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Yield and physiological attributes of soybean as influenced by P mobilizers under varying irrigation regimes

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Abstract : A field experiment was carried out during Summer 1994 and 1995 at Vamban, Pudukkottai to study the yield and physiological attributes of soybean *(Glycine max* (L) Marrill) as influenced by P management using P mobilizers under varying irrigation regimes. Irrespective of season, irrigation at IW/CPE ratio of 0.8 were significantly increased the various growth analysis parameters *viz.* DMP, LAI, LAD, CGR and NAR of soybean. The grain yield was increased by irrigation at IW/CPE ratio of 0.8 in both the experiments. An appreciable increase in physiological attributes and grain yield were recorded at 80 kg P_2O_5 ha^{-1}). *(Key words : Soybean, Physiological attributes, Yield, P management, "P" mobilizers, Irrigation.)*

Soybean is an important protein cum oil yielding leguminous crop. Water is a major limiting factor for successful production of soybean in Tamil Nadu and India. Achieving greater water use-effciency is possible in irrigated soybean production through efficient and judicious application of irrigation water. Irrigation scheduling technique is one of the means of attaining this goal. Soybean requires adequate amount of phosphorus for better growth and yield. It is evident that application of P influences the physiological attributes positively in soybean as reported by Rajput *et al.* (1994). Therefore, the present experiment was conducted to evaluate the effect of different irrigation regimes and phosphorus management using P mobilizers on yield and physiological attributes of soybean.

Materials and Methods

A field experiment was conducted for two years during summer season of 1994 and 1995 at National Pulses Research Centre, Vamban, Pudukkottai (Tamil Nadu). The experiment was conducted in split-split plot design with 2 irrigation regimes (0.8 and 0.6 IW/CPE) in main plots, 4 P mobilizers (pressmud, gypsum, enriched FYM and phosphobacteria) in sub plots and 3 phosphorus levels (40 kg P_2O_5 ha^{-1}, 60 kg P_2O_5 ha^{-1} and 80 kg P_2O_5 ha^{-1}) in sub-sub plots replicated 3 times. The soil was red soil with sandy clay loam texture. The fertility status of the soil was 220, 9.8 and 200 kg of available N, P and K ha^{-1} respectively. The soil pH was 6.4 with the organic carbon content of 0.35 per cent.

The seeds of soybean var. Co 1 were sown on 1.1.1994 and 30.1.1995 adopting a inter-row spacing of 30 cm and inter-plant spacing of 10cm. Before sowing pressmud @ 2 t ha^{-1}, gypsum @ 250 kg ha^{-1}, enriched FYM @ 750 kg ha^{-1} with treatmental

does of P kg ha^{-1} and phosphobacteria @ 3 pkt + sand ha^{-1} uniformly spread over the field and mixed with soil and leveled. Recommended dose of 20 kg nitrogen, and 40 kg potash were applied at the time of sowing through urea and muriate of potash respectively. Phosphorus (@ 80 kg) was applied as per the treatment schedule in the form of Mussoric rock phosphate.

Pendimethalin @ 2 litre ha^{-1} was applied as pre-emergence herbicide three days afer sowing followed by one irrigation. Two hand weedings were given for the crop, one at 20 DAS and another at 40 DAS after sowing. Monocrotophos @ 500ml ha^{-1} were sprayed to control the leaf minor with spray volume of 500 litres ha^{-1}. The crop was harvested on 4.4.1994 and 6.5.1995 respectively during the corresponding years.

The integrated use of 600 kg ha^{-1} sulphitation pressmud (SPM) with 25 kg $P_2O_5 ha^{-1}$ produced more greengram than that obtained with 50 kg $P_2O_5 ha^{-1}$ on a silty clay soil (Kumar and Mishra, 1991). Kandpal and Chandel (1993) showed that P uptake in soybean was enhanced because of gypsum application. Application of FYM in combination with phosphorus increased the P status of the soil (Sharma and Gupta, 1992) Rachewad *et al.* (1992) reported that use of phosphate solubilizing inoculant (*Bacillus megatherium* var. phosphoticum) in the presence of applied P enhanced the P content as well as P uptake by sunflower. It is evident from the above literature that application of P mobilizers increases the P availability in soil and its uptake by the crops.

The LAI was calculated using the formula of Williams (1946). LAD was calculated from LAI as per the formula suggested by Power *et al.* (1967). The CGR during the growth period was calculated as suggested by Buttery (1970) and expressed as gm^{-2} day^{-1}. The NAR during the crop growth period was worked out as suggested by Enyi (1962) and expressed in gm^{-2} day^{-1}.

Results and Discussion

Effect of season and years of yield and physiological attributes

Prevalence of favourable temperature and sunshine hours with adequate rainfall and less incidence of pest during the period of crop growth enhanced the yield and physilogical attributes in summer 1995 than in summer 1994.

Dry matter production (DMP)

Irrigation scheduling at low pan value resulted in increased dry matter production at all stages as compared to other irrigation treatments (Table 1). Irrigation at IW/CPE ratio of 0.8(I1) increased the DMP in the crops over irrigation at IW/CPE ratio of 0.6(I2). Moisture stress during the crop growth period reduced the size of the assimilatory surface, decreased the photosynthesis, stunted the plant growth resulting in drastic reduction in biological corn yield (Dale and shaw, 1965). The lower DMP recorded under moisture stress condition (I2) may be due to reduced plant growth characters and lower photosynthetic rate as compared to higher level of irrigation.

Application of enriched FYM exhibited appreciable increase in DMP over pressmud, gypsum and phosphobacteria. Increased DMP of soybean with the application of enriched FYM was reported by Badiyala and Verma (1991). A positive response in DMP with application of P was observed. Similar increase in DMP with higher levels of P application was reported by Ali *et al.*(1993).

Growth analysis

Growth analysis, LAI, LAD, CGR and NAI were measured at a fixed intervals to study th influence of treatments and their interactions on plar growth (Tables 1 and 2) Irrigation at IW/CPE rati of 0.8 (I1) invariably increased the LAI at all stage of observation. The LAI is a function of leaf numbe and size. Obviously higher level of irrigation favoured the above stated aspects and there by increased the LAI. Higher moisture regime favoured the LAI (Rajput *et al.* 1994). LAD is the integral of LAI over the growing season. LAD was explicitly increased at higher level of irrigation (I1). This increase might be due to prolonged survival of leaves with restricted availability of water. CGR increased with higher level of irrigation (I1) than at lower levels (I2) Lower CGR at higher pan value of irrigation may be due to inadequate moisture supply for better crop growth (Rajput *et al.* 1994). The NAR showed a rapid increase in the vegetative phase and then decreased with advancing age of the crop. Decreasing in NAR during the later stage was due to the high leaf area which caused mutual shading.

The LAI, LAD and CGR were appreciably increased with P mobilizer and phosphorus application. P level at 80 kg P_2O_5 ha^{-1} as enriched FYM application increased the LAI, LAD and CGR. Higher LAI and increased photosynthetic rates may be responsible for the increased CGR.

Grain Yield

Irrigation at IW/CPE ratio of 0.8(I1)

Table 1. DMP, LAI and LAD of soybean as influenced by P management using 'P' mobilizers under varying irrigation regimes

Treatments	Summer 1994						Summer 1995					
	DMP (kg ha^{-1})		LAI		LAD (Days)		DMP (kg ha^{-1})		LAI		LAD (Days)	
	60 DAS	At harvest	60 DAS	At harvest	30-60	60-has	60 DAS	At harest	60 DAS	At harvest	30-60	60-har
Levels of irrigation												
I_1-0.8 IW/CPE	2759	3315	1.962	1.770	46.9	55.9	2959	3612	2.007	1.811	48.2	57.2
I_2-0.6 IW/CPE	2596	2903	1.906	1.704	42.7	54.2	2595	3202	1.950	1.744	44.2	55.4
CD (P=0.05)	47.7	46.3	0.0181	0.0131	1.08	0.48	51.5	49.1	0.0195	0.0137	0.74	0.48
'P' mobilizers												
S_1-Pressmud	1808	2680	1.227	1.189	31.4	36.3	1911	2850	1.295	1.287	33.1	38.8
S_2-Gypsum	2012	2982	1.374	1.330	35.0	40.6	2131	3181	1.447	1.436	36.9	43.2
S_3-Enriched FYM	2527	3745	1.751	1.677	44.4	51.4	2668	3980	1.847	1.809	46.7	54.7
S_4-Phosphobacteria	2248	3332	1.539	1.492	39.4	45.5	2381	3548	1.625	1.608	41.3	48.4
CD (P=0.05)	31.9	47.2	0.0265	0.0246	0.65	0.75	33.4	55.1	0.0268	0.0242	0.72	0.75
Levels of phosphorus												
P_1-40kg P_2O_5 ha^{-1}	2037	3019	1.386	1.333	35.6	40.8	2153	3218	1.461	1.440	37.3	43.5
P_2-60kg P_2O_5 ha^{-1}	2264	3355	1.565	1.511	39.4	46.2	2380	3560	1.648	1.626	41.9	48.9
P_3-80kg P_2O_5 ha^{-1}	2275	3380	1.567	1.522	39.8	46.3	2394	3590	1.651	1.639	42.0	49.3
CD (P=0.05)	47.1	25.3	0.0145	0.0137	0.46	0.42	48.6	31.9	0.0154	0.0155	0.40	0.44

Table 2. Effect of P levels, P mobilizers and irrigation regimes on CGR, NAR and grain yield of soybean

Treatments	Summer 1994					Summer 1995				
	CGR ($g.m.^{-2}day^{-1}$)		NAR ($g.m.^{-2}day^{-1}$)		Grain yield ($kg\ ha^{-1}$)	CGR ($g.m.^{-2}day^{-1}$)		NAR ($g.m.^{-2}day^{-1}$)		Grain yield ($kg\ ha^{-1}$)
	30-60	60-har	30-60	60har		30-60	30-60	60-har	30-60	60har
Levels of irrigation										
I_1-0.8 IW/CPE	8.06	1.85	5.22	0.99	1134	8.42	2.19	5.31	1.15	1369
I_2-0.6 IW/CPE	6.89	1.68	5.05	0.97	1075	7.27	2.02	5.16	1.13	1347
CD (P=0.05)	0.124	0.011	NS	0.008	24.1	0.146	0.072	NS	NS	19.7
'P' mobilizers										
S_1-Pressmud	5.59	1.47	4.89	1.07	932	6.03	1.80	5.10	1.28	1096
S_2-Gypsum	6.76	1.56	5.00	0.93	1035	7.11	1.92	5.07	1.11	1315
S_3-Enriched FYM	8.93	2.04	5.21	0.91	1293	9.27	2.38	5.29	1.06	1537
S_4-Phosphobacteria	8.62	1.99	5.43	0.99	1158	8.97	2.32	5.47	1.13	1483
CD (P=0.05)	0.067	0.028	0.061	0.017	19.9	0.071	0.043	0.063	0.022	48.5
Levels of phosphorus										
P_1-40kg P_2O_5 ha^{-1}	7.13	1.69	5.02	0.92	1050	7.49	2.02	5.10	1.08	1285
P_2-60kg P_2O_5 ha^{-1}	7.73	1.79	5.12	0.99	1154	8.14	1.93	5.24	1.17	1396
P_3-80kg P_2O_5 ha^{-1}	7.87	1.82	5.26	1.01	1161	8.21	2.15	5.36	1.18	1422
CD (P=0.05)	0.072	0.036	0.060	0.019	21.7	0.077	0.047	0.057	0.027	30.5

significantly influenced the grain yield over irrigation at IW/CPE ratio of 0.6(12) (Table 2). As economic yield is a part of the total biological yield of the crop, DMP is an important determinant of seed yield (Donald, 1963). The cumulative effect of better plant growth characters and higher DMP, LAI, LAD and CGR at higher level of irrigation (0.8 IW/CPE ratio) were reflected in the yield components. All these enhanced the grain yield. Higher grain yield was observed at 80 kg $P_2O_5 ha^{-1}$ applied through enriched FYM. Increase in grain yield due to added P application was well documented by Abbas *et al.* (1994).

On the basis of 2 years results it may be concluded that DMP, LAI, LAD, CGR and grain yield were significantly increased by irrigation at IW/CPE ratio of 0.8 compared to 0.6 ratio. An increase in DMP, LAI, LAD, CGR, NAR and grain yield (1359 and 1640 kg ha^{-1} during summer 1994 and 1995 respectively) were observed with 80 kg $P_2O_5 ha^{-1}$ in the form of enriched FYM application.

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