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EFFECT OF MICROBIAL INOCULANTS AND PHOSPHORUS LEVELS ON GROWTH AND PHOSPHORUS NUTRITION OF VEGETABLE COWPEA

Phosphorus is a vital element in all biological systems and is a limiting factor in enhancing the productivity of legumes. Its availability in tropical soils is less due to fixation by various soil reactions. The commonly applied phosphatic fertilizer is mussoorie rock phosphate (MRP), which is slowly available to the crop. Cowpea being a short duration crop often suffers from phosphorus deficiency during its growth stages. Barea (1991) observed that vesicular arbuscular mycorrhizal fungi enhances plant growth as a result of improved mineral nutrition of the host plant especially immobile nutrients in soil. Phosphate solubilising microorganisms (PSM)

Table 1. Effect of microbial inoculants, phosphorus levels and interaction on vine length and LAI (at vegetative, flowering and harvest stages)

Treatments	Vine length (cm)			LAI		
	Vegetative stage	Flowering stage	Harvest stage	Vegetative stage	Flowering stage	Harvest stage
Bioinoculants						
AMF	147.38	259.42	342.58	2.47	2.41	2.32
PSM	167.20	256.95	338.23	2.28	2.49	2.40
AMF + PSM	174.50	269.03	350.45	2.37	2.50	2.39
CD (0.05)	15.35	NS	NS	NS	NS	NS
Phosphorus levels (kg ha^{-1})						
0	157.44	258.87	342.87	2.37	2.36	2.43
15	165.0	268.09	348.33	2.41	2.52	2.42
30	169.69	258.64	341.12	2.37	2.56	2.25
45	159.98	261.60	342.69	2.39	2.44	2.45
CD (0.05)	NS	NS	NS	NS	NS	NS
$M_1 P_1$	139.73	257.87	342.93	2.23	2.16	2.36
$M_1 P_2$	152.07	272.87	350.93	2.55	2.52	2.30
$M_1 P_3$	146.03	256.80	341.33	2.56	2.80	2.47
$M_1 P_4$	151.20	250.13	335.13	2.52	2.43	3.21
$M_2 P_1$	158.20	280.67	360.20	2.24	2.69	2.01
$M_2 P_2$	162.87	233.40	320.47	2.36	2.51	3.77
$M_2 P_3$	179.87	254.87	332.70	2.21	2.27	2.84
$M_2 P_4$	167.87	258.87	339.53	2.42	2.56	2.07
$M_3 P_1$	174.40	265.73	341.87	2.67	2.25	3.30
$M_3 P_2$	180.07	270.33	357.20	2.31	2.63	2.36
$M_3 P_3$	182.67	264.27	349.33	2.35	2.74	2.29
$M_3 P_4$	160.87	275.80	353.40	2.23	2.35	3.13
CD (0.05)	NS	NS	NS	NS	NS	0.56
Treatment means	163.03	261.80	343.75	2.39	2.50	2.68
C_1	175.47	253.27	329.0	2.07	2.43	2.18
C_2	152.80	261.93	342.53	2.42	2.35	2.57

also help in the solubilisation of fixed forms of phosphorus supplied through fertilizers. Keeping in view the above facts, a study was conducted to exploit the synergistic effect of arbuscular mycorrhizal fungi (AMF) and PSM along with varying levels of phosphorus in improving the phosphorus nutrition and growth of vegetable cowpea.

Field experiment was conducted at the Instructional Farm, College of Agriculture, Vellayani, Kerala during summer season of 1998-1999. The site is located at 8° 30'N latitude and 76° 54' E longitude at an altitude of 29 m above msl. The soil of the experimental site was laterite, acidic (pH 5.0) and tested low in available nitrogen (78.4 kg ha^{-1}) and potassium (29.12 kg ha^{-1}) and medium in available phosphorus (24.0 kg ha^{-1}). The experiment was laid out in factorial randomized block design (RBD) with three replications. The treatments consisted of the factorial combinations of three microbial inoculants (M_1 - AMF, M_2 - PSM and M_3 - AMF+PSM and four

Table 2. Effect of microbial inoculants, phosphorus levels and interaction on total P content in plant, residual P_2O_5 content in soil (vegetative flowering & harvest stages)

Treatments	Total P in plant (%)	Residual P_2O_5 content in soil, kg ha^{-1}		
		Vegetative stage	Flowering stage	Harvest stage
Bioinoculants				
AMF	0.32	44.05	120.82	100.80
PSM	0.32	50.77	108.77	103.60
AMF +PSM	0.34	59.58	147.09	107.15
CD (0.05)	0.19	5.35	28.02	NS
P levels (kg ha^{-1})				
0	0.29	46.54	114.81	114.74
15	0.33	59.98	148.74	111.25
30	0.37	55,25	116.61	88.36
45	0.33	44.09	122.14	101.05
CD (0.05)	0.21	5.98	23.10	18.16
M_1P_1	0.28	41.07	110.01	110.51
M_1P_2	0.29	49.28	139.72	119.47
M_1P_3	0.37	43.31	92.59	77.65
M_1P_4	0.35	42.56	140.96	95.57
M_2P_1	0.30	44.05	85.17	100.80
M_2P_2	0.31	56.75	127.89	112.00
M_2P_3	0.37	53.76	116.46	98.56
M_2P_4	0.32	48.53	105.55	103.04
M_3P_1	0.31	54.51	149.24	132.91
M_3P_2	0.39	73.92	178.75	102.29
M_3P_3	0.36	63.69	140.83	88.85
M_3P_4	0.32	41.18	119.92	104.53
CD (0.05)	0.13	12.85	NS	NS
Treatment means	0.33	51.47	125.59	103.85
C_1	0.26	20.16	75.92	66.45
C_2	0.26	24.64	81.46	74.67

levels of phosphorus (P_1 - 0 kg P_2O_5 ha^{-1}, P_2 - 15 kg P_2O_5 ha^{-1}, P_3 - 30 kg P_2O_5 ha^{-1} and P_4 - 45 kg P_2O_5 ha^{-1}) along with two control treatments [C_1 - No bioinoculants + No NPK (absolute control) and C_2 - No bioinoculants + N and K fertilizers + No P_2O_5]. The variety used was Sharika, a commonly cultivated trailing type of vegetable cowpea in Kerala. FYM was applied @ 25 t ha" ', uniformly to all plots and mixed with topsoil. A common dose of 30 kg N ha^{-1} and 10 kg K_2O ha^{-1} was given to all the plots except absolute control plot (C_1). The crop was agronomically managed as per the package of practice recommendations of the Kerala Agricultural University. Spores of *Glomus sp.* infected sorghum root pieces and perlite vermiculite medium was applied @ 5 g $plant^{-1}$ in plots receiving AMF treatment at the time of sowing. A mixture of bacteria (*Pseudomonas* and *Bacillus* sp.) and fungi (*Aspergillus* sp.) was used as PSM culture. It was applied *in situ* @ 1 g $plant^{-1}$ after mixing with well rotten FYM. Observations on growth characters and available phosphorus were recorded at three growth stages viz. vegetative, flowering and harvest stages. The total phosphorus content of plant was estimated at harvest stage by colorimetric method.

Among the different growth parameters viz. length of vine, number of primary branches, number of leaves and leaf area index (LAI) recorded, bioinoculants could produce a significant influence on length of vine at vegetative stage only (Table 1). Maximum vine length was registered by dual inoculation of AMF and PSM, which was significantly superior to the other two individual inoculants, which were on par (Table 1). These results corroborate with the findings of Dubey and Billore (1992) who have reported increased plant height due to combined inoculation of *Glomus fasciculatum* with PSM in chickpea. The lack of influence of bioinoculants in later stages of growth with respect to all growth characters might be due to the medium P status of soil. Similar results were reported by Detroja *et al.* (1997). P levels tried had no significant influence on growth parameters at any growth stage (Table 1). The poor response of growth parameters at higher levels of P might be due to imbalance in application of major nutrients especially N as well as due to medium P status of experimental soil. This result is in conformity with the findings of Mehta *et al.* (1996). However, bioinoculant–phosphorus interaction significantly influenced the LAI at harvest stage (Table 1). The treatment combination M_2P_2 recorded the maximum LAI value of 3.77 and was on par with M_1P_4.

The total phophorus content of plant was positively and significantly influenced by application of bioinoculants, P levels and their interaction effects. The three bioinoculant treatments were observed to be on par and superior to control (Table 2). The highest P content of plant was recorded by 30 kg P_2O_5 ha^{-1} and was significantly superior to other levels of P. Among the combinations, M_1P_3, M_2P_3, M_3P_2 and M_3P_3 were superior to others and were on par with respect to total plant P content. Residual phosphorus content in soil estimated at vegetative and flowering stages was significantly influenced by bioinoculants and phosphorus levels. Among bioinoculants, dual inoculation of AMF and PSM recorded the maximum available P_2O_5 content at both stages (Table 2). The P level of 15 kg ha^{-1} registered the highest residual phosphorus indicating that 15 kg phosphorus is sufficient for vegetable cowpea in soils with medium phosphorus status. At harvest stage, bioinoculants had no significant influence whereas the levels of P influenced the available phosphorus content in soil (Table 2). At P_1 and P_2 levels, the P requirement of the crop was already met from the native soil phosphorus. But at 30 kg P_2O_5 level, native as well as some applied P was utilized by the crop, which might be the reason for low residual P_2O_5 in soil at all the three crop growth stages. George (1980) also reported more available P_2O_5 in soil at lower doses of phosphorus application. The result of the study concluded that a combined inoculation of AMF and PSM at lower phosphorus levels enhanced the growth, phosphorus content and residual phosphorus of the soil.

College of Agriculture
Thiruvananthapuram 695 522, India.

Meena Mary Mathew
S. M. Shahul Hameed

REFERENCES

Barea, J. M. 1991. VA mycorrhizae and soil fertility. *Adv. Soil Sci.* Vol. 15. Springer-Verlag, London, pp.1-40

Detroja, K. S., Malavia, D. D., Kaneria, B. B., Khanpara, V. D. and Patel, R. K., 1997. Effect of phosphate fertilizer, phosphobacteria and seed size on plant stand, growth and yield of summer groundnut *(Arachis hypogaea). Indian J. Agron.* 42: 495-497

Dubey, S. K. and Billore, S.D. 1992. Phosphate solubilising microorganisms (PSM) as inoculant and their role in augmenting crop productivity in India: A review. *Crop Res.* 5: 11-24

George, A. 1980. Nutritional requirement of black gram *(Vigna mungo* (L) Hepper). M.Sc (Ag.) thesis, Kerala Agricultural University, Thrissur

Mehta, C. A., Malavia, D. D., Kaneria, B. B. and Khanpara, V. D. 1996. Response of groundnut *(Arachis hypogaea)* to farm yard manure, phosphorus and phosphate solubilising microorganisms. *Indian J. Agron.* 41: 172- 174