51
	P_3	19773.90	7024.61	7678.96	12094.94	2.58
S_4	P_0	15330.65	7024.61	7423.11	7097.54	2.07
	P_1	17431.10	7024.61	7595.31	9835.79	2.29
	P_2	19536.20	7024.61	7767.46	11768.74	2.52
	P_3	20500.09	7024.61	8111.86	12388.23	2.53

Cost of inputs and outputs : Urea : Rs.2.80/kg SSP : Rs.2.90/kg MOP : Rs.5.67/kg DAP : Rs.6.65/kg Rice grain : Rs.3.50/kg Rice straw : Rs.250/t.

was given at different growth stages (i.e) at boot leaf stage (67 DAS); 50 per cent flowering (82 DAS) and at post milk stage (89 DAS) as per the treatment schedule. Grain yield was recorded at 14 per cent moisture. Straw was sun-dried and yield recorded.

Based on the previous season results, test verification trial was conducted in the *rabi* season (Oct'93 - Feb'94) with the following (selected) treatments:

T_1 : No P
T_2 : 100% P
T_3 : 50% P + 2% DAP spray twice at flag leaf and 50% flowering.
T_4 : 50% P + 2% DAP spray twice at flag leaf and post-milk stages.
T_5 : 50% P + 2% DAP spray thrice at flag leaf, 50% flowering and at post milk stages.
T_6 : 100% P + 2% DAP spray thrice at flag leaf, 50% flowering and at post milk stages.

Table 4. Effect of selected treatments on yield attributes and yield of IR 20 rice

Treatments	Yield attributes				Yield	
	Productive tillers/ hill (No.)	Panicle length (cm)	Filled Grains/ panicle (No.)	1000 grain weight (g)	Grain yield (kg/ha)	Straw yield (t/ha)
No P (T_1)	5.9	23.9	116.1	20.12	4130.34	5.51
100% P (T_2)	9.0	24.0	135.2	20.60	4772.82	7.80
50% P + 2% DAP spray twice at flag leaf and 50% flowering (T_3)	8.7	24.0	129.7	20.57	5094.17	7.66
50% + 2% DAP spray twice at flag leaf and post-milk stages (T_4)	8.8	23.9	131.5	20.52	5130.76	7.86
50% + 2% DAP spray thrice at flag leaf, 50% flowering and at post milk stages (T_5)	8.9	23.9	127.6	20.60	5185.92	7.76
100% P + 2% DAP spray thrice at flag leaf, 50% flowering and at post milk stages (T_6)	9.2	24.2	138.4	20.60	5415.37	7.94

Table 5. Effect of selected treatments of P application on P uptake at different stages of crop growth and available soil P at post harvest stage

Treatments	P uptake (kg/ha)				Available soil P at post harvest stage (kg/ha)
	Tillering	Panicle initiation	Flowering	Harvest	
No P (T_1)	9.7	16.2	19.9	30.1	9.3
100% P (T_2)	11.4	19.0	23.7	47.2	12.9
50% P + 2% DAP spray twice at flag leaf and 50% flowering (T_3)	10.1	16.9	19.9	44.2	11.2
50% + 2% DAP spray twice at flag leaf and post-milk stages (T_4)	10.3	17.6	21.2	43.2	10.9
50% + 2% DAP spray thrice at flag leaf, 50% flowering and at post milk stages (T_5)	9.9	17.5	21.6	43.2	11.0
100% P + 2% DAP spray thrice at flag leaf, 50% flowering and at post milk stages (T_6)	11.7	19.2	24.2	47.7	11.7

The trail was laid out in plots of 272 m^2 (8 m x 34 m) in the wetlands of Tamil Nadu Agricultural University, Coimbatore. The experimental field soil was clay loam, classified as typic Haplustalf, with a pH of 7.9. It was low in available N (257 Kg/ha), medium in P (Bray P-12.5 Kg/ha) and high in K (ammonium acetate K: 525 Kg/ha). Medium duration (135 days) rice variety IR- 20 was used as test variety. The crop was planted on 11.11.93 and harvested on 28.2.94. A fertilizer dose of 150:50 Kg N, K_2O/ha was applied in 3 splits viz., 50 per cent basal, 25 per cent each at active tillering and panicle initiation. P uptake at different stages of crop growth, post harvest soil available P for both the crops and economics for first crop were also worked out.

RESULTS AND DISCUSSION

Yield and yield attributes

Phosphorus application significantly improved the number of productive tillers and 1000 grain weight. DAP spray increased all the yield attributes except panicle length. P at recommended dose (38 kg/ha) gave the highest yield. DAP spray thrice at boot leaf stage, 50 per cent flowering and post-milk stages gave the highest field. The interaction effect was non-significant for all the parameters except 1000 grain weight (Table 1). P applied at recommended dose increased the grain yield by 14 per cent over control. Likewise, the DAP spray given at boot leaf stage, 50 per cent flowering and post-milk stages increased the grain yield by 12.8 per cent over no spray. The same trend was also observed for straw yield. The increase in grain yield was due to better grain filling resulting in increased number of filled grains and 1000 grain weight. The similar trend was also observed in the test verification trial. Higher grain and straw yield was recorded by T_6, followed by T_5 and T_4 (Table 4).

P Uptake

The effect of P levels and DAP spray on P uptake at different stages of crop growth is presented in Table 2. P levels tested significantly increased the P uptake at active tillering, panicle initiation, flowering and harvest stages over no spraying. DAP spray given at different growth stages recorded higher P uptake in all the stages of crop growth except at panicle initiation. The interaction effect was significant for all the stages of crop growth except at panicle initiation (Table 2). With regard to P uptake for IR 20 (test verification trial) T_6 recorded higher uptake, followed by T_2, T_4 and T_5 (Table 5).

The P levels and DAP spray tested recorded significantly more available soil P at pest-harvest stage but interaction was not significant. In the second crop of rice (IR20), higher post harvest soil available P, was seen in the treatment T2, followed

by T6, T3 and T5 (Table 5) as reported by Lakha Sreekanthan (1987).

Economics

Highest net return (Rs.12,094/ha) was obtained for the treatment S_3P_3) 100% recommended P + 2% DAP spray given at flag leaf, 50% flowering and post-milk stages), followed by S_3P_2 and S_3P_1 (50% recommended P + 2% DAP spray given at boot leaf stage and 50% flowering or at post milk stage). The same trend was also observed for B/C ratio (Table 3).

From this study, it is concluded that considering the yield and net return, application of P at recommended dose (38 kg P_2O_5/ha) with 2 per cent DAP spray thrice at boot leaf, 50 per cent flowering, and post-milk stages would result in higher rice grain productivity and profitability. Considering the soil health and increase in P fertilizer price, the farmer may choose to apply P at 50 per cent of the recommended dose (19 kg P_2O_5/ha) with 2 per cent DAP spray twice at boot leaf stage and 50 per cent flowering or at post-milk stages, if capital is a constraint for the farmer.

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BENGAL GRAM INTERCROPPING UNDER RAINFED CONDITION

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ABSTRACT

Experiment was conducted over a period of three *rabi* seasons of 1990-1992 at the Tamil Nadu Agricultural University, Coimbatore. The study revealed that the intercropping system *viz.*, bengal gram + sesamum 4:2 ratio was found to give higher mean net returns of Rs.900/ha and LER value of 1.56 under rainfed condition.

KEY WORDS : Chickpea, Intercropping, Rainfed Condition.

Bengal gram occupies an important place among the pulses grown in India. It accounts for about 36 per cent of the total area and 48 per cent of the total production of grain legumes in the country. The country's requirement of pulses is going up while its production is not increasing to that extent. Hence production of pulses has to be increased either by increasing the area or increasing the yield/unit area/day to meet the protein requirement of growing population. Since the cultivated area is limited, increase in area under pulses is practically impossible. The only alternative is to push up the yield/ha per unit of time. This cannot be achieved unless the available land is intensively cropped by raising two or more crops per year through multiple, relay and intercropping and by utilising the available resources more efficiently. The main objective of such cropping systems is to reduce the risk of total crop failure due to uncertain monsoon, to have a variety of produce for the food requirement of farmers' family feeding the animal, improvement of soil fertility, minimising the damage caused by insect pests diseases and weeds and finally to meet the cash requirement (Palaniappan, 1984). Research has established that intercropping can give more stable yields than sole crops. But resea rch data on the bengal gram based cropping system is very meagre and hence this study was taken up at the Department of Agronomy, Agricultural College and Research Institute, Coimbatore, Tamil Nadu.

MATERIALS AND METHODS

The study consisted of 11 treatments *viz.*, bengal gram sole crop (T1); sorghum sole crop (T2); *cumbu* sole crop (T3); sesamum sole crop