The Pharma Innovation Journal 2022; 11(5): 2185-2188

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 2185-2188

www.thepharmajournal.com
Received: 01-03-2022
Accepted: 11-04-2022

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Impact of different spacing on production of pole type lima bean (*Phaseolus lunatus* L.) with intercropping of brinjal crop

Sanjay Kumar, Abhimanyu, RN Singh and Arvind Kumar Singh

Abstract
Lima beans are very nutritious underutilized legume crops. It is two types; bush type and pole type or vine varieties. Pole lima beans are grown for their distinctive flavour prized by local cooks (Namkeen) and high value as a fresh market crop in the district Farrukhabad. The pods are picked when they semi mature and seed sold for namkeen making. The experiment consisted three plant spacing (T_1 S-1x1m Farmers practice without trellis, T_2 S-2x2m+trellis, T_3 S-3x3 trellis) and that effect on growth, yield and quality of lima bean and additional crop of brinjal as an intercrop at initial stage of lima beans. Flowering parameters Days to first flowering significantly earliest flowering was observed in the treatment T_3 (S-3.0m x 3.0m + trellis), with minimum days for first flowering (72.50) and 50% flowering (92.50) at days after sowing. The number of pods per cluster (7.20) was found to be superior among all the treatment in spacing T_3 followed by T_2 and minimum in T_1. Green Seed yield per hectare (q) as influenced by different spacing was found to be significant. The green seed yield per hectare (185q) was found significantly superior in the treatment T_3 followed by (178q) in T_2 and minimum (129q) in T_1. The economics of the lima bean and intercrop of brinjal was found superior in treatment T_3 with highest BC ratio.

Keywords: Impact, spacing, pole, brinjal, *Phaseolus lunatus* L.

Introduction
Lima beans (*Phaseolus lunatus* L.) is a legume crop which belongs to family Fabaceae. It is found in humid, semi humid and tropical climate as well as warm temperate climate. Lima bean is the annual to perennial climbing plants which have a hood shape of standard flowers and twinning keels. The wild lima bean species show uncertain climbing growth habits, with prolonged flowering periods and large pod production. There is also a form of annual shrub developed in cultivation. The seeds have a rich variant, consist of the shape, size, colour, and eye appearance. Its sprouts, leaves, young pods and green seeds are edible as vegetables. It is one of the underutilized legume groups, but its nutritional content can be used as an alternative to overcome the malnutrition problem for people in developing Countries. Lima beans are very nutritious, high in protein (25%), thiamine, riboflavin, and iron. There are two types of lima beans; bush type and pole type or vine varieties. Bush type grow to about 2-2.5 feet tall and tends to smaller seeds; they bear more quickly than pole lima bean varieties. Pole lima beans have large seeds and can grow 10 to 12 feet height. Small seeds limas also called butter beans and baby limas while large seeded called potato limas. Lima beans have pale green pods that vary from 3-6 inches long depending upon variety. Pole type varieties are ready for harvest from 60-80 days from sowing while bush type 85 to 90 days taken to harvest. Pole lima beans are grown for their distinctive flavor prized by local cooks (Namkeen) and high value as a fresh market crop in the district Farrukhabad. The pods are picked when they semi mature and seed sold for namkeen making. In intercropping systems, the arrangement of the component crops in time and space has significant influence on their relative success. However, very less systemic work has been carried out on production technology of this crop. The cropping practices on profitability are needed to implement changes to make economically profitable this crop. Good agricultural practices such as spacing, time of sowing and fertilizer application have been associated to high biological and economic yield. So that, spacing is ensure proper utilization of inputs like nutrients, moisture, light and intercropping space resulting better production and got additional crop yield by intercropping during initial stages with optimum plant population per unit area (Shrikanth *et al*., 2008) [5].

Material and Methods

Lima bean has a good adaptation capability in the in less fertile, high humidity soils, dry climate and wet soil. Soil of the experimental plot was sandy loam, well drained with 7.9 P^H, NPK- low: medium: medium (180: 14.5:175 kg/ha) and organic carbon 0.25% Lima bean local (Indian red bean) is a high yielding variety recommended for namkeen making in the district Farrukhabad. It is a tender annual grown for their large flat, crescent, oval shaped seeds and gave yield two flushes November to January and March to April. The present trial was carried out at three different locations by KVK, Farrukhabad, U.P., during kharif in the year 2017-18 and 2018-19. The experiment consisted three plant spacing (T_1 S-1x1m Farmers practice without trellis, T_2 S-2x2m+trellis, T_3 S-3x3m+ trellis) and that effect on growth, yield and quality of lima bean and additional crop of brinjal as an intercrop at initial stage of lima beans. Sturdy wooden or metal posts should be spaced every 15 to 20 ft in the row. Additional smaller spacer stakes may be needed in between posts. At least 5 ft, preferably 6 ft, of the posts or stakes should be above ground. Tightly stretch a 10 to 12 gauge wire and nail to the tops of the stakes. Stretch a smaller wire or twine and nail to the posts halfway up above the ground. Then tie the twine in a crisscross fashion to the top wire and to the bottom wire (or twine) on which the beans will climb. An individual stake or line should be placed at each plant for initial climbing to the trellis. Bean supports should be put up before the bean plants begin producing "runners" and falling over. A ground wire may also be used and then twine is woven in a V fashion over the top wire and under the bottom wire. An alternative system would use 6 foot plastic netting attached to the posts and a top and bottom wire. It is very important to have a sturdy trellis due to the heavy weight of the lima bean vines. Observations were recorded on flowering parameters like days to first flowering, days to 50% flowering, inflorescence per plant and flowers per inflorescence and yield parameters like number of pods per cluster, length of pod (cm), Number of seed per pod, seed yield per plant (g) and seed yield per hectare (q/ha) and collected data were statistically analyzed as per method suggested by Pansey and Sukhatme (1985).

Results and Discussion

The data regarding flowering, yield and quality parameters are presented in table1. Flowering parameters Days to first flowering significantly earliest flowering was observed in the treatment T_3 (S-3.0m x 3.0m + trellis), with minimum days for first flowering (72.50) and 50% flowering (92.50) at days after sowing. It was followed by the treatment T_2 (S-2.0m x 2.0m + trellis in 76.30 days after sowing. Maximum days 88.20 required for first flowering was observed in the plant spacing T_1 (S-1.0m x 1.0m farmers practice without trellis) which was at par with the spacing T_2 (S-2.0m x 2.0m+trellis). It is observed that maximum inflorescence /plant and flower /inflorescence was recorded in the T_3 which is optimum spacing instead of other treatments. This might have occurred due to the fact that pole type lima beans are very vigorous and too close planting results in excessive vegetative growth but poor reproductive growth whereas wider spacing results in more horizontal growth and plant canopy area due to less population density and competition for space, light, nutrients and moisture. The present results are contradictory to the findings of Kumar *et al*., (1997) [3] who reported that the effect of spacing for days to flower initiation was non-significant. The significant differences were observed for days required to 50% flowering as influenced by different plant spacing's of lima bean. Inflorescence per plant Inflorescence per plant may be due to resulting in maximum number of inflorescence per plant in the spacing T_5 whereas inflorescence in the too closer and wider spacing was less because of more vertical and horizontal growth respectively. This resulted in excessive vine growth and thus reducing flowering and yields. This finding is supported by Anonymous (2016) [1]. Flowers per inflorescence Flowers per inflorescence was observed maximum (6.20) in T_3 followed by T_2. However minimum flowers per Inflorescence (5.30) was obtained in T_1 Flowers per inflorescence in the too closer and too wider spacing was less because of more vertical and horizontal growth. It results due to excessive vine growth and it reduces flowers per inflorescence. This is in support to the findings of Anonymous (2016) [1].

Yield parameters Number of pods per cluster the significant differences were observed for number of pods per cluster as influenced by different plant spacing of lima bean. The number of pods per cluster (7.20) was found to be superior among all the treatment in spacing T_3 followed by T_2 and minimum in T_1. The present findings confirms that optimum plant spacing is required for obtaining maximum number of pods per cluster. Length of pod (cm) the significant differences were observed in length of pod as influenced by different spacing significantly maximum length of pod (11.20cm) was observed in spacing T_3 followed by spacing T_2. The present findings suggests that pod length was reduced with too closer and too wider spacing whereas it was increased in the plant spacing which might be due to optimum vegetative growth and uptake of nutrients and moisture from soil. Joshi and Rahewar (2014) [4] in wider row spacing of 60cm in Indian bean however the results were non-significant.

Table 1: Flowering, yield and quality parameters as influenced by plant spacing and foliar spray with additional brinjal yield

Treatments	Days to first flowering	Days to 50% flowering	Inflorescence /plant	Flowers /Inflorescence	No. of pods/ Cluster	Length of pod (cm)	No of seed /pod	Green Seed yield (q/ha)	Brinjal yield (q/ha)
T_1-Farmers practice (S-1x1 m) bed method	88.20	105.00	19.00	5.30	3.40	7.80	3.50	129.00	21.00
T_2-(S-2X2m+trellis	76.30	95.20	26.30	6.60	6.10	8.90	4.40	178.00	62.50
T_3-(S-3X3m+trellis	72.50	92.50	29.50	6.75	7.20	11.20	4.80	185.00	96.00
SE(m) +_	0.70	0.55	0.75	0.07	0.09	0.40	0.04	1.95	1.35
CD at 5%	3.60	4.45	1.95	1.20	1.05	1.02	0.10	5.75	8.05

Table 2: Economics of different treatments

Treatments	Cost of cultivation lima bean (Rs/ha)	Cost of cultivation as an intercrop brinjal (Rs/ha)	Gross cost (Rs/ ha)	Gross return (Rs/ha) with Lima bean and brinjal crop	Net return both crops (Rs/ha)	BC Ratio
T_1-Farmers practice (S-1x1 m) bed method	175000	14500	189500	418500	229000	2.20
T_2-(S-2X2m+trellis	195000	49500	244500	627750	383250	2.56
T_3-(S-3X3m+trellis	192000	55000	249000	699000	450000	2.80

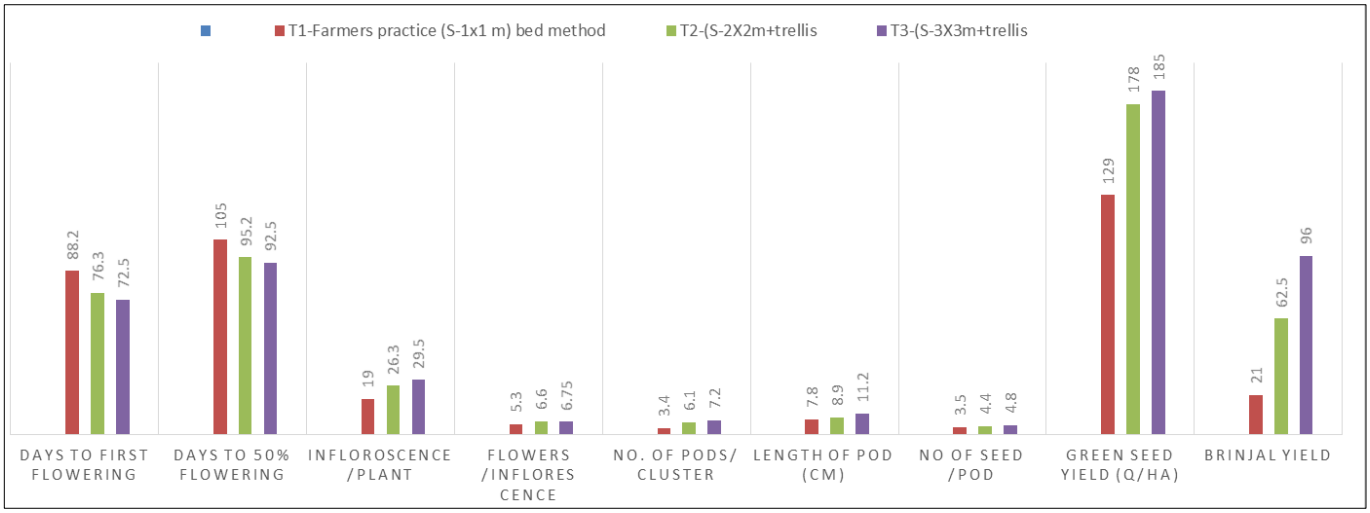

Fig 1: Flowering, yield and quality parameters as influenced by plant spacing and foliar spray with additional brinjal yield

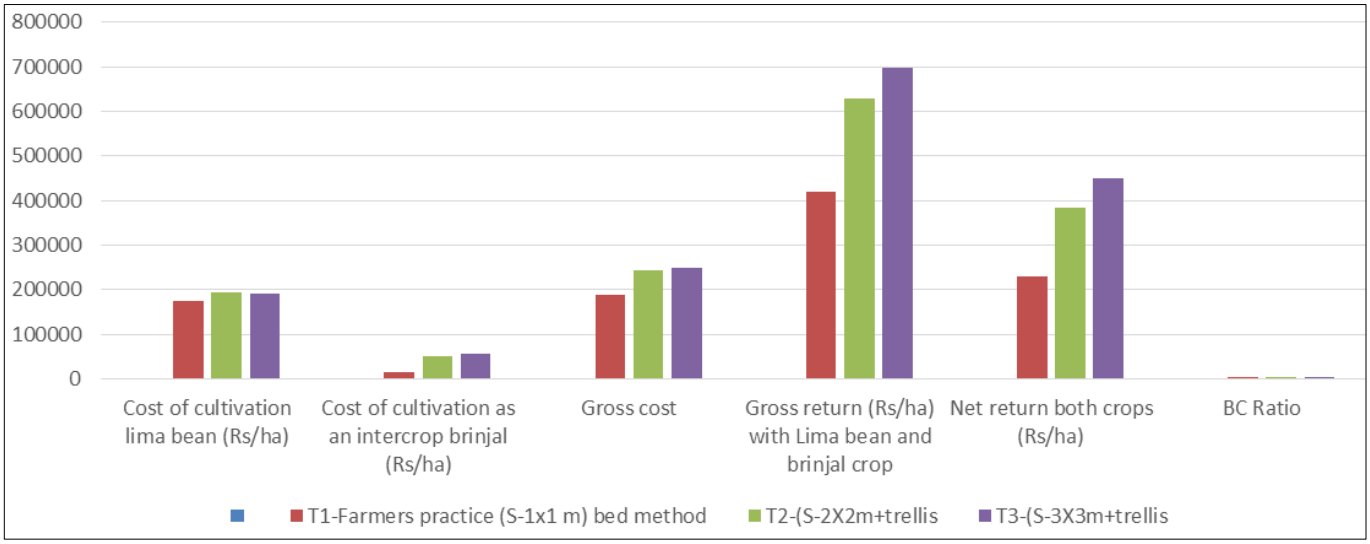

Fig 2: Economics of different treatments

Green Seed yield per hectare (q) as influenced by different spacing was found to be significant. The seed yield per hectare (185q) was found significantly superior in the treatment T_3 followed by (178q) in T_2 and minimum (129q) in T_1. It is well evident from the present findings that seed yield per hectare was maximum in the optimum plant spacing than closer and wider spacing. This is in confirmation with Achakzai and Panizai (2007) [2] who reported positive correlations of number of pods per plant and seed yield per plant with grain yield per hectare. However too closer spacing resulted in less yield per hectare.

The economics of the lima bean and intercrop of brinjal was found superior in treatment T_3 with highest BC ratio. Lima bean green seed was sold in direct market on average 30 Rs/kg round the crop season and additional crop grown between row and got extra income with maximum utilization of all agricultural inputs while T_1 got low yield with poor quality seeds.

Conclusion

It is concluded that plant spacing 3x3m with trellis found the best treatment for lima bean green seed production and additional crop also taken between rows.

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