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# Vegetable intercropping: An approach for doubling the small Farmers' income under semi-arid conditions of Haryana

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## Abstract

Land holding size is decreasing day by day due to urbanization, high population growth and industrialization across the country. Therefore, the strategies should be framed to produce more vegetables per unit area with optimum use of water, fertilizers and land by adopting better agronomical management practices to fetch up the demand. A field experiment was conducted at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during kharif season of 2016-17 in a Randomized Block Design with three replications to find out suitable intercrop combination of *palak* with brinjal with maximum land utilization to attain higher yield and other economic benefits. Based on the research investigation, it was found that the growth and yield attributes of sole brinjal (60x60 cm) and sole *palak* (20x5 cm) exceeded over rest of the treatments due to minimum competition. Brinjal + *palak* single row gave highest net returns (Rs. 222652) and benefit to cost ratio (3.76) due to low cost of production, closely followed by paired row brinjal + *palak* (two rows). Paired row brinjal + *palak* (two rows) intercropping system also gave maximum gross returns (Rs. 304598), brinjal equivalent yield (507.6 q/ha) and *palak* equivalent yield (217.6 q/ha) followed by brinjal + *palak* single row. Brinjal normal or paired row intercropped with *palak* single row could be more remunerative for earning maximum net returns than the brinjal sole crop. In addition, intercropping could be considered as emerging tool for doubling small holder farmer's income and sustain national food security.


**Key words:** Crop equivalent yield, economics, intercropping, off season *palak*, paired row brinjal.

## Introduction

The demand of vegetables is increasing day by day among people due to high income and awareness about health benefits of vegetables being rich source of vitamins, minerals, antioxidants, fibers, carbohydrates, *etc*. and medicinal value. Presently, the availability of vegetables per day per capita is about 200 g, which is below the required quantity (300 g per head per day) (Sachdeva et al. 2013). Rapidly increasing population, increased demand for food, limited scope for extension of cultivation to new areas, diversified needs of small farmers for food and cash etc. have necessitated the adoption of intercropping systems. Intercropping refers to growing two or more dissimilar crops simultaneously on the same piece of land, which can be followed for higher production of vegetables per unit area. Moreover, intercropping could be considered as a step towards doubling farmers' income in Indian sub-tropics (Singh et al., 2018). Many studies have indicated that intercropping with different vegetables was more productive and profitable than sole cropping because of complementary effects of intercrop (Varghese 2000).

Eggplant (*Solanum melongena* L.), an annual herbaceous plant with semi-erect or semi-spreading growth habit belongs to the family *Solanaceae*. Due to its high production potential, it is a good source of income to small and marginal farmers in developed and developing countries. India ranks second after China for area and production of brinjal in the world, accounting 730 thousand hectares with an annual production of 128 lakh tonnes and productivity of 17.53 tonnes per hectare (Anonymous 2018). Brinjal is a long duration (210-230 days) and wide spaced (100 cm×75 cm) crop. Rodge and Yadlod 2009, studied the intercropping in different vegetables and found that *palak* had better companion effect on the yield of brinjal as compared to radish, onion and coriander if taken as intercrop. Moreover, beet leaf or *palak* (*Beta vulgaris* var. *orientalis*), a short duration widely grown leafy vegetable, can be grown in tropical

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and subtropical regions throughout the year but the main crop is taken in winter from September-January at spacing of 20x5 cm. The *palak* crop becomes ready for first cutting in about 35 days after sowing and subsequent cuttings are taken at 15-20 days interval. There is a great possibility to cultivate minimum canopy spread herbaceous plant like *palak* in the inter row space of brinjal as they have different growth habit and duration. Very little work has been done on intercropping systems in brinjal and *palak* in India and no recommendation on this aspect exists under Haryana conditions. Hence, the study was undertaken to find out the best combination and efficiency of *palak* productivity for intercropping at different planting densities with brinjal and to evaluate intercropping as emerging tool for doubling small holder farmer's income and sustain national food security.

## Materials and Methods

**Experimental site:** Experiment was carried out during *kharif* season of the year 2016-17 at Research Farm of the Department of Vegetable Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar, located at 29° 10′ latitude north, 75° 46′ longitude east and 215.2 m above mean sea level with semi-arid subtropical climate. The soil type was a well-drained sandy loam with pH 8.13 and 0.26 dS/m electrical conductivity. According to soil analysis conducted in 2016, the

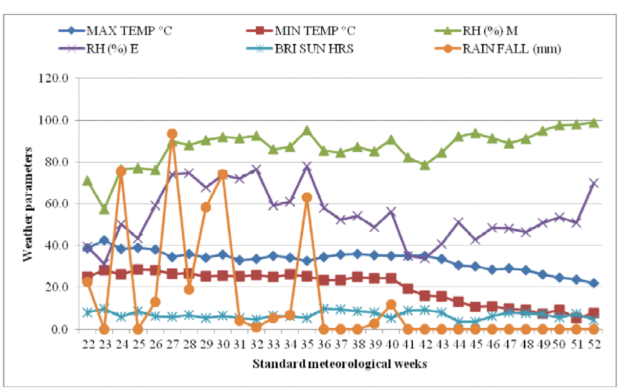


**Figure 1:** Weather parameters at CCS Haryana Agricultural University, Hisar

research station was characterized by 0.48% organic matter and 158:20.6:251.6 kg N:P:K/ha. The meteorological data for maximum and minimum temperature (ºC), total rainfall (mm), relative humidity (%), bright hours of the day and pan evaporation recorded during the crop season at the Meteorological Observatory located in Research Area of the Department of Meteorology, CCS Haryana Agricultural University, Hisar are presented in Figure 1.

**Experiment details and layout:** The present experiment comprising of eleven treatments (Table 1) was conducted at Research Farm of the Department of

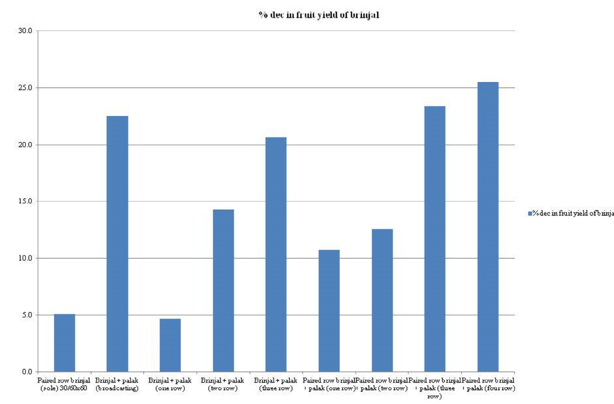

**Figure 2:** Percent decrease in fruit yield of brinjal

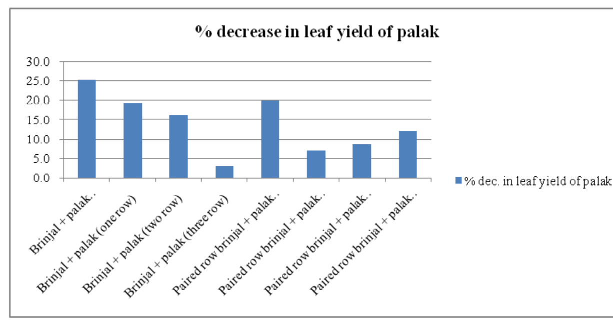


**Figure 3:** Percent decrease in leaf yield of *palak*

**Table 1:** Intercropping treatments

| | |
|---|---|
| $T_1$ | Brinjal sole crop at spacing of 60 x 60 cm |
| $T_2$ | *Palak* sole crop 20 x 5 cm |
| $T_3$ | Paired row brinjal sole 30/60 x 60 cm |
| $T_4$ | Brinjal + *palak* (broadcasting) |
| $T_5$ | Brinjal + *palak* single row |
| $T_6$ | Brinjal + *palak* (two rows) |
| $T_7$ | Brinjal + *palak* (three rows) |
| $T_8$ | Paired row brinjal + *palak* single row |
| $T_9$ | Paired row brinjal + *palak* (two rows) |
| $T_{10}$ | Paired row brinjal + *palak* (three rows) |
| $T_{11}$ | Paired row brinjal + *palak* (four rows) |

Vegetable Science, CCS Haryana Agricultural University, Hisar during *kharif* season of 2016-17. The experimental treatments were laid out in a Randomized Block Design (RBD) and replicated thrice. The seed of eggplant cv. HLB-12 tolerant to shoot and fruit borer was procured from the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. Cultural practices to raise disease free healthy seedlings were followed as per the package of practices. Five weeks old seedlings of brinjal cv. HLB 12 were transplanted at 60×60 cm spacing for single row and 30/60x60 cm for paired row in plots of 3.6x4.2 m in last week of July. The transplanting was done in the evening hours. The seedlings not performing well were replaced within week from the reserve seedlings stock. The seeds of *palak* cv. HS-23 were sown at a spacing of 20x5cm in between the brinjal rows on same day before brinjal transplanting. As per recommendation of CCSHAU, Hisar, 120-70-25 kg N-P-K/ha was applied. Full dose of phosphorus and potassium along with one third dose of nitrogen was applied at the time of brinjal transplanting and remaining two third of nitrogen was applied into two splits, first one month after transplanting and second at the time of flowering. The crop was irrigated immediately after transplanting and thereafter as per the requirement of the crop, usually at an interval of 8-10 days. Other cultural operations were done as per the package of practices. The first picking of brinjal fruits was done 60 days after transplanting and the subsequent pickings were carried out at a regular interval of 10 days. The first cutting of *palak* was done at 35 days after sowing and subsequent two cuttings of *palak* were taken at 50 and 65 days after sowing. Only three leaf cuttings were taken.

**Statistical analysis:** The data were recorded on plant height, number of branches, number of days to first picking, number of fruits per plant, fruit diameter, fruit length, fruit weight and yield of brinjal, and leaf length, petiole length, leaf width and yield of *palak* and analyzed statistically using randomized block design. The brinjal and *palak* equivalent yield was converted by converting yield of *palak* and brinjal based on market price of individual crop following the formula:

Crop equivalent yield = $Y_{m} + Y_{i} \times P_{i} / P_{m}$

Where,

$Y_m$ = Yield of *main crop* in intercropping system (q/ha)

$Y_i$ = Yield of intercrop in intercropping system (q/ha)

$P_m$ = Price of main crop (Rs.)

$P_i$ = Price of intercrop (Rs.)

## Results and Discussion

**Growth and yield attributes of brinjal:** The plant height was significantly influenced by various intercropping treatments at first, second, third and final picking. Sole brinjal crop plants grew taller than the brinjal grown with intercrop (Table 2). Within the intercropping treatments, the maximum plant height was obtained from brinjal + *palak* single row, which was at par with paired row sole brinjal crop. These results are in conformity with the findings of Paul et al. (2015) and Islam et al. (2016). The number of primary branches, fruit attributes such as fruit length, fruit diameter, number of fruits per plant, average fruit weight and total fruit yield were recorded significantly maximum in both single and paired row sole brinjal crop (Table 3). Among the different intercropping treatments, the treatment brinjal + *palak* (single row) was found significantly superior than rest of the intercropping treatments. This might be due better utilization of light and nutrients from the soil as result, the photosynthetic rate increased, which led to more production and accumulation of carbohydrates and favorable effect on vegetative growth and retention of flowers and fruits, which might have increased the number, size and fruit weight per plant in both single and paired row sole brinjal crop. Decreased number of branches in response to intercropping due to increase in plant population has also been reported by Mehta et al. 2010 in coriander. Kandeyang (2004), also obtained maximum fruit weight, increased fruit length and fruit diameter in sole okra crop. Decreased fruit length with increasing rate of plant population of garlic in brinjal was observed (Islam et al. 2016). Also, there was no significant difference in days to first picking (earliness) of brinjal between sole and intercropping treatments (Table 3). This might be due to the reason that there

**Table 2:** Effect of different planting combinations on plant height (cm) of brinjal at different pickings in brinjal + *palak* intercropping system

| Treatment | Picking | | | |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | Final |
| Brinjal sole at 60x60 cm | 61.6 | 70.2 | 79.5 | 87.3 |
| *Palak* sole at 20x5 cm | - | - | - | - |
| Paired row brinjal sole at 30/60x60 cm | 60.5 | 68.1 | 77.6 | 85.0 |
| Brinjal + *palak* (broadcasting) | 53.8 | 61.4 | 70.7 | 79.0 |
| Brinjal+ *palak* single row | 59.5 | 67.4 | 76.2 | 84.6 |
| Brinjal+ *palak* two rows | 57.4 | 64.6 | 74.7 | 81.7 |
| Brinjal+ *palak* three rows | 54.7 | 62.0 | 72.6 | 80.7 |
| Paired row brinjal+ *palak* single row | 59.4 | 65.6 | 75.3 | 82.2 |
| Paired row brinjal+ *palak* two rows | 55.9 | 63.1 | 73.6 | 81.7 |
| Paired row brinjal+ *palak* three rows | 52.1 | 60.7 | 71.3 | 79.3 |
| Paired row brinjal+ *palak* four rows | 50.4 | 59.5 | 70.0 | 80.3 |
| SEm± | 0.8 | 0.8 | 0.6 | 0.6 |
| CD at (p= 0.05) | 2.5 | 2.3 | 1.8 | 1.8 |

**Table 3:** Effect of different planting combinations on number of branches per plant, days to first picking, fruit length, fruit diameter, fruit weight, number of fruits per plant and total fruit yield of brinjal in brinjal + *palak* intercropping system

| Treatment | No. of branches per plant | Days to first picking | Fruit length (cm) | Fruit diameter (cm) | Fruit weight (g) | No. of fruits per plant | Total fruit yield (q/ha) |
|---|---|---|---|---|---|---|---|
| Brinjal sole at 60x60 cm | 9.4 | 64.0 | 21.8 | 3.7 | 50.7 | 35.2 | 335.3 |
| *Palak* sole at 20x5 cm | - | - | - | - | - | - | - |
| Paired row brinjal sole at 30/60x60 cm | 9.3 | 64.0 | 20.6 | 3.5 | 48.3 | 33.6 | 318.3 |
| Brinjal + *palak* (broadcasting) | 8.4 | 65.0 | 16.2 | 2.4 | 42.6 | 28.5 | 260.3 |
| Brinjal+ *palak* single row | 9.3 | 64.7 | 19.8 | 3.3 | 47.1 | 32.8 | 319.7 |
| Brinjal+ *palak* two rows | 9.1 | 64.7 | 19.6 | 2.9 | 45.0 | 31.6 | 287.8 |
| Brinjal+ *palak* three rows | 8.5 | 65.0 | 17.5 | 2.8 | 44.4 | 29.0 | 266.5 |
| Paired row brinjal+ *palak* single row | 9.2 | 64.7 | 19.2 | 3.1 | 46.2 | 32.3 | 299.7 |
| Paired row brinjal+ *palak* two rows | 8.8 | 64.7 | 18.8 | 2.7 | 43.5 | 31.2 | 293.3 |
| Paired row brinjal+ *palak* three rows | 8.2 | 65.0 | 16.9 | 2.3 | 41.8 | 27.8 | 257.3 |
| Paired row brinjal+ *palak* four rows | 8.1 | 65.0 | 15.9 | 2.2 | 40.7 | 26.2 | 250.3 |
| SEm± | 0.2 | 0.5 | 0.9 | 0.2 | 0.7 | 0.5 | 7.0 |
| CD at (p= 0.05) | 0.7 | N/S | 2.7 | 0.7 | 2.2 | 1.6 | 21.0 |

**Table 4:** Effect of different planting combinations on length of leaf (cm), petiole length (cm), leaf width (cm) of *palak* at different harvestings in brinjal + *palak* intercropping system

| Treatment | Leaf length | | | Petiole length | | | Leaf width | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| Brinjal sole at 60x60 cm | - | - | - | - | - | - | - | - | - |
| *Palak* sole at 20x5 cm | 14.2 | 16.2 | 17.1 | 13.7 | 15.4 | 16.1 | 6.2 | 8.1 | 9.1 |
| Paired row brinjal sole at 30/60x60 cm | - | - | - | - | - | - | - | - | - |
| Brinjal + *palak* (broadcasting) | 11.1 | 11.2 | 12.1 | 9.5 | 10.1 | 10.7 | 5.2 | 6.1 | 7.2 |
| Brinjal+ *palak* single row | 13.8 | 16.0 | 16.7 | 13.3 | 15.3 | 15.8 | 6.1 | 7.9 | 8.8 |
| Brinjal+ *palak* two rows | 13.4 | 15.1 | 15.9 | 13.1 | 14.8 | 15.4 | 5.6 | 7.1 | 8.2 |
| Brinjal+ *palak* three rows | 12.2 | 13.9 | 14.2 | 11.9 | 12.9 | 13.6 | 5.4 | 6.6 | 7.6 |
| Paired row brinjal+ *palak* single row | 13.8 | 15.6 | 16.4 | 12.8 | 14.4 | 14.9 | 5.9 | 7.5 | 8.4 |
| Paired row brinjal+ *palak* two rows | 12.8 | 14.6 | 15.5 | 12.3 | 13.7 | 14.5 | 5.5 | 6.8 | 7.9 |
| Paired row brinjal+ *palak* three rows | 12.0 | 12.0 | 13.8 | 11.4 | 11.4 | 12.6 | 5.3 | 6.3 | 7.4 |
| Paired row brinjal+ *palak* four rows | 10.0 | 10.7 | 11.5 | 10.0 | 10.4 | 11.2 | 5.1 | 6.0 | 7.0 |
| SEm± | 0.3 | 0.2 | 0.4 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.5 |
| CD at (p= 0.05) | 0.8 | 0.6 | 1.2 | 1.0 | 0.8 | 1.1 | NS | 1.1 | NS |

**Table 5:** Effect of different planting combinations on leaf yield (q/ha) of *palak* at different harvesting stages and total yield of all three cuttings in brinjal + *palak* intercropping system

| Treatment | Harvestings | | | Total leaf yield |
|---|---|---|---|---|
| | 1st | 2nd | 3rd (Final) | |
| Brinjal sole at 60x60 cm | - | - | - | - |
| *Palak* sole at 20x5 cm | 26.6 | 30.2 | 42.0 | 98.8 |
| Paired row brinjal sole at 30/60x60 cm | - | - | - | - |
| Brinjal + *palak* (broadcasting) | 17.1 | 22.3 | 34.5 | 73.9 |
| Brinjal + *palak* single row | 19.0 | 24.3 | 36.4 | 79.7 |
| Brinjal + *palak* two rows | 20.0 | 25.5 | 37.3 | 82.8 |
| Brinjal + *palak* three rows | 25.7 | 29.1 | 41.0 | 95.8 |
| Paired row brinjal + *palak* single row | 19.0 | 24.5 | 35.7 | 79.2 |
| Paired row brinjal + *palak* two rows | 24.7 | 27.2 | 40.0 | 91.9 |
| Paired row brinjal + *palak* three rows | 23.4 | 27.8 | 39.2 | 90.4 |
| Paired row brinjal + *palak* four rows | 22.2 | 26.5 | 38.3 | 86.9 |
| SEm± | 0.3 | 0.6 | 0.7 | 1.1 |
| CD at (p= 0.05) | 1.0 | 1.7 | 2.2 | 3.3 |

was no shading effect of *palak* on brinjal. Obadoni et al. 2005, also observed insignificant difference for days to 50% flowering in tomato.

The number of fruits per plant and total fruit yield exhibited decreasing trend with the increase in number of *palak* rows as intercrop in brinjal crop. The percent decrease in fruit yield of brinjal (Figure 2) due to *palak* intercropping in various treatments ranged from 25.5 to 4.7%. The reduction in number of fruits per plant under different intercropping treatments might be due to the higher plant population and mutual competition among both the crops. Decreased in number of fruits and total fruit yield in response to increased plant population has been reported by Islam et al. 2016 and Paul et al. 2015 in brinjal. Also the results of present experiment are in concurrence with the findings of Obadoni et al. (2005), Suresha et al. (2007) and Islam et al. (2016), while working with brinjal, tomato and chilli in intercropping systems, respectively. Singh and Kushwah (2012), reported that intercropping of radish or spinach reduced the potato yield by 17 and 8%, respectively. The yield reduction of brinjal in intercropping combinations was 2.02-5.98% as compared to sole crops (Islam et al. 2016).

**Growth and yield attributes of palak:** The leaf attributes such as, leaf length, leaf width and petiole length (Table 4) and total leaf yield (Table 5) were found significantly better while *palak* was grown as sole crop. The perusal of data reveals that leaf attributes and total leaf yield continued to increase with the advancement in crop age due to the availability of more favorable environment conditions for *palak* crop as the temperature was high at initial stage of crop growth. Gaharwar 2014), mentioned that the length, petiole and diameter of leaf increased with the increase in number of cuttings, which also tend to increase leaf yield of *palak*. Among the treatments of intercropping, the maximum value for these attributes was obtained from brinjal + *palak* single row treatment as this treatment involves minimum plant population as compared to other treatments, which led to minimum reduction for these attributes. Similar results were obtained by Islam et al. 2016), for garlic crop when intercropped with brinjal. Paired row brinjal + *palak* four rows and brinjal + *palak* (broadcasting) recorded minimum value for these leaf attributes, which were at par with each other. The lower biomass of *palak* might be due to more competition and shading effect from main crop and thereby led to lowest use of all the available resources by *palak*. The growth and yield attribute of coriander suppressed by main brinjal crop (Paul et al. 2015). Within the intercropping treatments, the maximum leaf yield was obtained from treatment combination brinjal + *palak* three rows, which was at par with sole *palak* crop, while the minimum leaf yield of *palak* was observed in brinjal + *palak* (broadcasting). The similar trend was reported in brinjal-coriander intercropping system (Paul et al. 2015). The percent decrease in total leaf yield of *palak* during first three harvestings (Figure 3) might be due to decreased plant population of *palak* and competitive and shading effect of main crop among the various treatments, ranging from 25.2 to 3.1%. The maximum decrease in leaf yield of *palak* was observed in treatment brinjal + *palak* broadcasting, followed by paired row brinjal + *palak* single row, brinjal + *palak* single row and brinjal + *palak* two rows, while the

**Table 6:** Brinjal equivalent yield (q/ha) and *palak* equivalent yield (q/ha) in brinjal + *palak* intercropping system

| Treatment | Brinjal equivalent yield (q/ha) | *Palak* equivalent yield (q/ha) |
|---|---|---|
| Brinjal sole at 60x60 cm | 335.3 | 143.7 |
| *Palak* sole at 20x5 cm | 230.5 | 98.8 |
| Paired row brinjal sole at 30/60x60 cm | 318.3 | 136.4 |
| Brinjal + *palak* (broadcasting) | 432.6 | 185.4 |
| Brinjal + *palak* single row | 505.7 | 216.7 |
| Brinjal + *palak* two rows | 481.1 | 206.1 |
| Brinjal + *palak* three rows | 489.9 | 209.9 |
| Paired row brinjal + *palak* single row | 484.5 | 207.6 |
| Paired row brinjal + *palak* two rows | 507.6 | 217.6 |
| Paired row brinjal + *palak* three rows | 468.1 | 200.6 |
| Paired row brinjal + *palak* four rows | 453.1 | 194.2 |

**Table 7:** Economics and benefit cost ratio of brinjal + *palak* intercropping system

| Treatment | Gross returns (Rs/ha) | Total cost (Rs/ha) | Net returns (Rs/ha) | Benefit to cost ratio |
|---|---|---|---|---|
| Brinjal sole at 60x60 cm | 201180 | 78040 | 123140 | 2.58 |
| *Palak* sole at 20x5 cm | 138320 | 68310 | 70010 | 2.02 |
| Paired row brinjal sole at 30/60x60 cm | 190980 | 81046 | 109934 | 2.36 |
| Brinjal + *palak* (broadcasting) | 259598 | 88540 | 171058 | 2.93 |
| Brinjal + *palak* single row | 303442 | 80790 | 222652 | 3.76 |
| Brinjal + *palak* two rows | 288582 | 83540 | 205042 | 3.45 |
| Brinjal + *palak* three rows | 293978 | 86290 | 207688 | 3.41 |
| Paired row brinjal + *palak* single row | 290700 | 83796 | 206904 | 3.47 |
| Paired row brinjal + *palak* two rows | 304598 | 86546 | 218052 | 3.52 |
| Paired row brinjal + *palak* three rows | 280898 | 89296 | 191602 | 3.14 |
| Paired row brinjal + *palak* four rows | 271882 | 91546 | 180336 | 2.97 |

Note: Sale price of brinjal @ Rs. 6/kg and *palak* @ Rs. 14/kg minimum decrease in leaf yield was observed in brinjal + *palak* three rows cropping system, followed by paired row brinjal + *palak* two rows. These results corroborate the findings of Ahmed et al. (2013) and Islam et al. (2016), who found reduction in yield of intercrop in brinjal and okra intercropping system, respectively. Also, these findings confirm the results of Abdelgaic et al. (2014), who reported reduction in the yield of bean in tomato-bean intercropping system. The effect of different intercropping treatments on days to first, second and third harvest of *palak* was found non-significant. Muoneke et al. (2007) also reported no significant effect of maize-soybean intercropping system on days to 50% flowering and 50% podding in soybean crop.

**Brinjal equivalent yield (BEY) and *Palak* equivalent yield (PEY):** All the intercropping treatments showed higher value for these yield attributes over the sole cropping (Table 5). The maximum value for BEY and PEY was recorded for paired row brinjal + *palak* two rows, followed by brinjal + *palak* single row and brinjal + *palak* three rows. The increase in yield of brinjal might be attributed to the increase in growth attributes, number of fruits per plant and fruit weight, as the main crop brinjal was slow growing and *palak* as intercrop was fast growing with higher price received in the market to give substantial yield advantage. Similar findings were reported by Ahmed et al. (2013) in okra-amaranth intercropping, Islam et al. (2014) in brinjal-coriander intercropping and Singh et al. (2016) in potato based intercropping system.

**Economics of production:** Among different treatment combinations, brinjal + *palak* single row intercropping system was found most remunerative with maximum net return and benefit to cost ratio followed by paired row brinjal + *palak* two rows (Table 5). This might be due to higher brinjal equivalent yield and comparatively lower cost of cultivation than most of the treatments. *Palak* grown alone was least remunerative than all other treatments with minimum values for net return and benefit to cost ratio followed by paired row sole brinjal crop at 30/60x60 spacing and brinjal sole crop at spacing of 60x60 cm. These results are in conformity with the findings of Sujay and Giraddi (2015), who obtained highest net return and benefit cost ratio from chilli intercropped with onion. Similar results were recorded by Kumar et al. (2005) and Kumar et al. (2014) in maize-cowpea intercropping system and okra based intercropping system, respectively.

## Conclusion

Brinjal + *palak* single row gave highest net returns (Rs. 222652) and benefit to cost ratio (3.76) due to low cost of production, closely followed by paired row brinjal + *palak* (two rows) with net returns (Rs. 218052) and B:C ratio (3.52). Paired row brinjal + *palak* (two rows) intercropping system also gave maximum brinjal equivalent yield (507.6 q/ha) and *palak* equivalent yield (217.6 q/ha) followed by brinjal + *palak* single row with brinjal equivalent yield (505.6 q/ha) and *palak* equivalent yield (216.7 q/ha). It has been concluded that brinjal normal or paired row intercropped with *palak* single row could be more remunerative for earning maximum net returns than the brinjal sole crop. Comprehensively, intercropping could be considered as emerging tool for doubling small holder farmer's income and sustaining national food security.

**सारांश**

देश में शहरीकरण, उच्च जनसंख्या वृद्धि और औद्योगिकीकरण के कारण भूमि का आकार दिन–प्रतिदिन कम होता जा रहा है। इसलिए माँग को पूर्ण करने के लिए बेहतर कृषि प्रबंधन प्रथाओं पानी, उर्वरकों और भूमि के इष्टतम उपयोग को अपनाकर प्रति इकाई क्षेत्र में अधिक सब्जियाँ पैदा करने के लिए रणनीतियों को तैयार किया जाना चाहिए। वनस्पति सब्जी विज्ञान विभाग, हरियाणा कृषि विश्वविद्यालय, हिसार (हरियाण) के अनुसंधान प्रक्षेत्र में वर्ष 2016–17 (खरीफ) के दौरान एक यादृच्छिकी खण्ड अभिकल्पना (रैंडोमाइज्ड ब्लॉक डिजाइन) के साथ एक प्रक्षेत्रप्रयोग किया गया, जिसका लक्ष्य अधिकतम प्रतिकृति के साथ बैंगन और पालक के उपयुक्त भूमि उपयोग, उच्च उपज और अन्य आर्थिक लाभ प्राप्त करने के लिए उपयुक्त अन्तःसस्यन (इंटरप्रॉप) संयोजन का पता लगाना था। अनुसंधान जाँच के आधार पर, यह पाया गया कि एकमात्र बैंगन (60 x 60 सेंमी.) और पालक (20 x 5 सेंमी.) की वृद्धि और उपज की विशेषताएं न्यूनतम प्रतिस्पर्धा के कारण अन्य उपचारों से अधिक थी। उपचार बैंगन + पालक (एक पंक्ति) में उच्चतम शुद्ध प्रतिफल (222652 रूपये) और उत्पादन की कम लागत के कारण उच्चतम लाभ लागत अनुपात (3.76) पाया गया है। युग्मित पंक्ति बैंगन + पालक (दो पंक्तियाँ) के परिणाम भी इसके निकट ही पाये गये हैं। युग्मित पंक्ति बैंगन + पालक (दो पंक्तियाँ) अन्तःसस्यन प्रणाली (सिस्टम) ने भी अधिकतम सकल प्रतिफल (304598 रूपये), बैंगन समरूप उपज (507.6 कुन्तल/हेक्टेयर) और पालक समरूप उपज (217.6 कुन्तल/हेक्टेयर) के परिणाम पाये गये हैं। बैंगन को एकमात्र फसल की तुलना में बैंगन की सामान्य या युग्मित पंक्ति को पालक एकल कतार (सिंगल रो) के साथ अन्तःसस्यन किया जा सकता है, जो अधिक से अधिक शुद्ध लाभ अर्जित करने लिए अधिक लाभदायक हो सकता है। इसके अलावा, अन्तःसस्यन को छोटे धारक किसान की आय को दोगुना करने और राष्ट्रीय खाद्य सुरक्षा को बनाए रखने के लिए उभरते तकनीकी के रूप में माना जा सकता है।

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