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Effect of Phosphorus and Biofertilizer on Growth and Yield of pea *(Pisum sativum* L.)

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Abstract: A field experiment was conducted at Effect of Phosphorus Levels and Biofertilizers on Growth, Yield and Quality of Pea (*Pisum sativum* L.)" conducted during *rabi* 2022-23 at Agronomy farm, Suresh Gyan Vihar University, Jaipur on loamy sand soil. The experiment Consisting four levels of each phosphorus (0, 50, 75 and 100% RDP) and biofertilizers (control, PSB, VAM and PSB + VAM). The total 16 treatment combinations were tested in randomized block design with three replications. Results revealed that application of 75% RD of phosphorus to the pea crop significantly increased the plant height (cm), number of nodules per plant (total and effective), number of pickings, number of pods per plant, number of seeds per pod, pod length (cm), fresh pod weight (g), Net return and B: C ratio as compared to control and 50% RDP but statistically at par with 100% RDP. Seed inoculation with PSB + VAM significantly increased the plant height (cm), number of pickings, pod length (cm), fresh weight per pod (g), green pod yield (kg/plot and q ha^{-1}) net return and B:C ratio as compared to control, PSB and VAM inoculation.

Keywords: VAM, Phosphorus, pod, yield

Introduction

Pea *(Pisum sativum* L.) is an important vegetable crop grown throughout the world. In India, it is mainly grown as winter vegetable in the plains of North India and as summer vegetable in the hills. It is generally used as fresh vegetable and in the form of canned, processed or dehydrated. Pea occupies an area of 0.408 million hectares with the production of 3.74 million tonnes in India (Anonymous, 2021). It is cultivated in Rajasthan in approximately 12520 hectares area with an annual production of 22580 metric tonnes pod (Anonymous, 2021). It is largely cultivated in Jaipur, Baran, Bundi, Kota and Bharatpur districts. The Jaipur district covers an area of 9261 hectares with a total production of 14745 metric tonnes pod (Anonymous, 2020). The average yield of pea is 70-80 q (green pods) per hectare with a shelling percentage of 30-35 (Fageria *et al.*, 2003). Its fresh pod contains 7.2 per cent protein, 19.8 per cent carbohydrate, 0.8 per cent mineral matter, while dried pea grain contains

19.7 per cent protein, 56.6per cent carbohydrate, 2.1 per cent mineral matter and 4.4 per cent iron, besides being a rich source of vitamins A, B and C (Choudhary, 1967). phosphorus is reported to serve dual purpose in legumes by increasing the yield of current as well as succeeding crop. An adequate supply of phosphorus has been reported beneficial for better growth and yield, better quality and enormous nodule formation in legumes (Sammauria *et al.*, 2009). It acts as a structural component of membranesystem of cells, chloroplasts and mitochondria. It is a constituent of energy phosphates like ADP and ATP, nucleic acid, nucleo proteins, purines, pyrimidine, nucleotides and several coenzymes. It is involved in the basic reaction of photosynthesis and plays an important role in cell division, reak down of carbohydrate, transfer of inherited characteristics and hastening the maturity of plants (Verma, 1993). Symbiosis between plant root and certain soil fungi *e.g.* Vesicular Arbuscular Mycorrhiza (VAM) play an important role in phosphorus cycling and in the uptake of phosphorus by plants (Biswas *et al.* (2001). VAM as symbiotic association with plant roots helps in mobilization of P‟.

Materials and method

The experiment was laid out at Agronomy farm, Suresh Gyan Vihar University, Jaipur during *Rabi* season 2022-23 Suresh Gyan Vihar University, Jaipur is situated 45 km West of Jaipur at 26^0 05˝ North latitude, 75^0 58‟ East longitude and at an altitude of 427 meters above mean sea level. In Rajasthan, this region falls under agro-climatic zone-IIIA (Semi-Arid Eastern Plains). The experiment was comprised of 16 treatment combination with four levels of each phosphorus (0, 50% RDP, 75% RDP, 100% RDP ha^{-1}) and inoculation with biofertilizers (control, PSB, VAM and PSB + VAM) with three replications. The experiment was taken on cross 6416 x 1605 and released in 1993 from CSAUA &T, Kanpur (U.P.). Pea variety Azad P-1 is a mid-season/main season variety. The seeds of pea variety Azad P-1 were first treated with bavistin @ 2 g kg^{-1} seed to control seed borne diseases and thereafter inoculated with PSB culture. Seeds were sown @ 80 kg ha^{-1} in rows at30 cm on 12 October apart by "kera method". The fertilizer single super phosphate (SSP) containing 16% P_2O_5 as basal dose was drilled as phosphorus source at sowing as per treatments. Sulphur added through application of single super phosphate in the treatment of 60 kg P_2O_5 ha^{-1} was compensated in remaining treatments through gypsum at the time of sowing. VAM was applied to the respective plots @ 2 kg/ha using field soil to bulk the carrier. PSB was applied by weighed 30 g jaggery and boiled in half litre water to prepare jaggery solution, cooled it and added 50 g of culture in it. The required quantity of seed was thoroughly mixed with paste of culture to inoculate with PSB culture as per treatments and dried in shade. The experimental data recorded were subjected to statistical analysis using analysis of variance technique suggested by Panse and Sukhatme (1985).

Results and discussion

Application of 75% recommended dose of phosphorus (45 kg P_2O_5 ha^{-1}) have favorable and significant effect ongrowth and biomass production. All the growth parameters *viz.* plant height and number of nodules per plant (total and effective) increased linearly with the corresponding increase in levels of recommended dose of phosphorus up to 100% RDP. Phosphorus is more indispensable mineral nutrient for pulse crops as it helps in better root growth and development and thereby making them more efficient in biological N_2 fixation (BNF). Theresults obtained in this investigation are in close conformity with those of Kasturi Krishna and Ahlawat (2000), Biswas and Patra (2007) and Kumar (2011), who reported significantly higher plant height and nodules per plant.

Seed inoculation with biofertilizers (PSB, VAM and PSB + VAM) significantly enhanced the days to flower initiation, number of pickings, number of pods per plant, pod length (cm), fresh pod weight, number of seeds per pod and green pod yield over no inoculation. The significantly higher values of yield attributes were registered under PSB + VAM followed by PSB inoculation.

Application of 75% RDP (45 kg P_2O_5 ha^{-1}) significantly increased yield attributes *viz.*, days to flowering initiation, number of pods per plant, pod length (cm), fresh pod weight and number of seeds per pod as compared to control and 50% RDP but remained at par with 100% RDP. Application of phosphorus might have resulted in increased carbohydrate accumulation and their remobilization to reproductive part of the plant, being the closest sink and hence, resulted in right time flowering and increased fruiting and seed formation. These findings corroborate the results of Gupta *et al*. (2000), Yadav and Luthra (2005) and Maurya *et al*. (2009) in pea.

VAM inoculation in soil significantly plays an important role in P cycling, mobilization and uptake by plants *i.e.* earlier P availability, greater root extension, higher nutrient uptake, higher photosynthesis and balanced portioning as discussed in previous section are the main factors of significant increase in yield attributes and yield. It is well established that pod yield of a crop is function of yield attributes. Increase in these yield attributes such as number of pods per plant, number of seeds per pod, pod length and fresh weight of pod due to different biofertilizers might have increased pod yield of pea. These findings corroborate the results of Ram *et al*. (2007) in chickpea, Tarafdar and Rao (2001) in clusterbean, inoculation of seed with PSB also significantly enhanced the yield and yield attributes. The beneficial effect of phosphate solubilizing bacteria as explained earlier increased the availability of phosphorus. Greater root extension under higher availability of phosphorus might have helped in greater uptake of other nutrients especially micronutrient and secondary nutrients, enhanced photosynthesis, production of photosynthates and their partitioning between vegetative and reproductive structure might have helped in improving the yield attributes (days to flower initiation, number of pickings, number of pods per plant, number of seeds per pod, fresh pod weight) finally the green pod yield. These findings corroborate the results of Yadav (2009) in pea.

The combined inoculation of PSB + VAM significantly enhanced the yield attributes and yield of pea over control, PSB and VAM and proved superior to PSB. The combined effect of PSB and VAM might have increased the growth, yield attributes and ultimately the yield in the present investigation due to enhance nutrient uptake and available P status of soil. Similar findings were also reported by Singh *et al*. (2004) in pea, Dadhich *et al*. (2006) in soybean and Rathore (2010) in urdbean.

Application of phosphorus 75% RDP (45 kg P_2O_5 ha^{-1}) to pea crop recorded significantly higher net return over lower levels of phosphorus. Since the cost of treatment was low under 75% RDP therefore, it may be considered as superior treatment for increasing the yield which led to increased net return and B:C ratio. Further pea seed inoculated with PSB + VAM also recorded significantly maximum net return and B:C ratio as compared to other biofertilizers treatments.

Table: 1 Effect of phosphorus levels and biofertilizers on growth attributes

Treatments	Plant	Number	Total	Days to	Number of

	height (cm)	**of nodules per plant**	**number of Nodules**	**flower initiation**	**picking**
Phosphorus levels					
(i) 0	54.15	51.28	32.58	39.20	2.42
(ii) 50% RDP	64.90	59.08	40.42	44.03	2.92
(iii) 75% RDP	72.67	65.56	45.22	48.11	3.26
(iv) 100% RDP	74.89	66.49	46.45	51.23	3.33
SEm±	1.99	1.15	0.79	1.34	0.11
CD at 0.05%	5.74	3.31	2.29	3.88	0.31
Biofertilizers					
Control (No inoculation)	56.98	52.74	33.62	40.61	2.29
PSB inoculation	68.87	63.43	43.68	47.83	3.30
VAM inoculation	66.12	59.53	41.41	45.14	2.71
PSB + VAM inoculation	74.64	66.71	45.95	48.99	3.63
SEm±	1.99	1.15	0.79	1.34	0.11
CD at 0.05%	5.74	3.31	2.29	3.88	0.31
CV	10.33	6.55	6.66	10.20	12.42

Table: 2 Effect of phosphorus levels and biofertilizers on yield attributes and yields

Treatments	**Pod length (cm)**	**Fresh pod weight**	**Number of seeds per pod**	**Green pod yield kg/plot**	**Green pod yield q/ hectare**
Phosphorus levels					
(i) 0	6.88	4.56	5.52	3.45	63.94
(ii) 50% RDP	7.68	5.78	6.57	4.39	81.20
(iii) 75% RDP	8.56	6.66	7.47	4.88	90.37
(iv) 100% RDP	8.59	6.87	7.60	5.08	94.07
SEm±	0.19	0.10	0.21	0.07	1.29
CD at 0.05%	0.56	0.30	0.61	0.21	3.73
Biofertilizers					

Control (No inoculation)	7.03	4.99	5.92	3.72	68.80
PSB inoculation	8.12	6.08	6.99	4.60	85.14
VAM inoculation	7.81	6.03	6.69	4.45	82.41
PSB + VAM inoculation	8.74	6.78	7.56	5.04	93.24
SEm±	0.19	0.10	0.21	0.07	1.29
CD at 0.05%	0.56	0.30	0.61	0.21	3.73
CV	8.51	6.09	10.83	5.65	5.44

Table 3: Effect of phosphorus levels and biofertilizers on net return and B:C ratio

Treatments	**Net return (Rs ha^{-1})**	**B:C ratio**
Phosphorus levels		
(i) 0	75894	1.46
(ii) 50% RDP	107637	1.96
(iii) 75% RDP	125174	2.25
(iv) 100% RDP	131784	2.34
SEm±	2570	0.04
CD at 0.05%	7421	0.11
Biofertilizers		
Control (No inoculation)	83308	1.52
PSB inoculation	115764	2.12
VAM inoculation	109951	1.99
PSB + VAM inoculation	131467	2.38
SEm±	2570	0.04
CD at 0.05%	7421	0.11
CV	8	6.45

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