Bangladesh Agron. J. 2022, 25(2): 51-56

COMPARATIVE PRODUCTIVITY AND PROFITABILITY OF CHILLI-LEGUME VEGETABLE INTERCROPPING SYSTEMS

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(**Received**: 03 October 2022, **Accepted**: 13 April 2023)

Keywords: Chilli, legume vegetable, intercropping, chilli equivalent yield, benefit cost ratio

Abstract

The field experiment was carried out on chilli legume vegetables intercropping system using five treatments at the Agronomy Research Field of Bangladesh Agricultural Research Institute, Gazipur during *rabi* season, 2019-2020 and 2020-2021. The study was conducted to find out the suitable intercrop combination for higher productivity and economic return. The treatments were viz., T_1= Sole chilli (60 cm × 50 cm), T_2 = Chilli (100%) + one row bush bean (50%), T_3= Chilli (100%) + two row bush bean (100%), T_4= Chilli (100%) + one row pea (50%), T_5= Chilli (100%) + two row pea (100%). Significantly the highest yield (8.67 t/ha) was obtained in sole chilli. But chilli + one inter row pea intercropping system gave the highest chilli equivalent yield (21.47 t/ha). The highest gross margin (Tk. 151896/ha) and BCR (3.42) were obtained from the same treatment. The results revealed that one row pea (50%) intercropped with chilli (100%) might be suitable intercrop combination for higher productivity and economic return.

Introduction

Intercropping system is an important feature of tropical agriculture which could be a viable option to increase productivity of crops per unit area and per unit time. Intercropping is a crop management system involving growing of two or more dissimilar crops simultaneously on the same land area. It involves crop intensification in respect to both time and space dimensions (Ahlawat and Sharma, 2002) and increases total productivity through efficient utilization of land, labour, growth resources such as solar radiation and different inputs including fertilizer and water. It is a cropping system which integrates crop production with soil conservation. Intercropping is an excellent technique to increase total productivity (Islam *et al.*, 2010), monetary return (Begum *et al.*, 2010) and resource use efficiency (Islam *et al.*, 2006) as well as to fulfill the diversified need of farmers (Akhteruzzaman *et al.*, 2008). Moreover, it provides several major advantages namely; diversification reduces risk associated with crop failure, offers greater yield stability and utilizes the available growth resources more efficiently and sustainably (Islam *et al.*, 2006). The use of early maturing crop varieties, row arrangement, spacing and plant population are some important methods that help increase the yield of intercrop (Rahman *et al.*, 2009). Better intercrop production could be achieved with the choice of the appropriate crops (Santalla *et al.*, 2001), population density and planting geometry of component crops (Myaka 1995). Benefits of intercropping may be briefed as: better use of resources, improvement of soil fertility by legume components of the system, soil preservation through covering the bare land between the rows, reduction of biotic and abiotic risks by increasing diversity, suppression of weed infestation etc. (Van Wolfswinkel, 2012). Another advantage of mixing crop is the yield and quality improvement compared with sole cropping. The most

common crop combination in tropical intercropping systems is mixture of legumes and non-legumes (Wood and Mayers 1987; Fujita *et al.*, 1990). Inclusion of legumes enhances crop and nitrogen yields of the non-legumes (Baker and Blamey, 1985; Wood and Mayers, 1987).

Chilli is one of the major spices crops in Bangladesh cultivated in 2, 49,748 acres of land (both winter and summer) with a production of 492000 metric tons (BBS, 2021). It is usually grown as sole and in some cases as intercrop in various parts of Bangladesh. Chilli is generally grown with wide row spacing about 60 cm, which makes it suitable for intercropping. Intercropping of chilli with different vegetables offer greater scope to utilize the land and other resources to the maximum extent. Productivity of the system can be enhanced by judicious selection of vegetables differing in duration and growth rhythms, so as to adjust the demand for the above and underground resources (Suresha *et al.*, 2007). So, in the inter-row space of chilli, legume crop such as french bean or pea can be introduced as intercrop for higher economic return as well as incorporated plant biomass can be improved soil nutritious status. Therefore, this experiment was conducted to find out suitable legume vegetable species to grow as an intercrop with chilli for higher productivity and economic return.

Materials and Methods

A field experiment was conducted under irrigated condition during *rabi* season, 2019-2020 and 2020-2021 at the Agronomy Research Field of BARI, Gazipur (23°53'-24°21'N latitudes and 90°09'-92°39'E longitudes). Gazipur located at an elevation of 14 meters (45.93 feet) above sea level, a tropical wet and dry or savanna climate (Classification: Aw). The district's yearly temperature is 28.95ºC (84.11ºF) and it is 1.21% higher than Bangladesh's averages. Gazipur typically receives about 71.24 millimeters (2.8 inches) of precipitation and has 115.47 rainy days (31.64% of the time) annually. The soil of research area belongs to the Chhihata series under AEZ-28. The soil was silty clay loam with pH 6.23, OM 1.29% (very low), total N 0.112% (very low), exchangeable K 0.098 meq/100g soil (very low), available P 15.23µg/ml (optimum), available S 24.94 g/g (optimum), available Zn 0.654 g/g (low) and available B 0.168 g/g (very low). Organic matter, N, K and B were under critical level in the soil. The experiment consisted of five different treatments viz., T_1= Sole Chilli (60 cm × 50 cm), T_2= Chilli (100%) + one row bush bean (50%), T_3= Chilli (100%) + two row bush bean (100%), T_4= Chilli (100%) + one row pea (50%), T_5= Chilli (100%) + two row pea (100%). Experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and each gross plot was of size 3.6 × 3.0 m^2. Bushbean (var. BARI Jharsheem-2) and pea (var. BARI Motorsuti-3) were used as intercrop. Chilli cv. BARI Morich-3 was transplanted with 2 seedlings per hill and later maintained one seedling per hill. The inter row spacing was 60 cm and intra row spacing was 50 cm. Intercrops were sown between the rows. Five tons of cowdung per ha was applied to the crop before transplanting. Basal dose of fertilizer was applied @ 96-45-75-15-1.5-1.4 kg/ha N P K S Zn B (FRG, 2018). Half of N and all other fertilizers were applied as basal during final land preparation. Remaining N was applied in three equal splits at 25, 50 and 70 DAT in chilli as ring method. Under intercropping situation no additional fertilizer was applied. Chemical fertilizers were used in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid. Thirty days old seedling of chilli was transplanted on 21 November 2019 and 18 November 2020, respectively and intercrops were sown 10 days after planting of chilli in line according to the treatment combinations. Intercultural operations and plant protection measures were taken up as and when required. First harvesting of chilli was done at 120 DAP (days after planting) in 2020.and 118 DAP in 2021 and harvesting was continued up to 196 DAP in 2020 and 200 DAP in 2021. French bean was harvested three

times at 73, 78 and 85 DAS in 2020 and 75, 80 and 86 DAS in 2021. Pea was harvested on 10 January 2020 and 8 January 2021. Observations were taken on five randomly selected plants in each plot in respect to plant height, number of chilli fruits/plant, weight of chilli fruit, number of pods, pod length, single plant pod weight and yield. For economic analysis, gross income, total operational cost, gross margins and BCR were calculated. Data on yield and yield contributing characters were taken and statistically analyzed following MSTAT-C software package. Means were adjudged by LSD test at 5% level of significance.

Chilli equivalent yields (CEY) were computed by converting yield of intercrops on the basis of prevailing market price of the individuals by using the formula of Bandyopadhayay (1984).

$$\text{Chilli equivalent yield (CEY)} = \text{Yield of component crop} + \frac{\text{Yi} \times \text{Pi}}{\text{Price of chilli}}$$

where, Yi = Yield of component crop (pea/bushbean) in intercropping
Pi = Price of component crop (pea/bushbean) in intercropping

Results and Discussion

Yield and yield contributing characters of chilli

The growth of chilli was found to be affected by the intercrops. The two years pooled yield and yield attributes data of chilli have been presented in table 1. The plant height was significantly lower in all the treatments than the sole (Table 1). The plant height was comparatively higher in sole chilli (90.40 cm) and the lowest (61.15 cm) was recorded when two row bushbean intercropped with chilli at harvest. This might be due to insufficient nutrient uptake through competition in this intercropping system. Similar results were also obtained by Ahmed *et al.* (2018). The number of fruit/plant and weight of fruit/plant differed significantly due to influence exerted by different treatments. The maximum number of fruits/plant (232) and highest weight of fruit/plant (320.46 g) were observed in sole chilli, while the lowest number of fruits/plant (168) and weight of fruit/plant (186.44 g) were observed in chilli + two inter row bushbean intercropping. In sole chilli, the values of these parameters were more might be due to the utilization of wider space and less compitition for natural resources. Similar results were observed by Begum *et al.* (2015). Yield of chilli varied from 6.72 t/ha to 8.67 t/ha due to influence exerted by different treatments. Among the treatment combinations sole chilli gave the highest yield of 8.67 t/ha. Among the intercropping systems, the highest chilli yield was recorded in chilli + single row pea cropping (8.57 t/ha) might be due to less competition for different growth resources. Chilli yield was the lowest (6.72 t/ha) in the chilli + two inter row bushbean treatment, might be due to the large canopy of french bean which hampered the growth and yield of chilli. Similarly, Varghese *et al.* (1979) reported the negative effects of intercropping on yield of cabbage. Islam *et al.* (2006) and Santalla *et al.* (2001) also reported that seed yield was higher in monoculture as compared to their corresponding intercropped yield. The yield loss due to intercropping also reported by Ahmed *et al.* (2013), Muoneke and Ndukwe (2008) and Manga *et al.* (2003).

Intercropping system also significantly reduced chilli yield by 1 to 23% over sole chilli (Table 1) might be due to inter-specific competition for space, solar radiation, nutrients and water. Chilli + two row bush bean intercropping system reduced 23% chilli yield followed by Chilli + two row pea (19%) while the minimum yield loss of chilli was found in chilli + one row pea (1%) followed by chilli + one row bush bean (4%) combinations. The yield loss due to intercropping also reported by Ahmed *et al.* (2013).

Table 1. Crop characters and yield of chilli as influenced by different intercropping (Pooled of 2019-2020 and 2020-2021)

Treatments	Plant height (cm)	Fruits/plant (no.)	Fruit weight/ plant (g)	Chilli Yield (t/ha)	intercropped chilli yield decreases over sole chilli (%)
Sole chilli (60 cm 50 cm)	90.40	232	320.46	8.67	-
Chilli (100%)+one row bush bean (50%)	72.15	196	255.65	8.31	4
Chilli (100%)+two row bush bean(100%)	61.15	168	186.44	6.72	23
Chilli (100%) + one row pea (50%)	78.70	215	229.55	8.57	1
Chilli (100%) + two row pea (100%)	65.85	186	212.93	7.06	19
$LSD_{(0.05)}$	13.56	11.11	77.05	0.22	-
CV (%)	6.49	4.55	3.89	2.29	-

Yield of legume vegetables

The two years pooled yield of pea and bush bean have been presented in Table 2. The yield of pea and bush bean was significantly influenced by intercropped with chilli. Among the intercropping combinations the higher yield of bushbean (11.15 t/ha) was recorded in T_3 treatment (Chilli 100% + two row bush bean 100%) and the lowest bushbean yield (8.17 t/ha) from T_2 treatment (Chilli 100% + one row bush bean 50%). This might be due to higher plant population in T_3 treatment. In case of pea the similar trend also observed due to similar cause. The higher pea yield (7.14 t/ha) was recorded in T_5 treatment (Chilli 100% + two row pea 100%) and the lowest pea yield (6.45 t/ha) was obtained from T_4 treatment (Chilli 100% + one row pea 50%). Ahmed *et al.,* (2006) also reported similar result.

Table 2. Yield of legume vegetables as influenced by intercropping (Pooled of 2019-2020 and 2020-2021)

Treatments	Yield (t/ha)
Chilli (100%) + one row bush bean (50%)	8.17
Chilli (100%) + two row bush bean (100%)	11.15
Chilli (100%) + one row pea (50%)	6.45
Chilli (100%) + two row pea (100%)	7.14
$LSD_{(0.05)}$	1.57
CV (%)	3.89

Equivalent yield and Cost and return analysis

Total productivity of system was expressed in chilli equivalent yield (CEY). Chilli equivalent yield (CEY) and cost benefit analysis data are presented in Table 3. The chilli equivalent yield was influenced in response to different intercropping systems (Figure 2). All intercropping gave higher CEY than sole chilli indicating higher productivity than sole cropping. Among those, the highest CEY (21.47 t/ha) was observed in chilli + one row intercrop pea combination followed by T_5 combination (21.34 t/ha) and the lowest (8.67 t/ha) was observed in sole chilli. Maximum CEY in aforesaid combination was observed due to additional yield of component crop. Further, economics of different chilli intercropping system was analyzed taking into account the prices prevailed at local market. Though, the sole chilli gave significantly the highest yield per ha but gross return and gross margin/ha were highest in all intercropped treatments because of higher CYE. Considering the economics of intercropping in chilli, chilli + one interrow pea was found to be the best with highest gross return (Tk. 214700/ha) and gross margin (Tk. 151896/ha)

where as next best treatment was chilli + two inter row pea (Tk. 213400/ha and Tk. 150449/ha respectively. The highest BCR (3.42) was observed in chilli + one row intercrop pea intercropping system followed by chilli + two rows inter crop pea (3.39). Cost of production of all intercropping systems was more than sole chilli because of the involvement of higher seed cost as well as cost of more labours engaged in different operations. Chilli + legume Intercropping system increased total productivity by 90 -148% over sole chilli (Table 3). Among the treatments, CEY in chilli + one row pea combination was 148% higher over the sole chill and lowest in Chilli + one row bush bean. Similar results were also reported by Begum *et al.* (2015) in chilli + root crop intercropping systems.

Table 3. Chilli equivalent yield and economics of different chilli intercropping (Pooled of 2019-2020 and 2020-2021)

Treatments	Chilli equivalent yield (t/ha)	% Increase CEY over sole chilli	Gross return (Tk/ha)	Cost of cultivation (Tk/ha)	Gross margin (Tk/ha)	BCR
T_1	8.67	-	86700	57000	29700	1.52
T_2	16.48	90	164900	62280	102620	2.65
T_3	17.87	106	178700	62876	115824	2.84
T_4	21.47	148	214700	62804	151896	3.42
T_5	21.34	146	213400	62951	150449	3.39

Market price (Tk./kg): Chilli= 10, Bushbean= 10, Pea= 20
T_1= Sole chilli (60 cm × 50 cm), T_2 = Chilli (100%) + one row bush bean (50%), T_3= Chilli (100%) + two row bush bean (100%), T_4= Chilli (100%) + one row pea (50%), T_5= Chilli (100%) + two row pea (100%).

Conclusion

It can be concluded that chilli intercropped with bushbean or pea produced higher yield than sole chilli. All studied combinations can be cultivated for higher productivity but chilli (100 %) + one row of pea (50%) in between chilli lines combination could be more suitable combination for higher productivity and profitability of intercrop,

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