Efficacy and economics of certain insecticides and neem oil against tomato fruit borer, *Helicoverpa armigera* (Hubner) on tomato

Article type: *Original Research Article*

ABSTRACT

A field trail was carried out at P. Kothapalli village in Ananthpur District, Andhra Pradesh, India, in Randomised Block Design, each replicated thrice during the kharif season of 2021. Two applications were used against Helicoverpa armigera (Hubner) and the results revealed that the highest incremental per cent reduction of larvae was recorded in the plot treated with T6 Indoxacarb 14.5% SC (48.47) which was at par with T4 Spinosad 45%SC (42.24), T2 Emamectin benzoate 5%SG (33.7), T3 Chlorantranilprole 18.5%SC (33.17), T1 Flubendamide 480 %SC (30.89), T7 Fipronil 5%SC (29.42) and T5 Neem oil 4% (25.06) is found to be least affective than all other treatments. Cost benefit ratio were found highest in Indoxacarb 14.5% SC (1:12.6), followed by Spinosad (1:11.7), Emamectin benzoate 5% SG (1:9.85), Chlorantranilprole 18.5%SC (1:9.82) Flubendiamide 480 SC (1:8.7), Fipronil 5% SC (1:6.7), Neem oil 0.03% EC (1:7.9) as compared to control T0 (1:5.06).

Keyword: Benefit Cost ratio, Helicoverpa armigera, Tomato fruit borer

INTRODUCTION

“Tomato (Lycopersicon esculentum Mill) is one of the most important vegetables in the world, ranking second in importance to potato in many countries. It is a warm season crop and native to Peru and Mexico. It is grown as an off-season vegetable in the hills of India and farmers fetch a good income after sending their produce to the plains from June to

September. It is popularly known as Wolf apple, Love of apple or Vilaayati baingan". **(Choudhary, 2002)**[3]. "It ranks the third largest vegetable crop after potato and sweet potato, but it tops the list of canned vegetables. It can be used freshly in salads, curries or in bi-products like chutney, pickle, soups, ketchup, sauce, powder, purees and as a whole etc" **(Patil *et al*., 2018)**[15]**.** "In terms of nutrition, the tomato contains double the amount of nutritive elements compared to the apple. It is the cheapest source of vitamins (A, B and C), minerals like calcium and proteins which the majority of people can buy easily" **(Bose and Som, 1990; Pedro and Ferreira, 2007)**[2]**.** "Lycopene in ripe tomatoes is a potential antioxidant which reduces the risk of prostate cancer in humans. Regular consumption of tomatoes can prevent short sightedness, night blindness, and other eye diseases. It is also helpful in preventing joint pain problems and respiratory disorders as well" **(Friedman, 2013).**[5]

Globally, India ranks second in tomato production after China. The area under cultivation of vegetables was 10383 thousand hectares with production of 179692 thousand metric tons during 2020 - 21. In India, tomatoes were grown in an area of 865.29 million hectares with production of 21055.85 million tonnes during 2020 - 21. Around 11% of the total world produce of tomatoes is cultivated in India. Madhya Pradesh ranks first followed by Tamil Nadu and Andhra Pradesh. **(Department of Agriculture and Farmers welfare)**

"The major insect pests are the fruit borer, Helicoverpa armigera (Hubner); whitefly, Bemisia tabaci (Gen); jassids, Amrasca devastans (Ishida); leaf miner, Liriomyza trifolii (Blanchard); potato aphid, Myzus persicae (Thomas) and hadda beetle, Epilachana dedecastigma (Widemann). In India, the fruit borer is one of the major pests of tomatoes, limiting production and the market value of crop produce. The fruit borer, Helicoverpa armigera (Hubner) is the most destructive pest of tomato, which is commonly known as the gram pod borer, American bollworm and fruit borer" **(Meena and Raju, 2014)**[12]**.**

"Young larvae feed voraciously on foliage, flower buds and flowers, while the later instars of these insects bore into fruit and render them unmerchandable. Due to wider host range, multiple generations, migratory behavior, high fecundity and existing insecticide resistance, the insect has become a difficult pest to handle" [24].

"The problem of pests is magnified due to its direct attack on fruiting structure, voracious feeding habits, high mobility, fecundity and multivoltine overlapping generations.

Losses solely due to this pest up to Rs. 10,000 million have been reported in various crops like chickpea, cotton, pigeonpea, groundnut, tomato and other crops of economic importance. Tomatoes being a commercial vegetable crop, farmers have a tendency to overuse and even abuse insecticide in an over-ambitious approach to knocking down this destructive pest” [24]. “As a result, it has caused turbulence in the Agri-ecosystem. It has led to many problems like buildup of insecticide resistance, pest resurgence, reduction or killing of natural enemies and insecticide residue in the tomato fruit. In such situations, newer groups of insecticides and biological insecticides offer great scope as they maintain higher toxicity to insects at lower doses and are not persistent like conventional groups of insecticides” [24]. “Several new groups of insecticides like Indoxacarb, Fipronil, Spinosad belonging to a novel class of insecticides have been introduced which have a unique chemical structure and have been reported to be effective against insect pests of many crops. These are also reported to be safe from natural enemies and the environment. In order to avoid the adverse consequences of traditional insecticides on non-target organisms, environmental pollution, health hazard and development of resistance, it has become necessary to evaluate the new insecticides which are not only safe to natural enemies and the environment but also effective at very low doses” [24].

MATERIALS AND METHODS

The Field experiment was conducted during the kharif season of 2021 at Kothapalli village in Ananthpur District, Andhra Pradesh, India, in Randomised Block Design, each replicated thrice. The experiment was laid out in RBD with 8 treatments comprising of Flubendamide 480 %SC (100 ml/lit), Emamectin benzoate 5%SG (0.4 g/lit), Chlorantraniliprole 18.5%SC (0.4 ml/lit), Spinosad 45%SC (0.3 ml/lit), Neem oil 4% EC (40ml/lit), Indoxacarb 14.5%SC (0.65 ml/lit), Fipronil 5%SC (1.5 ml/lit) and untreated control. All the treatments were randomly distributed among the plots and replicated three times. Observations were recorded on healthy and infected fruits on 5 randomly selected plants in each plot. The incidence of pests was recorded one day before the spray as pre-treatment observations taken on the first observation were recorded before the spray of each plot and 3,7 and 14 after each spray. After last picking, the total of all pickings of individual plots produced was calculated to work out the yield of the treatments. Yields of healthy fruit were converted into quintals per hectre. As the experiment was conducted in fruit terms, the economics of the treatments were calculated in terms of cost benefit ratio.

Percent reduction by fruit borer

The total number of infested and healthy plants at fruiting stage were counted from selected five plants of each plot. Thus the larva was calculated using the formula:

$$\text{Per centage reduction} = \frac{\text{Control- Treatment}}{\text{Control}} \text{X100}$$

Benefit cost ratio

Gross returns was calculated by multiplying total yield with the market price of the produce. Cost of cultivation and cost of treatment imposition was deducted from the gross returns, to find out net returns and cost benefit ratio by the following formula:

$$\text{Benefit cost ratio} = \frac{\text{Gross return}}{\text{Total cost}}$$

RESULTS AND DISCUSSION

The present study entitled, **"Efficacy and economics of certain insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner)".** The data so obtained through observation on various aspects were subjected to statistical analysis wherever necessary and the compiled mean data are tabulated in the following pages.

The data on the per cent population reduction of fruit borer on mean after first spray revealed that all treatments were significantly superior over control. Among all the treatments, The highest per cent population reduction of fruit borer was recorded in Indoxacarb 14.5 %SC (67.85) followed by, Spinosad 45% SC (65.71), Chlorantraniliprole 18.5% SC (58.52), Emamectin benzoate 5% SG (51.85) Fipronil 5%SC (50.07) Flubendiamide 480% SC (44.5) and Neem oil 4 % EC (40.48) was found to be least effective than all the treatments and is significantly superior over the control.

The data on the per cent population reduction of fruit borer on mean after second spray revealed that all treatments were significantly superior over control. Among all the treatments, The highest per cent population reduction of fruit borer was recorded in Indoxacarb 14.5% SC (48.58) followed by Spinosad 45% SC (42.4), Emamectin benzoate 5% SG (33.72), Chlorantraniliprole 18.5%SC (32.77) Flubendamide 480 %SC (31.04), Fipronil 5% SC (29.95), and Neem oil 4% (25.22) was found to be least effective than all the treatments and is significantly superior over the control.

The overall data on the per cent population reduction of fruit borer on overall mean of first and second spray revealed that all treatments were significantly superior over control. Among all the treatments highest per cent population reduction of fruit borer was recorded in Indoxacarb 14.5% SC (58.21) followed by Spinosad 45% SC (54.05), Chlorantraniliprole 18.5%SC (45.64), Emamectin benzoate 5% SG (42.78), Fipronil 5% SC (40.01), Flubendamide 480 %SC (37.77), and Neem oil 4% (32.85) was found to be least effective than all the treatments and is significantly superior over the control.

All the treatments were found to be significantly superior to control in reducing fruit infestation. The maximum larval population reduction were recorded in Indoxacarb . The results were similar to be findings reported by **Reddy *et al.*, (2021)[16], Singh *et al.*, (2017)[21], Wajid *et al.*, (2016)[23]** spinosad found to be next best. The results of spinosad were supported by **Islam *et al.*, (2020)[7], Meena *et al.*, (2014)[12], Sushma *et al.*, (2016)[22], Sharma and Kumar *et al.*, (2020)[20].**

Emamectin benzoate found to be next best effective treatment. These results were similar finding of **Khademul *et al.*, (2020)[9]**, **Kumar *et al.*, (2015)[11].** Chlorantraniliprole found to be next best effective treatment. These results were similar finding of **Reddy *et al.*, (2019)[17], Patil *et al.*, (2018)[15], Sapkal *et al.*, (2018)[18].** Flubendiamide found to be next effective treatment and its results are supported by **Jat *et al.*, (2013)[8], Kubendran *et al.*,(2008)[10]** and **Deshmukh *et al.*,(2010)[4].** Fipronil are found to be effective treatments and the results were similar to findings reported by **Ghosal *et al.*, (2016)[6]**, **Satish *et al.*, (2018)[19]** and **Meena *et al.*, (2014)[12].** Neem oil found to be effective in reducing the larval population and the results were supported by **Bhati *et al.*, (2020)[1].**

Higher yield (226q/ha) and higher cost benefit ratio (1:11.6) was obtained from Spinosad and lowest in control plot (100q/ha). Similar findings made by **Nitharwal *et al.*, (2017)**[13], recorded the highest cost benefit ratio. **Pal *et al.*, (2018)**[14] who reported that the Indoxacarb is the best and most economical treatment recorded (220q/ha) and cost benefit ratio (1:10.6). **Khademul *et al.*, (2020)**[9] reported cost highest grain yield was recorded in Emamectin benzoate and cost effectiveness of Emamectin benzoate was also very high and very favorable with incremental benefit ratio. **Sapkal *et al.*, (2018)**[18] reported that cost effectiveness of clorantranpriole was high with cost benefit ratio. Recorded yield (200q/ha) and cost benefit ratio (1:9.03).

Table 1. Effect of certain insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner)

Treatment		Before spray (Average mean of larva/5 plants)	Per cent reduction of larvae of *H. armigera* / 5 Plants				Per cent reduction of larvae of *H. armigera* / 5 Plants				Overall Mean
			First Spray				Second Spray				
			3rd DAS	7th DAS	14th DAS	Mean	3rd DAS	7th DAS	14th DAS	Mean	
T_1	Flubendamide 480 %SC	3.33	53.59	41.04	38.87	44.5	36.56	28.83	27.75	31.04	37.77
T_2	Emamectin benzoate 5%SG	3.06	59.28	46.29	49.98	51.85	39.45	31.54	30.19	33.72	42.78
T_3	Chlorantranilprole 18.5%SC	3.46	67.22	58.22	50.14	58.52	36.41	31.67	30.24	30.24	45.64
T_4	Spinosad 45%SC	3	77.29	61.44	58.42	65.71	47.18	38.92	41.10	42.40	54.05
T_5	Neem oil 4%	3.33	45.72	37.21	38.53	40.48	30.48	22.96	22.23	25.22	32.85
T_6	Indoxacarb 14.5%C	3	75.2	65.05	63.31	67.85	53.24	44.66	47.84	48.58	58.21
T_7	Fipronil 5%SC	3.26	55.45	48.14	46.64	50.07	34.97	25.86	29.03	29.95	40.01
T_0	Control	3.2	0	0	0	0	0	0	0	0	0
	F-test	**NS**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
	C.D. at 5%	**NS**	**7.632**	**8.373**	**8.526**	**6.033**	**0.237**	**0.254**	**0.332**	**0.232**	**16.008**
	S.Ed. (+)	**0.243**	**34.56**	**29.07**	**27.51**	**30.27**	**22.36**	**18.80**	**19.93**	**20.30**	**19.95**

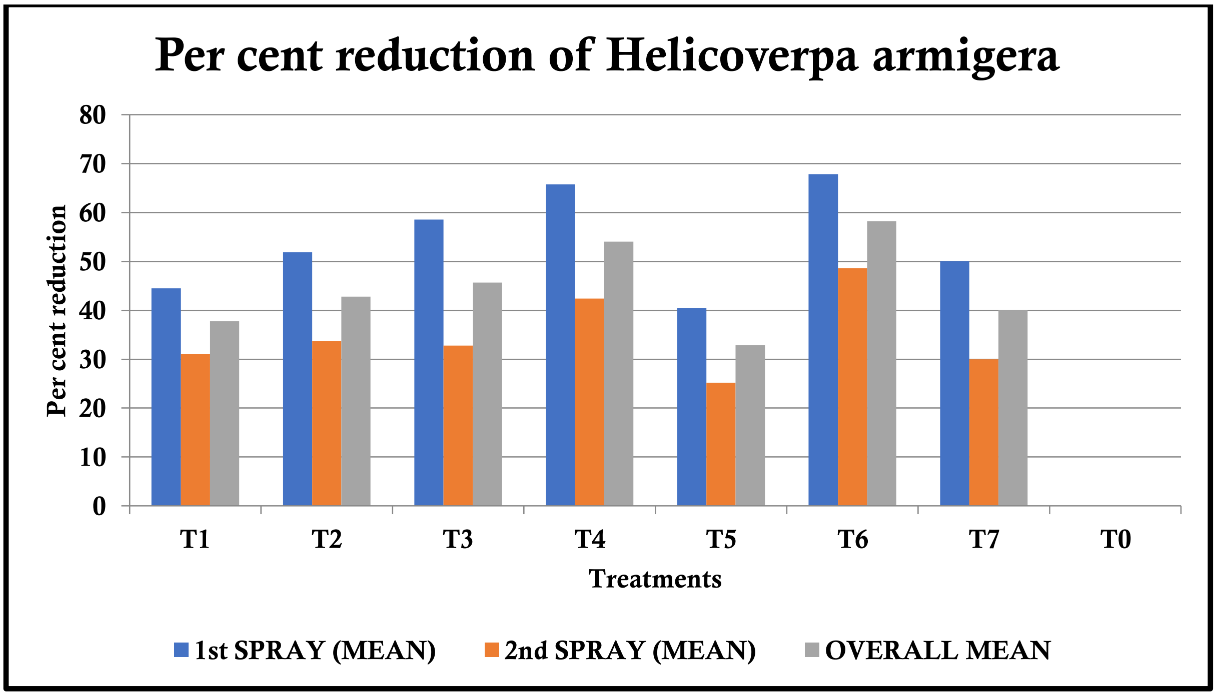
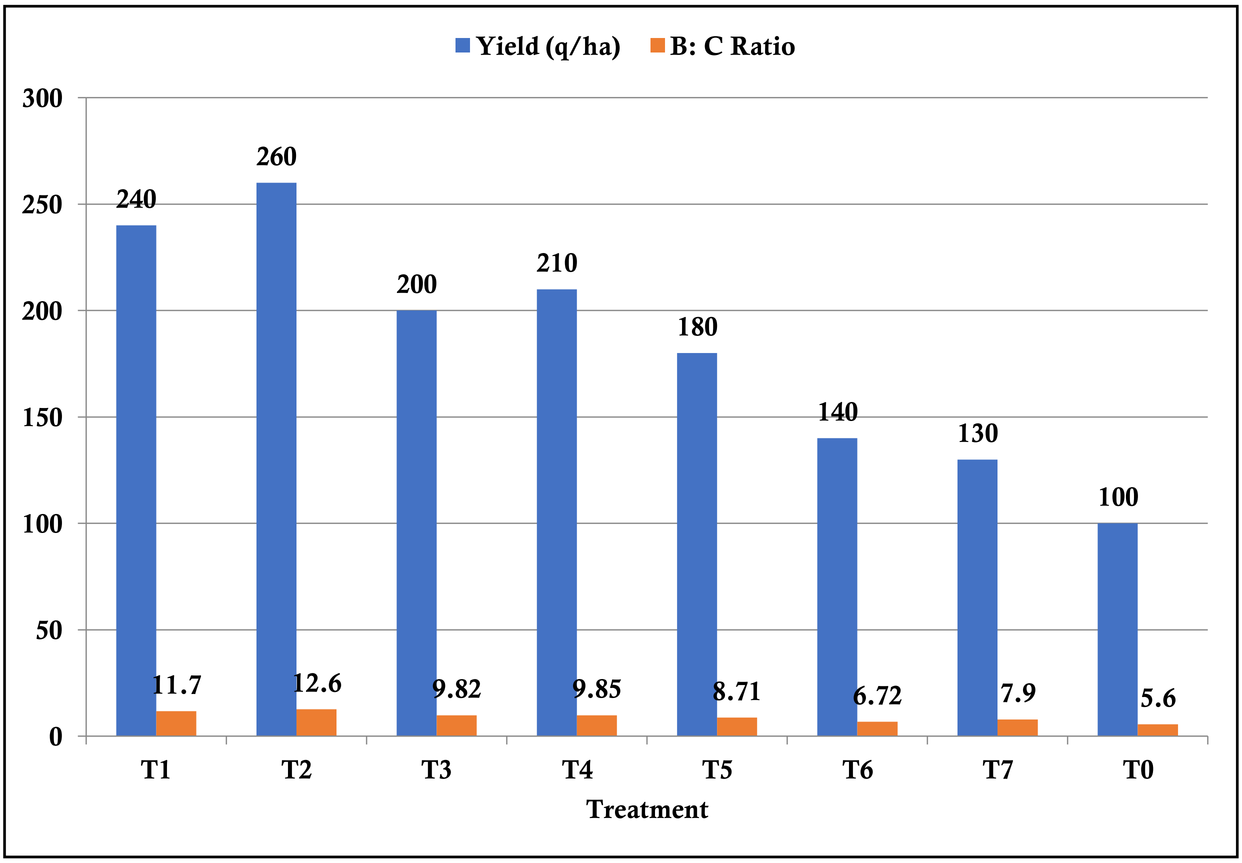


Fig 1: Effect of certain insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner) (Over all mean)

Table: 2. Economics and benefit cost ratio.

Treatments	Yield (q/ha)	Selling price (Rs/q)	Gross return (Rs)	Total cost of cultivation (Rs)	Net return (Rs)	B: C Ratio
Spinosad 45%SC	240 q/ha	2000	480000	40689	439311	1:11.7
Indoxacarb 14.5% SC	260q/ha	2000	520000	41051	478949	1:12.6
Chlorantranilprole 18.5%SC	200q/ha	2000	400000	40701	359299	1:9.82
Emamectin benzoate 5%SG	210q/ha	2000	420000	42636	377364	1:9.85
Flubendamide 480 %SC	180 q/ha	2000	360000	41301	318699	1:8.71
Fipronil 5%SC	140 q/ha	2000	280000	41651	238349	1:6.72
Neem oil 4%	130 q/ha	2500	325000	40801	284199	1:7.9
Control	100 q/ha	2000	200000	39451	160549	1:5.6

Fig 2: Yield and Benefit cost ratio



Economics of various Treatments: -

Higher cost benefit ratio (1:12.6) was obtained from Indoxacarb and lowest in control plot (100q/ha). Similar findings made by **Nitharwal *et al.*, (2017)**, recorded the highest cost benefit ratio. **Pal *et al.*, (2018)** who reported that the Spinosad is the best and most economical treatment recorded (210q/ha) and cost benefit ratio (1:9.85). **Khademul *et al.*, (2020)** reported cost highest grain yield was recorded in Emamectin benzoate and cost effectiveness of Emamectin benzoate was also very high and very favorable with incremental benefit ratio. **Sapkal *et al.*, (2018)** reported that cost effectiveness of chlorantraniliprole was high with cost benefit ratio. Recorded yield (200q/ha) and cost benefit ratio (1:9.82).

Conclusion :

Results showed that among all the treatments highest per cent population reduction of fruit borer was recorded in T_6 Indoxacarb 14.5% SC (58.21) which was significantly superior over the control followed by T_4 Spinosad 45% SC (54.05) and T_3 Chlorantraniliprole 18.5%SC (45.64) was least effective treatment against gram pod borer with highest mean larval population 2.25 of *Helicoverpa armigera* due to their mode of action compare to other selected Insecticides and Neem product.

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