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RESEARCH PAPER

Effect of biofertilizer and different sources of phosphatic fertilizers on the growth and yield of field pea (*Pisum sativum* L.) in alluvial soil

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Abstract : An experiment was conducted during *Rabi* 2001 to assess the effect of biofertilizer (*Rhizobium*) and different sources of phosphatic fertilizers (Diammonium phosphate and single super phosphate) on the growth and yield of field pea (*Pisum sativum* L.) in alluvial soil. The experiment was laid out in Randomized Block Design with six treatments and four replications. In this experiment, it was observed that the diammonium phosphate + *Rhizobium* had higher values of plant height, number of leaves, nodules per plant, fresh and dry weight of plant and grain yield followed by single super phosphate + diammonium phosphate. The diammonium phosphate + *Rhizobium* had given favorable results with regards to at various stages of 20, 40, 60 and 80 days after sowing. The diammonium phosphate + *Rhizobium* and single super phosphate + diammonium phosphate were found to be more effective in producing maximum growth extension than rest of the treatments, although the difference was significant among the treatments. Field pea crop applied with diammonium phosphate + *Rhizobium* recorded highest yield (102.6 q ha^{-1}) followed by single super phosphate + diammonium phosphate (98.6 q ha^{-1}) while minimum in control (77.4 q ha^{-1}). Among the diammonium phosphate + *Rhizobium* evaluated, showed better response compared all the treatments.

Key Words : Field, Pea, Phosphate fertilizer, *Rhizobium*, Yield, Alluvial soil

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INTRODUCTION

Pea (*Pisum sativum* L.) belonging to the family Leguminaceae its way in the five most important vegetable crops of India. The crop in green pods contains immature seeds. Pea is highly nutritive and contains high portion of digestible protein, carbohydrates, minerals and vitamins. Field pea is raised as a green manure crop for soil improvement. For successful production of pea, well-drained loam soil is suitable. Water logging is extremely harmful for the growth, development an even for survival. It does well under neutral soil reaction with soil pH 6.5-7.5 (Ahlawat *et al.*, 1998). India supports a large vegetation population and so pulses are the main stay of the India food market. Pulses play an important role in agriculture economy a part from being very rich and valuable protein source. Pulses are also referred to as poor man's meat as to these provide considerable amount of protein in the normal diet. Pulses are among the most important crop of India being a legume crop, pea fixes atmospheric nitrogen. Pulse crop have the ability to fix atmospheric nitrogen in association with bacteria *Rhizobium*, which is the important nitrogen fixing system from the agricultural point of view as 50% of natural nitrogen fixation is accomplished by this process and legumes themselves contribute 20% of the fixed nitrogen. This system is also important because nitrogen is fixed close

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to the plant roots where it is needed and a large proportion of it is utilized to support the growth process of the host plant. Biofertilizer increases soil fertility and crop yield by rendering unavailable sources of elemental nitrogen bound phosphate and decomposed plant reside into available form in order to facilitate the plant to absorb the nutrients of these bio fertilizers. *Rhizobium* inoculants specific for different leguminous crop are the most important in India. Other bacterial fertilizers produced are *Azotobacter, Azospierillum* and phosphate solubilizer bacteria etc. Most of the cultivated soil in India has large population of these *Rhizobium* and form nodules in pea crop. The influences of *Rhizobium leguminousaraum* on pea root growth at a decreased temperature given by Akimova *et al.* (1999). Keeping in view of the above facts, the present investigation was conducted to evaluate the effects of biofertilizer and different sources of phosphatic fertilizers on the growth and yield presented in this communication.

MATERIAL AND METHODS

A study was carried out on field pea (*Pisum sativum* L.) of cv. JM-6 which was sown in lines at the rate of 80 kg ha^{-1}. The lines were drawn with the help of rope manually maintaining row-to-row distance of 30 cm. Seeds were sown at a depth of 2.5 cm in the soil in these furrows in *Rabi* crop 2001 at the size of plot 1.5 x 2.0 m^2 was treated with different types of inorganic fertilizers and biofertilizer in the experiment station at the crop research farm Naini, Allahabad Agricultural Institute- deemed university, which is located at 25.57^{0}N latitude, 81.56^0 E longitude and 98 m above mean seal level during the 2001. The treatments were: T_0 (control), T_2 (Diammonium phosphate), T_3 (Diammonium phosphate+ *Rhizobium*), T_4 (Single super phosphate) and T_5 (Single super phosphate +diammonium phosphate). The experiment was laid out in Randomized Block Design with six treatments and four replications. Inorganic sources of diammonium phosphate (40 kg ha^{-1}), single super phosphate (40 kg ha^{-1}) and Rhizobium as source of biofertilizer was used @ 2.5 g kg^{-1} of the seed during November and control was not applied inorganic and biofertilizer. Plant height was measured with the help of meter scale, two plants were randomly selected from each plot and tagged from observation to be recorded. Height of plant in cm was recorded from ground level up to the base of the last fully opened leaf of the main shoot. Number of leaves per plant was recorded in the tagged plants only. Fresh and dry weight of plant samples were up rooted from each plot on different growth stages for their fresh weight and after that they were sun dried for 4-5 days. After that plant samples were dried in the oven 60^{0}C for 48 hrs. Dry weight and fresh weight of plant samples was recorded in g. For number of nodules each uprooted plant sample was washed thoroughly to remove the adherent soil fractions and number of nodules per plant was counted. Seed yield from the net plot area was recorded in kg/plot and then converted into q ha^{-1}.

The soil texture was standardized by Bouycous hydrometer method. The soil samples were analyzed for the properties *i.e.* soil reaction by pH metre, EC by EC metre, Organic carbon in soil was determined by Walkley and Black's rapid titration methods as suggested by Piper. Available Nitrogen was estimated by using alkaline $KMnO_4$ method as suggested by Subbiah and Asija (1956). Available Phosphorus content of the soil was extracted with sodium bicarbonate by Olsen *et al*. (1954). It was determined in the neutral normal ammonium acetate extract of soil through flame photometer. The observation related to growth and yields was recorded and were subjected to statistical analysis.

RESULTS AND DISCUSSION

Table 1 shows that the soil nutrient status of before sowing and after sowing of the crop. The soil texture was sandy loam in nature having low clay and high sand percentage. pH and Ec are generally neutral. Organic carbon was low before and after sowing of the crop but slightly increased after sowing. Available nutrient status of soil is Nitrogen, Phosphorus and Potassium. Available Nitrogen was low and Phosphorus was medium after sowing of the crop is increased. Available Potassium was low in soil status but generally decreased.

Plant height (cm):

Table 2 shows that those different sources of phosphatic fertilizers and biofertilizer are different treatments which reveal remarkable difference in plant height. The plant height at 20, 40, 60 and 80 days after sowing. The different sources of phosphatic fertilizer *i.e*. diammonium phosphate and single super phosphate, inoculated with *Rhizobium* increased the height of plant. At 20 and 40 days after sowing, it was

Table 1 : Some physical and chemical characteristics of soil

Texture class	Texture percentage			Before sowing						After sowing					
				pH	E.C (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)	Available nutrients ($kg\ ha^{-1}$)			pH	E.C (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)	Available nutrients ($kg\ ha^{-1}$)		
	Sand	Silt	Clay				N	P_2O_5	K_2O				N	P_2O_5	K_2O
Sandy loam	60	26	14	7.4	0.38	4.2	225.0	13.0	138.2	7.2	0.35	4.5	240.0	13.18	130.0

N= Nitrogen, P_2O_5= Phosphorus, K_2O= Potassium

found that maximum heights (21.12 and 44.62 cm, respectively) of plant was observed in T_3 (Diammonium phosphate+ *Rhizobium*) and minimum height (15.35 and 31.50 cm, respectively) of plant was observed in T_0 (control). At 60 and 80 days after sowing, the same treatment showed maximum plant height (98.87cm and 148.00 cm, respectively) while as minimum plant height (71.75 and 117.75 cm, respectively) was observed in T_0 (control). The treatment T_3 (Diammonium phosphate+ *Rhizobium*) was followed by T_5 (Single super phosphate +diammonium phosphate), statistical analysis showed significant difference between all the treatments. The treatments T_1 (*Rhizobium*), T_2 (Diammonium phosphate) and T_4 (Single super phosphate) single phosphatic fertilizer and biofertilizer that used by Rhizobium, Diammonium phosphate and Single super phosphate, plant height was less than that the combination treatments. The combination fertilizer treatments are T_3 (Diammonium phosphate+ Rhizobium) and T_5 (Single super phosphate +Diammonium phosphate) had a similar effect of plant height, thus is probably due to sufficient supply of required nutrients to the plants, which finally caused the photosynthesis and pea growth to be improved. Dileep Kumar *et al*. (2001) also reported that combined inoculation of pea seeds with rhizobium and phosphate solubilizing bacteria increased plant height. The results are in agreement with the results of Darzi *et al*. (2006) that they performed their study on the fennal plant.

Number of leaves:

Similar trend was observed in number of leaves (table 2) shows that a different treatment was observed the number of leaves at 20, 40, 60 and 80 days after sowing. At 20 and 40 days after sowing, it was achieve to maximum number of leaves were observed in T_3 (Diammonium phosphate+ Rhizobium) 30.00 and 117.25 respectively and minimum number of leaves was observed in T_0 (control) 22.00 cm and 79.00 cm. At 60 and 80 days after sowing, the same treatment showed maximum number of leaves T_3 (Diammonium phosphate+ Rhizobium) 255.00 cm and 366.87 cm while as minimum number of leaves was observed in T_0 (control) 169 and 234 treatment. The treatment T_3 (Diammonium phosphate+ Rhizobium) is followed by T_5 (Single super phosphate +Diammonium phosphate), statistical analysis showed significant difference between all the treatments. Increasing the number of leaves per plant could be caused by increase in plant height that was the result of improved nutrient absorption of phosphorus and nitrogen. Nitrogen as part of the protein compounds, enzymes, effective compounds in energy transfer, takes part in structure of DNA, present in the structure of chlorophyll and has a direct impact on vegetative growth (Assiouty and Abo-Sedera, 2005). These results are in accordance with the finding of Patel *et al*. (1996).

Table 2 : Effect of biofertilizer and different sources of phosphatic fertilizers on plant height (cm), number of leaves and number of nodules per plant

Treatments	Plant height (cm)				Number of leaves				Number of nodules				Fresh weight of plant				Dry weight of plant				Grain yield (q ha^{-1})
	Days after sowing				Days after sowing				Days after sowing				Days after sowing				Days after sowing				
	20	40	60	80	20	40	60	80	20	40	60	80	20	40	60	80	20	40	60	80	
T_0=(Control)	15.35	31.50	71.75	117.75	22.00	79.00	169.00	234.50	6.25	8.00	17.50	22.00	1.95	6.86	40.67	75.38	0.31	1.18	6.29	11.66	77.40
T_1=(Rhizobium)	17.75	38.75	86.87	128.62	23.75	84.50	198.25	310.87	6.25	13.75	24.50	27.75	2.00	7.76	46.92	85.92	0.33	1.26	7.15	13.53	84.70
T_2=(DAP)	18.65	37.25	83.25	129.12	22.75	87.00	190.75	271.50	8.75	10.50	18.87	26.25	2.30	8.82	43.87	108.75	0.38	1.31	7.58	12.21	78.40
T_3=(DAP+ Rhizobium)	21.12	44.62	98.87	148.00	30.00	117.25	255.00	366.87	10.50	21.75	32.25	36.75	2.65	12.43	86.22	188.25	0.53	1.75	13.61	20.05	102.6
T_4=(SSP)	16.50	39.62	88.87	134.25	26.00	91.75	215.50	315.37	14.00	17.75	27.00	29.25	2.38	6.36	64.87	124.77	0.45	1.20	8.90	16.62	96.10
T_5=(SSP+ DAP)	19.75	41.25	91.62	140.37	28.25	99.25	236.00	346.75	10.75	18.25	26.87	33.37	2.57	9.28	75.66	140.75	0.48	1.62	10.28	18.95	98.60
S.E.±	1.84	3.78	7.67	9.54	2.86	11.92	27.08	44.93	2.82	4.78	5.15	4.62	0.23	1.72	16.30	35.72	0.07	0.20	2.33	3.08	7.83
C.D. (P=0.05)	3.92	8.05	16.63	20.34	6.09	25.40	57.70	95.75	6.01	10.19	10.98	9.98	0.50	3.66	34.73	76.12	0.16	0.43	4.96	6.57	16.69

Number of nodules:

Table 2 shows that those different sources of phosphatic fertilizers and biofertilizer are different treatments which reveal remarkable difference in number of nodules. It was observed the number of nodules at 20, 40, 60 and 80 days after sowing. The different sources of phosphatic fertilizer i.e. Diammonium phosphate and single super phosphate, inoculated with rhizobium increases the number of nodules. At 20 and 40 days after sowing, it was found that maximum numbers of nodules per plant were observed in T_3 (Diammonium phosphate+ Rhizobium) 10.50 and 21.75 respectively and minimum nodules per plant were observed in T_0 (control) 6.25 and 8.00. At 60 and 80 days after sowing, the same treatment showed maximum nodules per plant T_3 (Diammonium phosphate+ *Rhizobium*) 32.25 and 36.25 while as minimum nodules per plant was observed in T_0 (control) 17.25 and 22.00 treatment. The treatment T_3 (Diammonium phosphate+ *Rhizobium*) is followed by T_5 (Single super phosphate +Diammonium phosphate), statistical analysis showed significant difference between all the treatments. Lower number of nodules treatments T_1, T_2, and T_4 that used by Rhizobium, Diammonium phosphate and Single super phosphate, nodules per plant was less that the other combination treatments may be due to the fact that in these single fertilizer levels, supplied nitrogen by nitrogen stabilizer bacteria has been gradually given to the plant. Increase the number of nodules per plant levels of single fertilizer may have caused the nodules in plants under those treatments to decrease. The same kind of funding reported by Vijai *et al.* (1990).

Fresh weight of plant:

Table 2 shows that similar trend was observed in fresh weight of plant. The different sources of phosphatic fertilizer i.e. Diammonium phosphate and Single super phosphate, inoculated with rhizobium increases the fresh weight of plant. At 20 and 40 days after sowing, it was found that maximum fresh weight was obtained in T_3 (Diammonium phosphate+ Rhizobium) 2.65 and 12.43 respectively and minimum fresh weight were observed in T_0 (control) 1.95 and 6.85. At 60 and 80 days after sowing, the same treatment showed maximum fresh weight T_3 (Diammonium phosphate+ Rhizobium) 86.22 and 188.25 while as minimum fresh weight was observed in T_0 (control) 40.67 and 75.38 treatment. The treatment T_3 (Diammonium phosphate+ Rhizobium) is followed by T_5 (Single super phosphate +Diammonium phosphate) between all the treatments is the best because of high productivity and less usage of fertilizer which is more environmental friendly.

Dry weight of plant:

Similar trend was observed in dry weight of plant. Statistical analysis dry weight of plant showed significant fluctuation among different treatments. Table 2 shows that different treatments it was observed the dry weight of plant were observed at 20, 40, 60 and 80 days after sowing. At 20 and 40 days after sowing, it was achieve to maximum dry weight of plant was observed in T_3 (Diammonium phosphate+ Rhizobium) 0.532 and 1.75 respectively and minimum dry weight of plant was observed in T_0 (control) 0.31 and 1.87. At 60 and 80 days after sowing, the same treatment showed maximum dry weight of plant T_3 (Diammonium phosphate + Rhizobium) 13.61 and 20.05 while as minimum dry weight of plant was observed in T_0 (control) 6.29 and 11.66 treatment. The treatment T_3 (Diammonium phosphate + Rhizobium) is followed by T_5 (Single super phosphate + Diammonium phosphate), statistical analysis showed significant difference between all the treatments. Whereas very poor growth rate was observed in control plants due to nutrients deficiency. The higher uptake of nutrients was due to synergistic effect if improved biomass and higher nutrient concentration in the inoculated plants. The Rhizobium inoculation treatment which could be due to improved symbiotic N_2 fixation activity. The result of this research is also in agreement with the results of (Preetha *et al.*, 2005).

Grain yield:

Table 2 shows that those different sources of phosphatic fertilizers and biofertilizer are different treatments which reveal remarkable difference in yield of field pea. The maximum yield of treatment T_3 (Diammonium phosphate+ Rhizobium) is 102.6 (q ha^{-1}) followed by T_5 (Single super phosphate + Diammonium phosphate) 98.60 (q ha^{-1}) while minimum yield were observed in T_0 (control) 77.4 (q ha^{-1}). Statistical analysis showed significant difference between all the treatments. It seems that fix atmospheric nitrogen and phosphorus, increasing yield component such as number of leaves, number of nodules per plant increased seed yield. For high yield, plant should have proper balance between vegetative and reproductive growth, and development stages of seeds completely. In treatment T_3 (Diammonium phosphate + Rhizobium) adequate nitrogen supply and fix atmospheric increased vegetative growth and thus yield was increased. The T_5 Treatment (Single super phosphate + Diammonium phosphate) nitrogen supply but not fix atmospheric nitrogen may be unable to fix nitrogen for complete need of plant. These results are in agreement with the finding of Kaur (1991).

Conclusion:

This study was conducted on the effect of biofertilizer and different sources of phosphatic fertilizers on the growth and yield of field pea (*Pisum sativum* L.) in alluvial soil. Optimum nutrition is a key to achieve maximum crop production yield is considered as a goal. The plant height, number of leaves, number of nodules, fresh and dry weight of plant was significantly increased. The treatments T_3 (DAP

+ Rhizobium) recorded maximum and minimum in T_0 (control). Although grain yield was significantly increased T_3 treatment (DAP + Rhizobium) recorded maximum grain yield and minimum in T_0 (control). The applied in single phosphatic fertilizer and biofertilizer is less yield than the combined phosphatic fertilizer + biofertilizer. The combined phosphatic fertilizers + biofertilizer are the best result. The results clearly show that the combined phosphatic fertilizers + biofertilizer have potential to be used practically as a natural nutrition sources in agricultural products.

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