

Response of grass pea (*Lathyrus sativus* L.) to row spacing and levels of phosphorus levels under rainfed conditions of Manipur

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ABSTRACT

An experiment was conducted to study the effect of row spacing and phosphorus levels on growth, yield and economics of grass pea (*Lathyrus sativus* L.) during *rabi* season of 2011-12 and 2012-13 at the Research Farm, College of Agriculture, Central Agricultural University, Imphal, Manipur, India. The factorial R.B.D. comprised of two spacings (20cm x 10cm and 30cm x 10 cm) and five levels of phosphorus (0, 20, 30, 40 and 50 kg P₂O₅ ha⁻¹) with three replications. Although wider spacing (30 cm x 10 cm) resulted in greater number of pods/plant (12.05) and seeds/pod (4.43) but higher grain yield (739 kg/ha) was recorded with closer spacing (20 cm x 10 cm) probably due to greater plant population in per unit area.

Key words: Apparent phosphorus recovery, Economics, Grass pea, Phosphorus level, Nutrient uptake, Spacing, Yield.

INTRODUCTION

Grass pea (*Lathyrus sativus* L.) is a hardy crop, tolerant of extremely dry conditions but still able to tolerate water-logging and poor soils. In Manipur most of the fields are lying vacant after the harvest of rice during *rabi* season due to scarcity of moisture where field can be brought under cultivation of grass pea. Optimum row spacing results in proper utilization of growth resources compared to both narrow and wider row spacing. Phosphorus is an important plant nutrient which is involved in root development, stalk and stem strength, flower and seed formation, crop maturity and production, crop quality and resistance to plant diseases. Phosphorus is needed in relatively large amounts by legumes for nodulation and nitrogen fixation as well as for balance biomass, yield, etc., in a number of legumes (Kashturikrishna and Ahlawat, 1999). Phosphorus deficiency can limit the nodulation in legumes where phosphorus fertilizer application can overcome the deficiency (Carsky *et al.*, 2001). Keeping these in view, the experiment was undertaken to study the effect of row spacing and levels of phosphorus on growth, yield and economics of grass pea (*Lathyrus sativus* L.).

MATERIALS AND METHODS

A field experiment was conducted at Research Farm, College of Agriculture, Central Agricultural University, Imphal, Manipur during *rabi* season of 2011-12 and 2012-13 to study the effect of row spacing and phosphorus levels on growth and yield of grass pea (*Lathyrus sativus* L.). The soil was clay loam with pH (5.4), organic carbon (0.58%), available N (213.60 kg/ha), P (12.33 kg/ha) and K (225 kg/ha) respectively. The experiment consisted of two row spacing (20 cm and 30 cm) with five different

levels of phosphorus (0, 20, 30, 40 and 50 kg P₂O₅/ha) and replicated thrice in factorial randomized block design. The required quantities of phosphorus in the form of Single Super Phosphate (16% P₂O₅) as per treatment were applied one day before sowing of the crop in the plots and was mixed properly with the soil. A uniform dose of 20 kg N/ha in the form of Urea (46% N) and 30 kg K₂O/ha in the form of Muriate of Potash (60% K₂O) was applied as basal to all the plots along with phosphorus. Grass pea variety 'Biol 212' was sown in the first week of November and harvested in the last week of March during both the years. A total of 88.3 mm rainfall was received during the month of November only but there was no rain during the months of December, January and February during both the years of study. The crop was raised under rainfed condition without any irrigation. Rest of the management practices were in accordance with the recommended package of practices for the crop.

Agronomic efficiency (kg grain/kg P applied) = $(Y_t - Y_0) / P_a$
where, Y_t = grain yield (kg/ha) in test treatment; Y_0 = grain yield (kg/ha) in the control plot; P_a = Phosphorus applied in test treatment (kg/ha).

The apparent P recovery was worked out as follows:

$$\text{Apparent P recovery (\%)} = \frac{(\text{P uptake in treated plot} - \text{P uptake in control plot})}{\text{P Fertilizer dose}} \times 100$$

The economics of cultivation of grass pea under different treatments was worked out based on the prevailing market prices of the inputs and outputs in the investigation.

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RESULTS AND DISCUSSION

Growth and yield attributes: The different row spacing as well as different levels of phosphorus influenced the growth and yield of grass pea. Data in Table 1 show that closer spacing produced significantly higher plant height (24.74 cm) than the wider spacing (22.45 cm), which might be due to lack of enough space for lateral growth, resulting into taller plants. Similar finding was also reported by Mansoor *et al.* (2010). Plant height increased with increase in levels of phosphorus, where the maximum height was recorded from the application of 50 kg P_2O_5 ha⁻¹ (25.30 cm) being at par with the 20, 30 and 40 kg P_2O_5 ha⁻¹ and the lowest from control (20.17 cm). The results obtained are in line with the findings of Kanaujia *et al.* (1999).

Wider row spacing (30 cm x 10 cm) resulted in significantly higher branches/plant (10.23), pods/plant (12.65) and seeds/pod (4.43) of grass pea than the closer row spacing (20 cm x 10 cm). The increase in the number of pods per plant in wider row spacing might be due to vigorous plant growth including more number of branches /plant compared to closer spacing of 20 cm x 10 cm in the investigation. Actually less plant population as well as less inter-plant competition in wider spaced plots favoured the growth and yield attributes of grass pea under rainfed condition in Manipur

The observations recorded were supported by the findings of Sajid *et al.* (2012). Application of phosphorus @ 50 kg P_2O_5 ha⁻¹ gave the significantly higher number of branches per plant (10.67) than the application of 20 kg P_2O_5

ha⁻¹ (7.98) and control (5.90) but remained at par with 30 (10.58) and 40 kg P_2O_5 ha⁻¹ (10.62). The results are in conformity with the findings of Kumar and Vani (2012). The interaction effect in the study, except pods/plant between spacing and phosphorus on yield attributes were found non-significant.

The maximum number of nodules was obtained at a wider spacing of 30cm x 10 cm than the closer spacing of 20 cm x 10 cm, which was an agreement with Luikham *et al.* (2009). Phosphorus fertilizer increased the number of nodules over the control (without phosphorus). The number of nodules /plant at 60 DAS was increased progressively with phosphorus level upto 50 kg P_2O_5 ha⁻¹ (16.03) over control.

Yield: The spacing of 20cmx10 cm gave the maximum yield (739.0 kg/ ha), which was significantly higher over 30cm x 10 cm spacing (661kg/ha). It might due to more number of plants per unit area as compared to wider spacing. Luikham *et al.* (2009) and Bruin and Pederson (2008) reported similar findings for grass pea. The highest grain yield was recorded with the application of 50 kg P_2O_5 ha⁻¹ (825 kg/ha) and it remained at par with the application of 40 kg P_2O_5 ha⁻¹ (794 kg/ha) and 30 kg P_2O_5 ha⁻¹ (779 kg/ha). However, significantly lower grain yield was recorded with the application of 20 kg P_2O_5 ha⁻¹ (672 kg/ha) and control (428 kg/ha). The greater dose of phosphorus resulted in higher root volume and also enhanced the activity of rhizobia as well as the formation of root nodules, thereby helping in fixing more atmospheric nitrogen, which bushed up the yield of the crop. These results were in line with the findings of

Table 1: Effect of row spacing and level of phosphorus on growth , yield attributes and yield of grass pea (average for two years)

Treatment	Plant height (cm)	Branches /plant	Pods/ plant	Seeds/ pod	Test weight (g)	Grain yield (kg/ ha)	Straw yield (kg/ha)	Harvest Index	No. of Nodules/ plant at 60 DAS
Row spacing									
20 cm x10 cm	24.74 ^b	8.07 ^a	11.28 ^a	4.25 ^a	88.73	739 ^b	989 ^b	42.68 ^a	11.31 ^a
30 cm x 10 cm	22.45 ^a	10.23 ^b	12.65 ^b	4.43 ^b	89.09	661 ^a	913 ^a	42.08 ^a	12.39 ^a
S.Em.(±)	0.75	0.44	0.13	0.05	0.59	21.92	25.31	1.05	0.41
C.D. (P=0.05)	2.24	1.31	0.38	0.16	NS	65.09	75.17	NS	NS
Level of phosphorus (P_2O_5 Kg/ha)									
0	20.17 ^a	5.90 ^a	7.50 ^a	2.52 ^a	87.70	428 ^a	613 ^a	41.25 ^a	7.10 ^a
20	23.27 ^{ab}	7.98 ^a	11.23 ^b	4.72 ^b	88.58	672 ^b	851 ^b	44.06 ^a	10.30 ^b
30	24.47 ^b	10.58 ^b	13.48 ^c	4.80 ^b	89.25	780 ^c	1063 ^c	42.38 ^a	12.52 ^c
40	24.77 ^b	10.62 ^b	13.77 ^c	4.82 ^b	89.43	794 ^c	1078 ^c	42.36 ^a	13.30 ^c
50	25.30 ^b	10.67 ^b	13.83 ^c	4.83 ^b	89.58	825 ^c	1149 ^c	41.75 ^a	16.03 ^d
S.Em.(±)	1.19	0.70	0.20	0.09	0.93	34.66	40.02	1.66	0.65
C.D. (P=0.05)	3.54	2.08	0.85	0.26	NS	102.92	118.85	NS	1.92
Interaction									
S.Em.(±)	1.68	0.99	0.29	0.12	1.32	49.01	56.60	2.35	0.92
C.D. (P=0.05)	NS	NS	0.85	NS	NS	NS	NS	NS	NS

* Means followed by same superscripts within the same column are not significantly different at the 5% level of probability based on Duncan's Multiple Range Test.

Table 2: Effect of row spacing and level of phosphorus on nutrient uptake of grass pea (average for two years).

Treatment	N uptake(kg/ha)	P uptake(kg/ha)	K uptake(kg/ha)
Row spacing			
20 cm x 10 cm	20.49 ^a	12.52 ^a	29.36 ^a
30 cm x 10 cm	21.95 ^b	13.31 ^b	31.52 ^b
S.Em.(±)	0.16	0.10	0.16
C.D. (P=0.05)	0.48	0.31	0.48
Level of phosphorus (P₂O₅ Kg/ ha)			
0	16.13 ^a	8.38 ^a	24.24 ^a
20	20.05 ^b	10.83 ^b	27.62 ^b
30	21.53 ^c	14.07 ^c	31.53 ^c
40	23.53 ^d	15.05 ^d	33.98 ^d
50	24.85 ^e	16.23 ^e	34.84 ^e
S.Em.(±)	0.25	0.17	0.26
C.D. (P=0.05)	0.76	0.49	0.76
Interaction			
S.Em.(±)	0.36	0.23	0.36
C.D. (P=0.05)	NS	NS	NS

* Means followed by same superscripts within the same column are not significantly different at the 5% level of probability based on Duncan's Multiple Range Test.

Table 3: Effect of row spacing and level of phosphorus on economics and phosphorus use efficiency of grass pea.

Treatment	Gross return (Rs./ha)	Net return (Rs. /ha)	B:C ratio	APUE (kg of grain increased /kg of p applied)	Apparent P recovery (%)
Row spacing					
20 cm x 10 cm	59095 ^b	38643 ^a	2.86 ^a	8.34 ^a	11.93 ^a
30 cm x 10 cm	52845 ^a	33946 ^a	2.77 ^a	8.08 ^a	13.52 ^b
S.Em.(±)	1753	1762	0.09	0.68	0.28
C.D. (P=0.05)	5208	NS	NS	NS	0.82
Level of phosphorus (P₂O₅ Kg/ ha)					
0	34219 ^a	17628 ^a	2.06 ^a	0.00	0.00
20	53745 ^b	35029 ^b	2.87 ^b	12.20 ^b	12.27 ^a
30	62341 ^c	42299 ^b	3.11 ^b	11.72 ^b	18.96 ^c
40	63545 ^c	42517 ^b	3.02 ^b	9.16 ^a	16.68 ^b
50	66001 ^c	44001 ^b	3.00 ^b	7.95 ^a	15.70 ^b
S.Em.(±)	2772	2786	0.13	1.08	0.44
C.D. (P=0.05)	8234	8274	0.40	3.21	1.30
Interaction					
S.Em.(±)	3921	3921	0.19	1.53	0.62
C.D. (P=0.05)	NS	NS	NS	NS	NS

Selling price of grass pea grain = Rs. 80/kg under Manipur condition Means followed by same superscripts within the same column are not significantly different at the 5% level of probability based on Duncan's Multiple Range Test.

Malik *et al.* (2006) and Singh *et al.* (2011). The interaction between spacing and levels of phosphorus could not bring significant effect on grain yield of grass pea. With the same trend, significantly higher straw yield was obtained at the spacing of 20 cm x 10 cm (989 kg/ha) than 30 cm x 10 cm (913 kg/ha). The interaction effect between levels of phosphorus and row spacing could not show significant difference in the harvest index of grass pea.

Nutrient uptake: The variation in row spacing could affect significantly the N, P and K uptake of grass pea in the experiment (Table 2). The higher N, P and K uptake (21.95, 3.31 and 31.52 kg/ha) were recorded with wider spacing (30 cm x 10 cm) than closer spacing (20 cm x 10 cm). The different levels of phosphorus also showed significant effect on the total nitrogen, phosphorus and potassium uptake. There was gradual increase in N, P and K uptake with

increase in phosphorus level upto 50 kg P_2O_5 /ha over control. P and K uptake was also significantly higher in wider spacing as well as application of 50 kg ha^{-1} and the lowest in control. Interaction between spacing and levels of phosphorus for total N, P and K was found non-significant. The higher uptake of total nitrogen, phosphorus and potassium with higher levels of phosphorus application might be due to greater yield as a result of higher nutrient utilization by the crop. The results are almost in agreement line with the findings of Bhat *et al.* (2002).

Economics: Gross return was significantly higher in 20 cm row spaced crop (Rs. 59,095/ha) due to greater production compared to 30 cm row spacing (Rs. 52,845/ha). Among the different doses of phosphorus, 30 kg P_2O_5 /ha, 40 kg P_2O_5 /ha and 50 kg P_2O_5 /ha were found to be at par regarding the gross return. The maximum net return (Rs. 44001/ha) was obtained with phosphorus level of 50 kg P_2O_5 /ha being at par with 40, 30 and 20 kg P_2O_5 /ha, but significantly greater over control. Although the B:C ratio was not influenced significantly by two row spacing, but it differed at different doses of phosphorus in the study. The highest B : C (3.11) was recorded with the application of 30 kg P_2O_5 /ha being at par with 40 kg P_2O_5 /ha and 50 kg P_2O_5 /ha. The results were in line with the findings of Sen *et al.* (2010).

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Efficiency Indices: Data in Table 3 shows that agronomic phosphorus use efficiency was best affected due to spacing adopted in the experiment, but it was decreased with increase in levels of phosphorus. In contrast, apparent phosphorus recovery was significantly higher in wider spacing (13.52%) than closer spacing (11.93 %). Among the different levels of phosphorus, apparent phosphorus recovery was increased significantly with progressive increase upto 30 kg P_2O_5 /ha (18.96%), but decreased thereafter with increased levels of phosphorus in the experiment. The declined in APUE with higher level of phosphorus might be due to fixation of phosphorus in the soil. Similar result was also reported by Kumar and Kushwaha (2006).

CONCLUSION

From the above results, it is concluded that grass pea can be grown profitably at a spacing of 20 cm x 10 cm with the application of 30 kg P_2O_5 /ha during *rabi* season in Manipur, considering the grain yield, B:C ratio and apparent P recovery.

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