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Bio-Efficacy of Combination Product Novaluron 9.45% + Lambda Cyhalothrin 1.9% ZC (GPI 1316) against Tomato Fruit Borer, *Helicoverpa armigera* (Hubner) in Western Ghat Region of Karnataka

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ABSTRACT: Tomato is more prone to attack of several insect pests mainly due to its tenderness and softness as compared to other crops. The crop is devastated by an array of pests like jassids, aphids, tobacco caterpillar, flea beetles, leaf miners, spider mites, and fruit borers. Tomato fruit borer, *Helicoverpa armigera* is the most destructive insect pest resulting in considerable losses in quantity as well as the quality of tomato fruits to the extent of 50 to 80 per cent. A field experiment was conducted to evaluate the bio-efficacy of GPI 1316 (Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC) against tomato fruit borer, *Helicoverpa armigera* at College of Horticulture farm, Sirsi during *Kharif*, 2019 and 2020. The treatment includes T_1-Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 78g a.i./ha; T_2- Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 90g a.i./ha; T_3- Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 102 g a.i./ha; T_4- Novaluron 10 % EC @ 75g a.i./ha; T_5-Lambda-cyhalothrin 5% EC @ 15g a.i./ha and T_6-Novaluron 5.25% + Indoxacarb 4.5% SC @ 85.32g a.i./ha, and T_7-Untreated check. Results revealed that, the treatment Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 90 g. a.i./ha was found to be most effective in reducing the population of *Helicoverpa armigera* (Hübner) and recorded higher fruit yield with maximum cost-benefit ratio.

Keywords: Bio-efficacy, combination product, fruit borer, *Helicoverpa armigera*, tomato.

INTRODUCTION

Tomato (*Solanum lycopersicon* L.) is one of the most important and widely grown vegetable crops in the world. It is a self-pollinated crop belonging to the family Solanaceae having chromosome number 2n = 24 (Rick, 1969). It is economically attractive and the area under cultivation is increasing daily (Pattnaik *et al.*, 2012). It ranks next to potatoes in world acreage and first among processed vegetables (Chaudhary, 1996). It is used directly as a raw vegetable and also in the form of various processed products like ketchup, puree, juice whole canned fruits, *etc.* (Bhagta, 2017).

Tomato is a good source of nutrition for the consumer and also a very good source of income for small and marginal farmers (Singh *et al.*, 2010). Tomato holds a significant position based on nutritional viewpoint as it contains essential nutrients including Vitamin A, C, and E providing approximately 20 mg of vitamin C per 100 grams (Wilcox *et al.*, 2003). Besides these nutrients, it also contains beta-carotene, lycopene pigments, and niacin, which are essential for metabolism (Olaniyi *et al.*, 2010). Due to the presence of lycopene, flavonoids, and antioxidant properties, tomato is universally treated as a 'Protective food' (Sepat *et al.*, 2013). Tomato and its products are also used as a preventive strategy against major lifestyle diseases, such as cancer and cardiovascular diseases (Canene-Adams *et al.*, 2005).

This crop is native to Central and South America (Vavilov, 1951) and perhaps introduced in India by the Portuguese, though there is no definite record of its introduction. Globally, India ranks second in the area as well as in the production of tomatoes with about 7.97 lakh ha area and production of 20.70 million tonnes. Around 11% of the total world production of tomatoes is cultivated in India. The Andhra Pradesh still holds a top position in tomato production, even after the creation of Telangana (Anonymous, 2018). Tomato is a warm-season annual plant that grows with an average optimum temperature range of 25°C to 29°C (Ejaz *et al.*, 2011). It is generally grown from June - July, October - November and January – February (Reddy and Kumar 2004). In heavy rainfall tracts and Malnad areas, the crop cannot be grown successfully during monsoon. The ideal months for planting tomato are October-April in the plains of India. However, like any other vegetables, the crop successful and economic cultivation is consistently threatened by many production constraints.

Tomato is more prone to attack of several insect pests mainly due to its tenderness and softness as compared to other crops. The tomato yield in India is considerably lower because of several factors, of which the damage caused by insect pests form a major limiting factor. The crop is devastated by an array of pests like jassids, aphids, tobacco caterpillar, flea beetles, leaf miners, spider mites, and fruit borers (Aswathanarayanareddy, 1999). However, the major economic damage is caused by the fruit borers (Sajjad *et al.*, 2011).

Tomato fruit borer, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) causing yield losses of up to 31.53 per cent (Singh *et al.*, 2017; Reddy and Kumar, 2004) is the most destructive insect pest resulting in considerable losses in quantity as well as the quality of tomato fruits (Singh and Chahal 1978; Tewari and Moorthy 1984). It reduces the market value of fruit to the extent of 50 to 80 per cent.

To manage the fruit borer, different insecticides are being used in large quantities by farmers except in a few cases where the crop is grown as per Good Agricultural Practices (GAP) for export purposes. Considering the economic importance of the pest and fruit, the present study was conducted to study the bioefficacy of combination products of Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC on tomato.

MATERIALS AND METHODS

Bio-efficacy studies. The experiment was carried out at the College of Horticulture, Sirsi, Uttara Kannada district of Karnataka during Kharif, 2019 and 2020 in a Randomized Completely Block Design (RCBD) with seven treatments, which were replicated thrice in plot size of 5 m × 5 m each. Tomato variety Abhilash seedlings were transplanted at 90 cm × 45 cm spacing between row to row and plant to plant. All the agronomic practices were followed except plant protection measures during the crop growth period. The details of the treatments used in the trial are given below:

Tr. No.	Treatment	Dosage (g a.i./ha)	Formulationdose (ml/ha)
T_1	Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC	78	650
T_2	Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC	90	750
T_3	Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC	102	850
T_4	Novaluron 10% EC	75	750
T_5	Lambda Cyhalothrin 5% EC	15	300
T_6	Novaluron 5.25% + Indoxacarb 4.5% SC	85.32	875
T_7	Untreated control (Water only)	—	—

The observations on fruit borer incidence and their number were recorded one day before spraying as a pre-treatment count. The post-treatment count was taken at 3, 7, 10, and 14 days after each spray. For recording the pest population counts, 5 plants were selected randomly and tagged in each plot. The data on mortality was recorded, based on the dead larvae of third, fourth, and fifth instars. All the counts were taken during morning hours. The data on fruit damage was taken during different harvest intervals for respective treatments by counting the number of healthy and damaged fruits and the mean per cent fruit damage was calculated.

Statistical analysis. The per cent reduction in population was calculated at different days after each spray. The data obtained were subjected to suitable transformations and analyzed statistically by applying RCBD as suggested by Gomez and Gomez (1984). The per cent reduction of larval population in all the treatments over control was calculated by using Henderson Tilton's formula (Henderson and Tilton 1955) as under:

$$\%\ \text{Reduction in population over control} = 100\left\{1 - \frac{(T_a \times C_b)}{(T_b \times C_a)}\right\}$$

Where,

T_a = Number of insects after treatment

T_b = Number of insects before treatment

C_a = Number of insects in untreated check after treatment

C_b = Number of insects in untreated check before treatment.

Total and damaged fruits were also recorded and the per cent damage was calculated by using the following formula.

$$\text{Percent fruit damage} = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

Fruit Yield and Economic Analysis. Total tomato fruit yield was recorded at different harvests and computed on a hectare basis. The fruit yield data recorded from each treatment was subjected to suitable statistical transformations prior to statistical analysis. The total cost of cultivation was calculated by adding the common input cost of cultivation including treatment costs and labour charges. The gross return per treatment was computed by multiplying the total yield per hectare by the prevailing market price. While net returns for each treatment were realized by subtracting the total cost from gross returns. Each treatment's benefit-cost ratio was derived by dividing gross returns from total cost (Shabozoi *et al.*, 2011).

RESULTS AND DISCUSSION

Reduction of larval population after the first spray. The data recorded a day before spray revealed that, the population of fruit borer was uniformly distributed in the field and ranged from 0.87 to 2.73 larvae per 5 plants (Table 1). There was a significant reduction in the population of larvae after the application of different insecticidal treatments. On three days after the first spray, the treatment Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC @ 102 g a.i./ha (T_3) recorded 0.53 larvae per 5 plants and was on par with the treatment T_2 (Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC @ 90 g a.i./ha), which recorded 0.60 larvae per 5 plants. While untreated control recorded 3.47 larvae per 5 plants. Seven days after the first spray, the higher dosage of Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 102 g a.i./ha (T_3) recorded 0.87 larvae per 5 plants, which was at par with Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 90 g a.i./ha (T_2), which recorded 0.93 larvae per 5 plants while untreated control (T_7) recorded 3.67 larvae per 5 plants.

Reduction of larval population after the second spray. After the second spray, a similar trend was noticed in the reduction of the larval population due to different treatments. On three days after treatment Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC @ 102 g a.i./ha (T_3) recorded 0.53 larva per 5 plants and it was on par with Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC @ 90 g a.i./ha (T_2), which recorded 0.80 larvae per 5 plants while untreated control (T_7) recorded 4.13 larvae per 5 plants. In untreated control (T_7) maximum larval population of 3.93 larvae per 5 plants was noticed at 14 days after the second spray while, Novaluron 9.45% + Lambdacyhalothrin 1.9 ZC @ 102 g a.i./ha (T_3) and @90 g a i/ha (T_2) recorded 0.33 and 0.40 larval populations respectively (Table 1).

Pooled data (Table 1) of two sprays reveals that, the treatment Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC @ 102 g a.i./ha (T_3) recorded 0.68 larvae per 5 plants with an 82.35 per cent reduction in population over control and it was on par with Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 90 g a.i./ha (T_2), which recorded 0.81 larvae per 5 plants with a 78.97 per cent reduction in population over control. While untreated control (T_7) recorded 3.83 larvae per 5 plants.

Reduction of fruit damage. The per cent of fruit borer damage was ranging from 42.73 to 57.29 before the treatment. The data on fruit damage per cent at the different intervals of harvesting after the treatments revealed that, all the treatments were found superior with less fruit damage compared to the control plot. Novaluron 9.45% + Lambdacyhalothrin 1.9% ZC @ 102 g a.i./ha (T_3) recorded 4.67 per cent fruit damage which was on par with Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 90 g a.i./ha (T_2), which recorded 5.60 per cent fruit damage. Among the chemical treatments Novaluron 10% EC @ 75 g a.i. /ha (T_4) recorded maximum fruit damage of 17.73 per cent. Untreated control (T_7) recorded 19.33 per cent fruit damage (Table 2).

The bio-efficacy of Novaluron and lambda-cyhalothrin against fruit borer was studied separately and in combination with other insecticides by several workers but very little study has been conducted on the combination product of Novaluron and lambda cyhalothrin. So, similar studies conducted to evaluate the bioefficacy of Novaluron and lambda cyhalothrin have been discussed here to support the present study. The results of the present study showed 82.35, 78.97, 71.71, per cent reduction in the larval population of fruit borer after two foliar applications of Novaluron + lambda cyhalothrin @ 102 g a.i./ha, Novaluron + lambda cyhalothrin @ 90 g a.i./ha, Novaluron + lambda cyhalothrin @ 78 g a.i./ha respectively which is in closer proximity with the findings of Ghosal *et al.*, (2015), who reported 95.64, 79.82 and 79.49 per cent larval reduction over control in fruit borer population after three application of Novaluron 5.25% + Indoxacarb 4.5% SC @ 875 ml/ha, Novaluron @ 750 ml/ha, and lambda-cyhalothrin 5% EC @ 400 ml/ha, respectively in the first season (2011). In the second season (2012), reduction in larval population was 96.12, 80.71 and 80.38 % in plots treated with Novaluron 5.25% + Indoxacarb 4.5% SC @ 875 ml/ha, Novaluron @ 750 ml/ha and lambda cyhalothrin 5% EC @ 400 ml/ha, respectively. The results of the present investigation confirm the observations of Kumar *et al.*, (2003) who reported Novaluron alone @ 0.75 ml/l providing 90 per cent mortality of diamondback moth larvae while all the combinations at full doses provided the highest (100%) mortality, whereas Novaluron + *Bt.k* (0.375 ml + 1 g/l) which is a half doses combination also gave 100 per cent mortality. Saini *et al.*, (2013) reported that Novaluron @ 18.75, 37.50, and 75 g a.i./ha was found significantly superior against *H. armigera* as compared to the standard check, quinalphos (525 g a.i/ha) concerning pod damage and grain yield in chickpea. Novaluron 10 EC @ 200 g a.i/ha reduced the population of spotted pod borer, *Maruca vitrata* up to 70 per cent with less than 17 per cent pod damage (Mahalakshmi *et al*, 2013). The present experimental findings are also supported by the results of Yogeeswarudu and Venkata (2014), who reported 87.12 to 94.38 and 87.12 to 90.83 per cent reduction over control in a larval population of gram pod borer, *H. armigera* in chickpea after two applications of Novaluron 10 EC @ 1.5 ml/l and lambda cyhalothrin 5 EC 1 ml/l, respectively. Lal and Jat (2016) reported minimum (7.3%) pod damage in chickpeas following the application of Novaluron 10 EC @ 375 ml/ha plus 2 per cent urea. Vinit Kumar (2019) also reported similar findings. Raghavendra *et al*. (2022) reported that Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC @ 90 g. a.i./ha treatment was found to be the most effective dose in reducing the population of *Helicoverpa armigera* in tomatoes.

Fruit Yield and economic analysis. Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC @ 102g a.i./ha (T_3) recorded 276.00 q/ha fruit yield with a 50.82 per cent increase in yield over control and it was on par with Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC @ 90 g a.i./ha (T_2), which recorded 273.00 qt/ha fruit yield with a 49.18 per cent increase in yield over control.

Novaluron 10% EC @ 75 g. a.i./ha (T_4) recorded 210.00 q/ha fruit yield with a 14.75 per cent increase in yield over control. Untreated control recorded the lowest fruit yield of 183.00 q/ha. The treatment Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC @ 90 g a.i/ha (T_2) was sufficient for the management of tomato fruit borer. Further, the treatment Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC @ 90g a.i/ha recorded maximum cost: benefit ratio (1:5.36) followed by Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 102g a.i./ha (1:5.40) (Table 4). Manu *et al.* (2014) reported that the highest benefit-cost ratio was obtained from lambda cyhalothrin 5 EC @ 0.5 ml/l (4.95) followed by Indoxacarb 14.5 SC @ 0.5 ml/l (4.26). Raghavendra *et al*. (2022) reported that, the Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC @ 90g. a.i./ha treatment was found to be the most effective dose in reducing the population of *Helicoverpa armigera* (Hübner) and recorded higher fruit yield (49.44 t/ha) and maximum cost-benefit ratio (1.4.20).

Table 1: Bio-efficacy of combination product (Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC) against fruit borer, *Helicoverpa armigera* (Hubner) on tomato (Mean of two years).

Sr. No.	Treatment	Dose/ha		Mean No. of larvae per plant at different days after spray									Pooled mean	% reduction in Population over control
		gai/ha	Formulation ml/ ha	I Spray					II Spray					
				Before Spray	3	7	10	14	3	7	10	14		
T_1	Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC	78	650	1.27 (1.33)	1.00 (1.22)	1.33 (1.35)	1.60 (1.45)	1.27 (1.33)	1.20 (1.30)	1.13 (1.28)	1.07 (1.25)	1.00 (1.22)	1.09 (1.30)	71.71
T_2	Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC	90	750	0.93 (1.20)	0.60 (1.05)	0.93 (1.20)	1.33 (1.35)	0.93 (1.20)	0.80 (1.14)	0.73 (1.11)	0.53 (1.02)	0.40 (0.95)	0.81 (1.13)	78.97
T_3	Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC	102	850	0.87 (1.17)	0.53 (1.02)	0.87 (1.17)	1.27 (1.33)	0.87 (1.17)	0.53 (1.02)	0.47 (0.98)	0.40 (0.95)	0.33 (0.91)	0.68 (1.07)	82.35
T_4	Novaluron 10% EC	75	750	1.33 (1.35)	1.00 (1.22)	1.27 (1.33)	1.73 (1.49)	1.33 (1.35)	1.27 (1.33)	1.20 (1.30)	1.13 (1.28)	1.00 (1.22)	1.28 (1.32)	66.75
T_5	Lambda Cyhalothrin 5% EC	15	500	1.20 (1.30)	1.07 (1.25)	1.33 (1.35)	1.80 (1.52)	1.20 (1.30)	1.20 (1.30)	1.13 (1.28)	1.07 (1.25)	1.00 (1.22)	1.25 (1.31)	67.50
T_6	Novaluron 5.25% +Indoxacarb 4.5% SC	85.32	875	1.27 (1.33)	1.00 (1.22)	1.20 (1.30)	1.67 (1.47)	1.27 (1.33)	1.13 (1.28)	1.07 (1.25)	1.00 (1.22)	0.93 (1.20)	1.18 (1.28)	69.21
T_7	Untreated Control	-	-	2.73 (1.80)	3.47 (1.99)	3.67 (2.04)	3.87 (2.09)	2.73 (1.80)	4.13 (2.15)	4.33 (2.20)	4.20 (2.17)	3.93 (2.11)	3.83 (2.07)	-
S.Em.±				0.08	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.02	-	-
CD @ 5%				NS	0.10	0.14	0.09	0.09	0.08	0.09	0.11	0.06	-	-

*Figures in parentheses are √ x+0.50 transformed values, NS: Non-significant

Table 2: Bio-efficacy of combination product (Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC) against fruit borer, *Helicoverpa armigera* (Hubner) on tomato (Mean of two years).

Tr. No.	Treatments	Dose/ha		Per cent fruit damage (Picking wise)						Mean fruit damage (%)
		Dosage a.i./ha	Formulation ml/ha	DBS	I	II	III	IV	V	
T_1	Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC	78	650	52.34 (46.63)	12.67 (21.28)	12.00 (20.7)	11.33 (20.12)	10.67 (19.52)	10.00 (18.91)	11.33
T_2	Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC	90	750	42.73 (41.11)	7.33 (16.25)	6.67 (15.53)	5.33 (13.97)	4.67 (13.14)	4.00 (12.25)	5.60
T_3	Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC	102	850	44.38 (42.06)	6.00 (14.77)	5.33 (13.97)	4.67 (13.14)	4.00 (12.25)	3.33 (11.29)	4.67
T_4	Novaluron 10% EC	75	750	51.79 (46.31)	19.33 (26.44)	17.33 (24.98)	18.00 (25.47)	17.33 (24.98)	16.67 (24.48)	17.73
T_5	Lambda Cyhalothrin 5% EC	15	300	42.81 (41.16)	16.00 (23.97)	15.33 (23.45)	16.67 (24.48)	16.00 (23.97)	14.67 (22.92)	15.73
T_6	Novaluron 5.25% +Indoxacarb 4.5% SC	85.32	875	52.58 (46.77)	9.33 (18.27)	8.33 (17.29)	8.67 (17.63)	8.00 (16.95)	7.33 (16.25)	8.33
T_7	Untreated Control	-	-	57.29 (49.48)	18.67 (25.97)	20.00 (26.92)	20.67 (27.39)	19.33 (26.44)	18.00 (25.47)	19.33
S.Em±				-	1.91	2.48	0.99	1.00	1.22	-
CD@5%				NS	5.88	7.63	3.06	3.07	3.76	-

DBS-Day before spray; *Figures in parentheses are √ x+0.50 transformed values, NS: Non-significant

Table 3: Bio-efficacy of combination product (Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC) against fruit borer, *Helicoverpa armigera* (Hubner) on tomato (Mean of two years).

Tr. No.	Treatments	Dose/ha		Fruit yield (Picking wise) (kg/Plot)						Fruit Yield (qt/ha)	% Increase in yield over control
		Dosage/ha	Formulation ml/ha	I	II	III	IV	V	Mean		
T_1	Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC	78	650	69.25 (7.92)	46.25 (8.35)	53.25 (6.84)	62.11 (7.33)	69.25 (7.92)	58.62	234.00 (15.31)	27.87
T_2	Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC	90	750	73.25 (8.29)	65.11 (8.59)	68.1 1(8.1)	67.12 (8.28)	73.25 (8.29)	68.36	273.00 (16.54)	49.18
T_3	Novaluron 9.45% + Lambda cyhalothrin 1.9% ZC	102	850	72.89 (8.66)	63.10 (8.57)	69.45 (7.97)	65.11 (8.36)	69.00 (8.1)	69.00	276.00 (16.63)	50.82
T_4	Novaluron 10% EC	75	750	53.2 5(7.6)	45.25 (7.33)	51.23 (6.76)	56.25 (7.19)	53.25 (7.6)	52.66	210.00 (14.51)	14.75
T_5	Lambda Cyhalothrin 5% EC	15	300	59.58 (7.62)	55.25 (7.75)	50.25 (7.47)	49.25 (7.12)	59.58 (7.62)	54.38	217.00 (14.75)	18.58
T_6	Novaluron 5.25% +Indoxacarb 4.5% SC	85.32	875	68.25 (8.1)	60.21 (8.29)	56.24 (7.79)	52.25 (7.53)	68.25 (8.1)	60.41	241.00 (15.54)	31.69
T_7	Untreated Control	-	-	48.25 (7.66)	44.58 (6.98)	40.25 (6.71)	38.25 (6.38)	48.25 (7.66)	45.92	183.00 (13.55)	-
S.Em±				6.06	4.67	4.29	8.54	6.31	-	-	-
CD@5%				18.68	14.40	13.22	26.32	19.43	-	-	-

Table 4. Cost economics of GPI 1316 (Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC) in tomato.

Sr. No.	Treatment	Formulation dose (ml /ha)	MRP (Rs/ lit)	Cost of chemical (2 sprays)	Cost of chemical + labor charges	Cost of treatment + Cost of cultivation	Tomato yield (qt/ha)	Grass Return in yield (Rs/ha)	Net Benefit (Rs/ha)	Cost: Benefit ratio
T_1	Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC	650	975	1267.50	6267.50	76267.50	234	351000	274732.50	1:4.60
T_2	Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC	750	975	1462.50	6462.50	76462.50	273	409500	333037.50	1:5.36
T_3	Novaluron 9.45% +Lambda cyhalothrin 1.9% ZC	850	975	1657.50	6657.50	76657.50	276	414000	337342.50	1:5.40
T_4	Novaluron 10% EC	750	3700	5550	8375	78375	210	315000	236625	1:4.02
T_5	Lambda Cyhalothrin 5% EC	300	770	462	5480	75480	217	325500	250020	1:4.31
T_6	Novaluron 5.25% EC+ Indoxacarb 4.5%SC	875	2200	3850	8850	78850	241	361500	282650	1:4.58
T_7	Untreated Control	-	-	-	-	70000	183	274500	204500	1:3.92

Note: GPI 1316: Rs 975/liter: Novaluron 10% EC: 3700/Liter: Lambda Cyhalothrin 5% EC:770/Liter: Novaluron 5.25% EC+ Indoxacarb 4.5%SC: 2200/Liter: Market price of tomato: Rs 1500/qt: Labour charges = Rs 5000/ha for 2 sprays;

CONCLUSIONS

Novaluron 9.45% + Lambda-cyhalothrin 1.9% ZC @ 90 g a.i./ha treatment was found to be the most effective dose in reducing the population of *H. armigera* and recorded higher fruit yield and maximum cost-benefit ratio.

FUTURE SCOPE

The scope of the study was to encompass combination of pesticides use in production system determine what type of chemical products are the most appropriate tools for ecologically based pest management. Identify the circumstances under which combination of chemical pesticides may be required in future pest management. Explore the most promising opportunities to increase benefits and reduce health and environmental risks of pesticides use.

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Conflict of Interest. None.

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