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Computation of Economic Feasibility of Brinjal and Palak Intercropping System

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Authors' contributions

This work was carried out in collaboration among all authors. Authors SK and SKD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AC and SK managed the analyses of the study. Author RK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim/Objective: To evaluate the economic feasibility of brinjal–*palak* intercropping system.
Study Design: Randomized Block Design.
Place and Duration of Study: Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during 2016-17.
Methodology: Experiment comprised of 11 treatments with three replications of *palak* (20 x 5 cm) as intercrop with brinjal (60 x 60 cm) and paired row brinjal (30/60 x 60 cm).
Results and Discussion: Brinjal + *palak* (single row) gave the highest production efficiency (532.3 kg/days), 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 exhibited maximum gross returns (Rs. 304598), monetary advantage index (MAI) (Rs.139055), replacement value of intercropping (RVI) (2.47), relative value total (RVT)

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(3.79) and relative net return (RNR) (2.71). This may be attributed to additional advantage of intercrop yield and higher economic value of intercropping.
Conclusion: From farmer's point of view, the treatment paired row brinjal + *palak* (two rows) was considered to be the most remunerative one among all the respective treatments due to its higher MAI, RVI and RNR.

Keywords: Economical analysis; paired row brinjal; intercropping; monetary advantage index (MAI); production efficiency (PE).

1. INTRODUCTION

Sustainable agriculture is a type of agriculture which is more efficient in use of resources, for the benefit of humanity, and is in balance with the environment [1]. Intercropping, an emerging tool for sustainable agriculture is expected to increase total productivity per unit area and time, besides equitable and judicious utilization of land resource and farming inputs including labour, with the insurance against crop failure. Also, sometimes sole crop cultivation is painful to the farmers due to low price and high management. Intercropping increases profitability and attractiveness of a farming system. Brinjal (*Solanum melongena* L.) and *palak* (*Beta vulgaris* var. *orientalis* L.) are excellent plant models for intercropping in the subtropical regions.

Brinjal (*Solanum melongena* L.), the member of family solanaceae, an annual herbaceous plant with semi-erect or semi-spreading growth habit. India holds second positionin terms of area and production of brinjal after china, accounting 730 thousand hectares with an annual production of 128 lakh tonnes and productivity of 17.53 tonnes per hectare [2]. Owing to its high production rate, it is a good source of income to small as well as marginal farmers in developing countries. Brinjal is a long duration (210-230 days) and widely spaced (100 cm × 75 cm) crop, with initial phase of slow growth which allows sufficient space between rows and plants within a row, that can be utilized to raise fast growing short duration crop as intercrop for generating additional income from same piece of land [3]. There is a great possibility to cultivate minimum canopy spread herbaceous plant like *palak* in the inter row space of brinjal as they both have different growth habit and duration. Beet leaf or *palak* (*Beta vulgaris* var. *orientalis* L.), a short duration widely grown leafy vegetable, can be grown in tropical and subtropical regions throughout the year at a spacing of 20 cm x 5 cm. The *palak* crop becomes ready for its first cutting in about 35 days after sowing and subsequent cuttings are taken at 15-20 days interval. Also, researchers and scientific community should emphasize on developing strategies that reduce the cost of production and enhance the profitability of the farming system. Farmers would be benefited economically through proper utilization of the resources as well as contributing to the national food security and nutritional aspect. Therefore, the study is undertaken to find out the best combination, efficiency and economics of brinjal and *palak* intercropping system which could assess in recommendation on this aspect for Haryana conditions.

2. MATERIALS AND METHODS

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. The present experiment comprises of 11 treatments laid out in a Randomized Block Design (RBD) and replicated thrice. The experimental treatments were: 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). The seeds of brinjal cv. HLB 12 tolerant to shoot and fruit borer was procured from the Department of Vegetable Science, CCS *Haryana* Agricultural University, Hisar. Five weeks old seedlings of brinjal cv. HLB 12 were transplanted at 60 × 60 cm spacing for single row and 30/60 x 60 cm for paired row in plots of 3.6 x 4.2 m in last week of July. The transplanting was done in the evening hours. The seeds of *palak* cv. HS 23 were sown at a spacing of 20 x 5 cm in between the brinjal rows on same day before transplanting the brinjal. As per the package of practices, cultural operations were done. 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. Data on yield and yield contributing characters were taken and analyzed statistically using randomized block design. Different economic indices like benefit to cost ratio, monetary advantage index (MAI), replacement value of intercropping (RVI), production efficiency (PE), relative value total (RVT) and relative net return (RNR) were calculated using formulas given below:

The monetary advantage index (MAI) was calculated as described by Ghosh [4].

MAI= Value of combined intercrop yield × (LER-1)/LER

Where, LER= Land equivalent ratio

The relative value total (RVT) was calculated using formula:

$$RVT = aP_1 + bP_2 / aM_1$$

Replacement value of intercropping (RVI) is superior to RVT because it accounts for variable cost in production process and was calculated according to Moseley [5].

$$RVI = aP_1 + bP_2 / aM_1 – C$$

Also, relative net return (RNR) was calculated using the formula:

$$RNR = (aP1 + bP2) – C / aM1$$

Where,

P1 & P2 are the yield of intercrops and a & b are the respective prices of these crops.

M1 is the yield and C is the input cost of the primary (main) crop in sole stand.

Production efficiency (PE) is worked out as given below to find out the economics of individual intercropping system:

PE = crop equivalent yield/number of days taken by crop.

3. RESULTS AND DISCUSSION

3.1 Economics of Production

Among different treatment combinations, brinjal + *palak* (single row) intercropping system was found the most remunerative one with maximum net returns and benefit to cost ratio followed by paired row brinjal + *palak* (two rows) (Table 1). This might be due to the higher brinjal equivalent yield and comparatively lower cost of cultivation than rest of the treatments. *Palak* grown alone was least remunerative than all other treatments with the least values for net return and benefit to cost ratio followed by paired row sole brinjal crop at 30/60 x 60 cm spacing and brinjal sole crop at a spacing of 60 x 60 cm. These results are in conformity with the findings of Sujay and Giraddi who obtained highest net return and benefit cost ratio from chilli intercropped with onion [6]. Similar results were recorded by Kumar et al. [7] and Kumar et al. [8] in maize-cowpea intercropping system and okra based intercropping system, respectively.

3.2 Monetary Advantage Index (Mai) and Replacement Value of Intercropping (RVI)

The most important tool of recommending a cropping pattern is the monetary advantage index (MAI) which defines the cost: benefit ratio more specifically total profit, because farmers are mostly interested in the monetary value of return [9]. The MAI values were positive in all the planting ratios. The maximum MAI and RVI value (Rs.139055 and 2.47 respectively) was found under Paired row brinjal + *palak* (two row) followed by brinjal + *palak* (one row) (Rs.131032 and 2.46 respectively) and the lowest (Rs.87679 and 2.10 respectively) was recorded in brinjal + *palak* (broadcasting) among different intercropping systems (Table 2). It might be due to the higher LER value which results in higher values of MAI. Higher MAI and RVI values in intercropping system in comparison to sole cropping were also reported by islam et al. [10] and Kheroar and Patra [11], while working on brinjal-garlic and paired row maize-legume intercropping system, respectively.

3.3 Production Efficiency (PE)

Production efficiency of various planting patterns was greater in different intercropping

Table 1. 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

Table 2. Monetary advantage index (MAI), replacement value of intercropping (RVI) and production efficency of brinjal + *palak* intercropping system

Treatment	MAI	RVI	PE (Kg/days)
Brinjal (sole) 60x60 cm	-	1.63	372.5
palak (sole) 20x5 cm	-	1.12	354.6
Paired row brinjal (sole) 30/60x60	-	1.55	353.6
Brinjal + *palak* (broadcasting)	87679	2.10	412
Brinjal + *palak* (one row)	131032	2.46	532.3
Brinjal + *palak* (two rows)	116807	2.34	490.9
Brinjal + *palak* (three rows)	125990	2.39	480.3
Paired row brinjal + *palak* (one row)	123631	2.36	510
Paired row brinjal + *palak* (two rows)	139055	2.47	517.9
Paired row brinjal + *palak* (three rows)	117585	2.28	458.9
Paired row brinjal + *palak* (four rows)	108097	2.20	431.5

Table 3. Relative value total (RVT) and relative net return (RNR) of brinjal + *palak* intercropping system

Treatment	RVT_b	RVT_p	RVT_t	RNR_b	RNR_p	RNR_t
Brinjal (sole) 60x60 cm	-	-	-	-	-	-
palak (sole) 20x5 cm	-	-	-	-	-	-
Paired row brinjal (sole) 30/60x60	-	-	-	-	-	-
Brinjal + *palak* (broadcasting)	1.29	1.88	3.17	0.85	1.24	2.09
Brinjal + *palak* (one row)	1.51	2.19	3.70	1.10	1.61	2.71
Brinjal + *palak* (two rows)	1.43	2.09	3.52	1.02	1.48	2.50
Brinjal + *palak* (three rows)	1.46	2.12	3.58	1.03	1.50	2.53
Paired row brinjal + *palak* (one row)	1.51	2.10	3.61	1.08	1.49	2.57
Paired row brinjal + *palak* (two rows)	1.59	2.20	3.79	1.14	1.57	2.71
Paired row brinjal + *palak* (three rows)	1.47	2.03	3.50	1.00	1.38	2.38
Paired row brinjal + *palak* (four rows)	1.42	1.96	3.38	0.94	1.30	2.24

combinations of brinjal + *palak* as compared to the sole cropping. Highest production efficiency (532.3) was recorded with brinjal + *palak* (one row) followed by Paired row brinjal + *palak* (two row) and the lowest (412) was recorded in brinjal + *palak* (broadcasting) among different intercropping systems (Table 2). This may be attributed to additional advantage of intercrop yield and higher economic value of intercropping, resulted into maximum production efficiency [12].

3.4 Relative Value Total and Relative Net Return

The values of RVT and RNR should always be greater than unity. The highest value of RVT and RNR recorded for the treatment paired row brinjal + *palak* (two rows) [3.79 and 2.71, respectively], followed by brinjal + *palak* (one row) [3.70 and 2.71, respectively] and the lowest for brinjal + *palak* (broadcasting), *i.e.,* 3.17 and 2.09, respectively, among various intercropping combinations due to higher market price of *palak* (Table 3). Also, this might be due to the spatial as well as temporal complementarily which resulted in substantial yield advantages from intercropping. Kheroar and Patra [12] had also reported the similar findings while working on paired row maize-legume intercropping system.

4. CONCLUSION

Results obtained from competition indices revealed a significant advantage from intercropping that facilitates in exploiting the available resources of the environment at its optimum compared to sole cropping which might be the result of better economics and land use efficiency. Brinjal + *palak* (single row) gave highest production efficiency (532.3 kg/days), 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), MAI (Rs.139055), RVI (2.47), RVT (3.79) and RNR (2.71). However, from farmer's point of view, the treatment Paired row brinjal + *palak* (two rows) was considered to be the most remunerative among all the respective treatments due to its higher MAI, RVI and RNR.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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