Management of chilli insect pests by using trap crops

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ABSTRACT

The field study was conducted at Spices Research Centre, Bangladesh Agricultural Research Institute (BARI), Bangladesh during Rabi season to evaluate the effectiveness of trap cropping with tomato, groundnut, French bean, carrot, and marigold with chilli for the management of chilli insect pests. Chilli *(Capsicum frutescens* L.*)* (BARI Morich-2) were protected by trap cropping with tomato, groundnut, French bean, carrot, and marigold. Among the different trap crops, chilli protected by trap cropping with marigold and tomato performed well by recording lowest population of sucking pests, leaf curl index, larval population of *Helicoverpa armigera* and *Spodoptera litura* with fruit damage. Whereas the highest pest population of aphids (*Myzus persicae)*, thrips (*Scirtothrips dorsalis*), mite (*Polyphagotarsonemus latus*), leaf curl index, number of larvae per plant of *H. armigera* (Noctuidae: Lepidoptera) and *S. litura* (Noctuidae: Lepidoptera) with percent of fruit damage was observed in pure chilli crop (control). Yield data revealed that treatment chilli protected by trap cropping with marigold recorded highest red ripe chilli yield of 11.70 t/ha and it was statistically similar to treatment chilli protected by trap cropping with tomato (11.30 t/ha) and chilli protected by trap cropping with carrot (9.57 t/ha) whereas, trap crop yield was higher in chilli + tomato (22.80 t/ha) followed by chilli + French bean (12.62 t/ha) and chilli + carrot (12.05 t/ha). Among the different trap crops, the highest marginal benefit-cost ratio (24.53) was recorded from chilli + marigold, followed by chilli + tomato (20.71), chilli + carrot (17.86), and chilli + groundnut (10.76) whereas chilli + French bean trap crop recorded lowest marginal benefit-cost ratio (7.99). It appeared that growing trap crops between main crop and border crops was found advantageous in the management of different sucking and borer insect pests of chilli besides yield benefits.

Keywords: Trap crop, pests, yield, chilli (*Capsicum frutescens* L.)

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INTRODUCTION

Chilli (*Capsicum frutescens* L.) is one of the major spice crops grown in Bangladesh. It is an important condiment used for imparting pungency and colour to the food being rich in vitamin C, A, B, oleoresin and red pigment. In Bangladesh, both summer and winter chilli covers about 2,310,077 acres and produces dry chilli about 1,02,251 tons (BBS, 2017). The pest spectrum of chilli crop is complex with more than 293 insects and mite species debilitating the crop in the field as well as in storage (Dey *et al.*, 2001). A total of 39 and 57 species of pests were recorded by Reddy and Puttaswamy (1984) in nursery and field crops. One of the practical means of increasing chilli production is to minimize losses caused by major insect pests; among them, the most important are green peach aphid, thrips, yellow mite, and fruit borer (Berke and Shieh, 2000). Thrips, mites, aphids, and whiteflies have been identified as sucking pests of chilli of which chilli leaf curl caused by mite and thrips are serious (Puttarudraiah, 1959). Besides, a number of viruses are transmitted by aphids, whiteflies etc. which result in a murda complex (Gundannavar *et al.*, 2007). The yield losses due to aphid and whitefly are approximately 50% (Hosamani, 2007). The loss caused by the thrips is reported ranging from 50–90% and fruit borers to an extent of 90% (Reddy and Reddy, 1999).

As chillies are picked at short intervals maintenance of insecticidal film is both uneconomical and hazardous. Besides the indiscriminate use of insecticides has eroded sustainability and resulted in the buildup of pesticide residues, resistance to pesticides, resurgence, and the secondary outbreak of these pests. Besides increasing the cost of production, the use of pesticides has negative effects on the environment and human health, which is attributed to high chemical residues. So, the use of insecticides for the control of these pests is highly criticized for various reasons and therefore switching from insecticides to trap cropping. Trap crop provides protection by preventing the pests from the main crop and the pests are diverted away from the main crop or concentrated in certain pockets of the field where they are easily arrested or controlled. Trap crops have an important attribute that it is distinctly more attractive to the pests than the main crop and have additional function for natural enemies. Intercropping and strip cropping reduce pest pressure on the cash crop through either a push (deterrent from cash crop) or pull (attraction to other species) approach. Boucher *et al.* (2003) concluded that the use of the perimeter trap crop technique as part of Integrated Pest Management (IPM) or organic program can help improve crop quality and overall farm profitability while reducing pesticide use and the possibility of secondary pest outbreaks.

Hussain and Bilal (2007) reported that in tomato field using marigold (3:1 combination) as trap crop reduced 81–89% in the larval population of tomato fruit borer. Tillman and Mullinix (2004) concluded that grain sorghum could serve as a successful trap crop for corn earworm in cotton. Duraimurugan and Regupathy (2005) assessed the effects of push-pull strategy with trap crops in cotton and showed *H. armigera* showed resistance against insecticides; while under trap cropping system, the *H. armigera* reduced on cotton and this insect showed preference on other minor crops. Clifton and Duphily (2006) reported that insect pests showed disturbance with the cultivation of trap crops such as corn, beans, sunflower, pigeon pea, and cowpea; where it was observed that the losses in the main crop due to insect pests reduced considerably due to trap cropping as compared to control. Vaiyapuri *et al*. (2007) argued that trap cropping is the planting of a trap crop to protect the main cash crop from a certain pest or several pests. The trap crop can be from the same or different family group, than that of the main crop, as long as it is more attractive to the pest. The trap crop lesser the use of pesticide, lowers the pesticide cost, preserves the indigenous natural enemies, improves the crop's quality and helps conserve the soil and the environment. Majumdar (2010) reviewed trap cropping as an IPM tool for controlling insect pests and concluded that trap crops can be arranged in various spatial patterns and the choice of design will depend on target pest, pest pressures, and garden or farm size. Maharjan *et al.* (2013) found that the insect pests on chilli may be reduced by using trap crops on the borers or at the alternate rows. However, there are no studies were done in Bangladesh on the management of chilli insect pests through different trap crops. This study was therefore undertaken to evaluate the effectiveness of different trap crops for the management of different sucking and borer insect pests of chilli.

MATERIALS AND METHODS

The field study was conducted at Spices Research Centre, Bangladesh Agricultural Research Institute (BARI), Bogura, Bangladesh (geographic coordinates 25.0167°N, 89.3167°E) during Rabi season of 2018–2019 to evaluate the effectiveness of trap cropping with tomato, groundnut, French bean, carrot, and marigold with chilli for the management of chilli insect pests. The experimental plot was prepared with five ploughings and cross ploughings followed by laddering to break the clods as well as to level the soil. The weeds and stubbles of previous crops were collected and removed from the soil. The unit plot size was 6 m × 5 m and the spacing was 50 cm × 50 cm for chilli, 45 cm × 50 cm for tomato, 45 cm × 10 cm for carrot, 30 cm × 15 cm for groundnut, 50 cm × 25 cm for French bean and 50 cm × 40 cm for marigold. Chilli (BARI Morich-2) were protected by trap cropping with tomato, groundnut, French bean, carrot, and marigold. The treatments were T_1 = chilli protected by trap cropping with tomato, T_2 = chilli protected by trap cropping with groundnut, T_3 = chilli protected by trap cropping with French bean, T_4 = chilli protected by trap cropping with carrot, T_5 = chilli protected by trap cropping with marigold and T_6 = sole chilli (control). Treatments were assigned in a Randomized Complete Block Design (RCBD) with three replications.

Thirty-five days old chilli seedlings were transplanted on 30 October 2018. The trap crops were transplanted or sown in 5:1 row proportions then thirty-five days old chilli seedlings were transplanted to the main field. In addition to 5 t/ha of cow dung, the crop was fertilized with nitrogen (N) 120 kg/ha, phosphorus (P) 60 kg/ha, potassium (K) 100 kg/ha, sulphur (S) 20 kg/ha, and boron (B) 2 kg/ha. The entire amount of cow dung, P, S, B and 1/3 of K was applied during final land preparation. The N and rest K was applied in 3 equal splits at 25, 50, and 70 days after transplanting (DAT) (SRC, 2010). Three weedings were done at 25, 50, and 75 DAT and three irrigations were done at 10–20 days during the vegetative growth stage. To control fruit rot/leaf rot disease of chilli, the crop was sprayed with Tilt 250EC @ 0.5ml/L of water at 65 DAT. No insecticides were applied during the entire growing period. Depending on the maturity, the red ripe chilli was harvested from February 2019 and completed on 29 April 2019.

The population of aphids, thrips, and yellow mite (*Polyphagotarsonemus latus*) were counted at 30, 60, and 90 DAT. For counting the population, five chilli plants were selected randomly in each plot and tagged. Six leaves on the top canopy of each selected plant were observed by using a binocular microscope in the laboratory following the destructive sampling procedure. The mean population of aphids, thrips, and mites per leaf was worked out. Ten plants were selected randomly in each plot and scored visually for leaf curling index (LCI) at 70 and 100 DAT following the 0–4 scale (Niles, 1980) where 0 = absence of symptoms, 1 = 1–25% leaves/plant showing curling, 2 = 26–50% leaves/plant showing curling moderately damaged, 3 = 51–75% leaves/plant showing curling, heavily damaged, malformation of growing points, reduction in plant height, and 4 = more than 75% leaves/plant showing curling severe to complete destruction of growing point, drastic reduction in plant height, defoliation, severe malformation.

The observations on larval population of chilli fruit borer, *H. armigera,* and *S. litura* were made on five randomly selected plants from each treatment at 60, 90, and 120 DAT. The mean larval population was worked out. The fruit damage was worked out by counting total number of fruits per plant and number of damaged fruits per plant on five randomly selected plants in each treatment at every picking. The population count of both larvae and adults of coccinellid beetles were recorded in each treatment by following the standard procedure followed in ecological studies. Population count was taken on five randomly selected plants at 60 and 90 DAT. The population density of the coccinellid beetles was recorded as the number of coccinellids per plant. The Minolta SPAD 502 chlorophyll meter was used for the measurement of chilli leaf color. Yields of red ripe chillies from different plucking were revealed from each treated field and computed as t/ha. Other data were recorded on plant height at 112 DAT, chlorophyll concentration index (CCI) at

112 DAT, fruit length, fruit diameter, single fruit weight, and red ripe chilli yield at harvest. Analysis of variance (ANOVA) was used for data analysis and multiple comparisons were carried out using Duncan's new multiple range test (DMRT) according to Gomez and Gomez (1984). The reduction of thrips and mite population over untreated control were calculated using the following formula of Dutta *et al.* (2014).

$$\text{Thrips/Mite population (\%)} = \frac{\text{Mean value of control} - \text{Mean value of treatments}}{\text{Mean value of control}} \times 100$$

The increase in yield over control in various treatments was calculated by using the following formula.

$$\text{Increase of yield (\%)} = \frac{\text{Yield of treated plot} - \text{Yield of control plot}}{\text{Yield of control plot}} \times 100$$

RESULTS AND DISCUSSION

Population of Sucking Pest and Leaf Curl Index in Chilli Protected by Trap Cropping with Different Crop

The population of sucking pest and leaf curl index in chilli protected by trap cropping with different crops is presented in Table 1. Among the different trap crops tested, the aphid (*M. persicae)* population in different treatments ranged from 1.13 to 3.87 aphids/leaf. The chilli + marigold trap crop recorded significantly less number of aphids (1.13 aphids/leaf) followed by chilli + tomato and chilli + carrot which recorded 1.27 and 1.67 aphids/leaf, respectively. The maximum number of aphids (3.87 aphids/leaf) was registered in sole chilli. However maximum (70.80%) reduction of aphid population over sole chilli was recorded from chilli + marigold trap crop followed by chilli + tomato and chilli + carrot trap crops with population reduction of 67.18% and 56.85%, respectively.

All the treatments except sole chilli registered a significantly lower number of thrips. Among the treatment significantly less number of thrips, *S. dorsalis* (2.44 thrips/leaf) was recorded in chilli + marigold followed by chilli + tomato (2.51 thrips/leaf), chilli + carrot (2.60 thrips/leaf), chilli + groundnut (3.16 thrips/leaf) and chilli + French bean (4.08 thrips/leaf) trap crops. But more number of thrips was found in sole chilli crop (7.54 thrips/leaf). However maximum (67.64%) reduction of thrips population over sole chilli was recorded from chilli + marigold followed by chilli + tomato and chilli + carrot trap crops with population reduction of 66.71% and 65.52%, respectively.

Among the treatments, a significantly lower number of mites, (*Polyphagotarsonemus latus* Banks Acari: Tarsonemidae) population was recorded in chilli + marigold (1.32 mites/leaf) with a population reduction of 71.61% followed by chilli + tomato (2.15 mites/leaf) and chilli + carrot (2.98 mites/leaf) with population reduction of 53.76% and 35.91% respectively. Whereas the highest number of mites (4.65 mites/leaf) was recorded from sole chilli which was statistically similar with chilli + French bean (4.10 mites/leaf) trap crop.

The results revealed that the lowest leaf curl index (0.88) was recorded from chilli + marigold with leaf curl reduction of 66.67% which was statistically similar to chilli + tomato (1.17) with leaf curl reduction of 55.68%. All treatments were found to be significantly superior over sole chilli. Moderate leaf curl was recorded in chilli + carrot, chilli + groundnut, and chilli + French bean trap crops with leaf curl index of 1.71, 1.83, and 2.25. However maximum leaf curl index (2.64) was recorded from sole chilli. Based on the extent of leaf curl index, the treatments could be grouped in the order of chilli + marigold, chilli + tomato, chilli + carrot, chilli + groundnut, chilli + French bean, and sole chilli.

Table 1 Population of sucking pest and leaf curl index in chilli protected by trap cropping with different crops

Treatments	Number of aphids/leaf	Reduction of aphid over sole chilli (%)	Number of thrips/leaf	Reduction of thrip over sole chilli (%)	Number of mites/leaf	Reduction of mite over sole chilli (%)	Leaf curl index	Reduction of leaf curl index over sole chilli (%)
Chilli + Tomato	1.27^{cd}	67.18	2.51^{c}	66.71	2.15^{d}	53.76	1.17^{d}	55.68
Chilli + Groundnut	2.69^{b}	30.49	3.16^{c}	58.09	3.60^{bc}	22.58	1.83^{c}	30.68
Chilli + French bean	3.07^{b}	20.67	4.08^{b}	45.89	4.10^{ab}	11.83	2.25^{b}	14.77
Chilli + Carrot	1.67^{c}	56.85	2.60^{c}	65.52	2.98^{c}	35.91	1.71^{c}	35.23
Chilli + Marigold	1.13^{d}	70.80	2.44^{c}	67.64	1.32^{e}	71.61	0.88^{d}	66.67
Sole chilli	3.87^{a}	-	7.54^{a}	-	4.65^{a}	-	2.64^{a}	-
Mean	2.28	-	3.72	-	3.13	-	1.75	-
SD	1.10	-	1.98	-	1.24	-	0.65	-
CV (%)	7.54	-	9.50	-	8.18	-	7.82	-

Note: ^{abcde} Data represent mean of three observations, mean followed by the same letter (s) in the same column did not differ significantly from each other at $P < 0.01$ by Duncan's new multiple range test. SD = standard deviation, CV = coefficient of variation

Population of Chilli Fruit Borer, Fruit Damage Percent and Natural Enemies in Chilli Protected by Trap Cropping with Different Crop

The population of chilli fruit borer, fruit damage percent, and natural enemies in chilli protected by trap cropping with different crops are presented in Table 2. Among the different treatments, significantly less fruit borer like *H. armigera* and *S. litura* was noticed in chilli + marigold (1.46 and 0.62 larvae/plant, respectively) and chilli + tomato (1.63 and 0.86 larvae/plant, respectively) followed by chilli + carrot (1.74 and 1.21 larvae/plant, respectively) and chilli + French bean (2.69 and 2.48 larvae/plant, respectively). The maximum number of these fruit borer larvae was registered in sole chilli crops (4.72 and 3.74 larvae/plant, respectively). However, the lowest fruit damage due to *H. armigera* (6.04%) and *S. litura* (5.44%) was also recorded from chilli + marigold which was statistically similar to chilli + tomato with fruit damage of 8.58% by *H. armigera* and 10.12% by *S. litura*. The maximum fruit damage due to *H. armigera* (21.37%) and *S. litura* (25.84%) was recorded from sole chilli.

Table 2 Population of chilli fruit borer, fruit damage percent and coccinellid in chilli protected by trap cropping with different crops

Treatments	Fruit borer (larvae/plant)		Fruit damage (%)		Number of coccinellids /plant	Increase of coccinellids over sole chilli (%)
	H. armigera	*S. litura*	*H. armigera*	*S. litura*		
Chilli + Tomato	1.63[d]	0.86[cd]	8.58[cd]	10.12[c]	2.19[b]	18.38
Chilli + Groundnut	3.60[b]	1.25[c]	18.44[b]	15.98[b]	1.95[bc]	5.41
Chilli + French bean	2.69[c]	2.48[b]	16.98[b]	16.09[b]	1.91[bc]	3.24
Chilli + Carrot	1.74[d]	1.21[c]	9.12[c]	10.44[c]	2.24[b]	21.08
Chilli + Marigold	1.46[d]	0.62[d]	6.04[d]	5.44[d]	3.18[a]	71.89
Sole chilli	4.72[a]	3.74[a]	21.37[a]	25.84[a]	1.85[c]	-
Mean	2.64	1.69	13.42	13.98	2.22	-
SD	1.30	1.19	6.28	7.06	0.49	-
CV (%)	9.10	9.46	8.16	9.77	5.52	-

Note: [abcd] Data represent mean of three observations, mean followed by the same letter (s) in the same column did not differ significantly from each other at $P < 0.01$ by Duncan's new multiple range test. SD = standard deviation, CV = coefficient of variation

It appears that the concept of trap cropping fits into the ecological framework of habitat manipulation of an agroecosystem for pest management. Many other methods alter the habitat as part of IPM strategy. However, in the present study, different trap crops were grown to attract insects or other organisms to protect target crops from pest attack, preventing the pests from reaching the crop or concentrating them in a certain part of the field, where they can be economically destroyed. Among trap crops, marigold reported significantly less fruit borer population, compared to other crops. It might be because of preference by the pest to marigold as either a food source or oviposition site than the main crop, thus preventing or making less likely the arrival of the pest to the main crop and/or concentrating it in the trap crop where it can be economically destroyed. Several authors have reported the role of marigold as trap crop in managing the fruit borer in chilli. Identical results were also obtained by Gundannavar and Giraddi (2007) as they found that the IPM model, comprising of marigold as trap crop resulted in reduction of *H. armigera* eggs and larvae on chilli crop, thereby helping to increase the yield. Similar effects of marigold as trap crop were reported in chilli by Mallikarjuna Rao and Ahmed (1986) and Mallikarjuna Rao *et al.* (1999) against chilli aphids, and Giraddi *et al.* (2003) versus thrips and mites in chilli.

The population of coccinellids ranged from 1.85 to 3.18 coccinellids/plant. A significantly higher number of coccinellids of 3.18 coccinellids/plant was noticed in chilli + marigold trap crop which was closely followed by chilli + carrot (2.24 coccinellids/plant) and chilli + tomato (2.19 coccinellids/plant). Whereas the lowest number of coccinellids (1.85 coccinellids/plant) was recorded from sole chilli. The increase of the coccinellid population over sole chilli was high in chilli + marigold, chilli + tomato, and chilli + carrot with records of 71.89%, 21.08% and 18.38%, respectively. These results revealed that chilli protected by trap cropping with different crops contributed a significant role in conserving and enhancing the population of coccinellids.

Effect of Different Trap Crops on Yield and Yield Contributing Characters of Chilli

The effect of different trap crops on yield and yield contributing character of chilli is presented in Table 3. All treatments gave a significant effect on plant height, SPAD value (CCI), fruit length, fruit diameter, single fruit weight and yield of chilli over sole chilli ($P < 0.01$). The tallest plant (67.70 cm) was recorded from chilli + marigold trap crop followed by chilli + tomato (66.30 cm), chilli + carrot (64.40 cm), and chilli + groundnut (59.23 cm) trap crops. The shortest plant (52.90 cm) was recorded from sole chilli. The maximum chlorophyll concentration index at 112 DAT (60.40), fruit length (8.90 cm), fruit diameter (0.78 cm), and single fruit weight (29 g) was recorded from the chilli + marigold trap crop while the lowest number of these parameters was recorded from sole chilli. The highest red ripe chilli yield was also obtained from chilli + marigold trap crop (11.70 t/ha) which increased 69.57% over sole chilli. The lowest red ripe yield (6.90 t/ha) of chilli was recorded from sole chilli.

Table 3 Effect of different trap crops on yield and yield contributing character of chilli

Treatments	Plant height at 112 DAT (cm)	SPAD value (CCI) at 112 DAT	Fruit length (cm)	Fruit diameter (cm)	Single fruit weight (g)	Red ripe yield (t/ha)	Increase of yield over sole chilli (%)
Chilli + Tomato	66.30[ab]	58.30[ab]	8.72[a]	0.74[a]	26.00[ab]	11.30[a]	63.77
Chilli + Groundnut	59.23[abc]	52.60[bc]	7.54[ab]	0.59[bc]	19.00[c]	8.20[bc]	18.84
Chilli + French bean	57.80[bc]	49.20[cd]	6.83[ab]	0.48[cd]	17.00[c]	7.41[bc]	7.39
Chilli + Carrot	64.40[ab]	57.70[ab]	8.42[a]	0.68[ab]	23.00[b]	9.57[ab]	38.70
Chilli + Marigold	67.70[a]	60.40[a]	8.90[a]	0.78[a]	29.00[a]	11.70[a]	69.57
Sole chilli	52.90[c]	44.80[d]	5.38[b]	0.42[d]	12.00[d]	6.90[c]	-
Mean	61.38	53.83	7.63	0.61	21.00	9.18	-
SD	5.70	6.04	1.35	0.14	6.23	2.01	-
CV (%)	5.22	5.22	10.89	8.40	7.17	8.89	-

Note: [abcd] Data represent mean of three observations, mean followed by the same letter (s) in the same column did not differ significantly from each other at $P < 0.01$ by Duncan's new multiple range test. DAT = days after transplanting, CCI = chlorophyll concentration index of leaf, SD = standard deviation, CV = coefficient of variation

Table 4 Economic analysis of different treatments against insect pest of chilli

Treatments	Yield (t/ha or lakh/ha)		Gross return (Tk./ha)		Gross return (Tk./ha)	Cost of treatment (Tk./ha)	Net return (Tk./ha)	Adjusted net return (Tk./ha)	Marginal benefit-cost ratio
	Chilli	Trap crop	Chilli	Trap crop					
Chilli + Tomato	11.30	22.80	164,000	182,400	346,400	9,600	336,800	198,800	20.71
Chilli + Groundnut	8.20	2.35	164,000	117,500	281,500	12,200	269,300	131,300	10.76
Chilli + French bean	7.41	12.62	148,200	201,920	350,120	23,600	326,520	188,520	7.99
Chilli + Carrot	9.57	12.05	191,400	144,600	336,000	10,500	325,500	187,500	17.86
Chilli + Marigold	11.70	3.38	234,000	338,000	572,000	17,000	555,000	417,000	24.53
Sole chilli	6.90	-	138,000	-	138,000	-	138,000	-	-

Note: Price of chilli = Tk. 20.00 per kg; carrot: price of fresh carrot = Tk. 12.00 per kg, seed cost = Tk. 6,000 per ha, labor cost (sowing + harvesting) = Tk. 300 per labor (15 labors); tomato: price of fresh tomato = Tk. 8.00 per kg, seed cost = Tk. 600 per ha, labor cost (sowing + harvesting) = Tk. 300 per labor (30 labors); groundnut: price of groundnut = Tk. 50.00 per kg, seed cost = Tk. 7,700 per ha, labor cost (sowing + harvesting) = Tk. 300 per labor (15 labors); French bean: price of French bean = Tk. 16.00 per kg, seed cost = Tk. 20,000 per ha, labor cost (sowing + harvesting) = Tk. 300 per labor (30 labors); marigold: price of marigold = Tk. 1.00 per flower, seed cost = Tk. 8,000 per ha, labor cost (sowing + harvesting) = Tk. 300 per labor (30 labors)

Economic Analysis of Different Treatments Against Insect Pests of Chilli

Economic analysis of different treatments against insect pests of chilli is presented in Table 4. It was noted that expenses incurred referred to those only on pest control. The results revealed that the highest marginal benefit-cost ratio (24.53) was obtained from chilli + marigold trap crop followed by chilli + tomato (20.71), chilli + carrot (17.86), and chilli + groundnut (10.76). In contrast, the lowest marginal benefit-cost ratio (7.99) was obtained from chilli + French bean trap crop. So, considering the marginal benefit-cost ratio, chilli protected by trap cropping with marigold and tomato may be recommended for effective management of pest complex in chilli field. Blaser *et al.* (2007) reported that benefits of trap crop system include erosion control, reduced leaching of nutrients, balanced distribution of labour and higher economic returns than sole cropping.

CONCLUSION

From the study, it may be concluded that chilli protected by trap cropping with marigold and tomato may be utilized for the management of insect pest complex of chilli with higher yield and economic return.

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