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Field efficacy of different chemicals against shoot and fruit borer [*Earias vittella* (Fabricius)] of okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract
The present study was carried out at Central Research Field, Prayagraj, Uttar Pradesh during August to November of 2021, the study entitled, "Field efficacy of different chemicals against shoot and fruit borer [*Earias vittella* (Fabricius)] of okra". Seven treatments were evaluated against *Earias vitella* i.e., T1 Flubendamid 20% WG. T2 Chlorantraniliprole 18.5% SC, T3 Indoxacarb 14.5 SC, T4 Spinosad 45% SC, T5 Emamectin benzoate 5% SG, T6 Fipronil 5% SC, T7 Neem Oil and untreated Control (T0) Were tested to compare the efficacy against *Earias vitella* and their influences on yield of okra. The best and most economical treatment was Spinosad 45% SC (1:9.3) which was par with Chlorantraniliprole 18.5% SC (1:8.2) and Indoxacarb 14.5 SC (1:8.1), Emamectin benzoate 5% SG (1:7.9), Flubendiamide 20%WG (1:7.6), Fipronil 5% SG (1:5.5), the least effective was Neem oil (1:5.3) as compared to control T0 (1:4.2). Among all the treatments T4 Spinosad 45% SC was found effective in controlling the shoot and fruit borer population followed by T2 Chlorantraniliprole 18.5% SC, T3 Indoxacarb 14.5 SC, T5 Emamectin benzoate 5% SG T1 Flubendamide 20% WG, T6 Fipronil 5% SC and T7 Neem oil is found to be least effective among all the treatments as compared to T0 control. The highest yield was noticed in Spinosad 45% SC (195.5q/ha) and the least with Neem oil (92.4q/ha).

Keywords: Benefit cost ratio, chemical, *Earias vittella*

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is an annual vegetable belonging to Malvaceae family; it is also known by different names *viz*., ladies finger, bhendi, bamia, okra or gumbo in different parts of the world. Okra is known as Queen of vegetables. Okra is a very useful plant. It is mainly cultivated for edible fruits but its other parts like leaves, flower petals, stems and roots are also being used as a food, bio-fuel and as a medicine in different parts of the world (Reddy *et al*., 2018) [13]. The total area and production under okra in the world is reported to be 1.26 million ha and 22.29 million tonnes, respectively. It is mainly grown in India, Nigeria, Sudan, Pakistan, Ghana, Egypt, Saudi Arabia, Mexico and Cameroon. India ranks first in okra production 5784.0 thousand tonnes (72% of total world production) having area of 1148.0 thousand hectares with an annual production of 6346 million tonnes and productivity of 11.9 million tonnes/ha. The crop is grown throughout India, Andhra Pradesh is the leading okra producing state which has production of around 1184.2 thousand tons from an area of 78.90 thousand ha, with a productivity of 15 tons / ha. It is followed by west Bengal (862.1 thousand tonnes from 74.00 thousand with 11.70 tonnes/ ha productivity. In Uttar Pradesh area, production and productivity of okra is 12.19 ha, 148.64 tonnes, 12.2 metric tons per hectare (National Horticulture Board 2018-19). Okra contains carbohydrate, proteins and vitamin c in large quantities [Water (%) 90, Energy (kcal) 38, Protein(g) 2.0, Fat (g) 0.1, Carbohydrate (g) 7.6, Fiber (g) 0.9, Ca (mg) 81, P (mg) 63, Fe (mg) 0.8, Na (mg) 8, K (mg) 303, Vitamin A (iU) m660, Thiamine (mg) 0.20, Riboflavin (mg) 0.06, Niacin (mg) 1.00, Ascorbic acid (mg) 21.1 and Vitamin B6 (mg) 0.22] (Pachole, 2017) [10]. One of the major constraints in okra cultivation is its susceptibility to a number of insect pests during the various phases of its growth. Though, okra shoot and fruit borer appeared to be the most serious inflicting 45-57.1% damage to fruits. The Okra shoot and fruit borer (*Earias vitella* F.) is one of the major destructive pests of okra. Okra shoot and fruit borer infestations typically accounted for a 48.97% loss in the okra pod yield. The Okra Shoot and Fruit borer larvae cause damage in the vegetative and reproductive phases of the okra. Larvae also bore into the flower buds and fruits in the reproductive stage, and feed on internal tissues. Therefore, the infested flower bud's drop-off and infested fruits become deformed in shape, which lowers their market value.

Okra shoot and fruit borer alone causes a damage of between 52.33% and 70.75%. (Md. Abdur, 2021).

Materials and Methods

The trial will be conducted during *kharif* season 2021 at Central Research Field, SHUATS, Naini, Prayagraj Uttar Pradesh, India in a randomized block design with 8 treatments replicated 3 time using of ABHAY variety. The alluvial soils of this geographical region in general are reported to be flat, well drained and moderately being less in available nitrogen and medium in available phosphorus and potash. The normal pH varies from 7.2 – 8.4. It has a plot size of 2m×2m at a spacing of 45cm × 30cm with a recommended package of practices excluding plant protection. The experiment was laid down in randomized block design (RBD) with three replications and 8 treatments using a variety ABHAY in a plot size of (2m ×2m) at a apacing of (45 ×30cm). The infestation and population of and fruit borer were recorded from five randomly selected plants from every plot. Two insecticidal sprays were applied at 15 days' interval starting from 45 days after sowing. The chemicals include Flubendiamide 20% WG (0.3gm), Chlorantranilip role 18.5SC(0.5ml), Indoxacarb 14.5SC(1.3ml/ha), Spinosad 45% SC (0.5ml), Emamectin benzoate 5% SG(0.45g/lt), Fipronil 5%SC(1ml/lt) and Neem oil (2ml/lt) along with the untreated control. The spraying was done after the population level reaching ltd ETL. The observations a was recorded one day before spray, 3rd, 7th, and 14th days after spraying. The assessment of the shoot damage was done by calculating the number of damaged shoots and total number of healthy shoots observed from five randomly selected plants per plot and expressed in percentage. The percent of fruit damage was assessed at each picking by counting the total number of affected fruits from each plot. The damage was calculated by using the formulae;

Percent shoot infestation

$$\text{Per cent shoot damage} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

Percent fruit infestation

$$\text{Per cent fruit damage} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

Cost Benefit Ratio

Gross return = Marketable Yield x Market price
Net return = Gross return – Total cost

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

(Choudhury. A.R *et al*., 2021)

Results and Discussion

The present study entitled "Field efficacy of different chemicals against shoot and fruit borer [*Earias vittella* (Fabricius)] of okra [*Abelmoschus esculentus* (L.) Moench]". Two applications of seven insecticides *viz*; Flubendiamide 20% WG (0.3gm/lit), Chlorantraniliprole 18.5SC, Indoxacarb 14.5 SC, Spinosad 45% SC, Emamectin benzoate 5% SG, Fipronil 5% SG and Neem oil were evaluated against shoot and fruit borer, Earias vittella. Minimum percent of shoot infestation, percent fruit infestation and B: C ratio were observed in Spinosad 45% SC (5.45) (1:9.3), Chlorantraniliprole 18.5SC (11.3), (1:8.2), Indoxacarb 14.5 SC (13.8) (1:8.11), Emamectin benzoate 5% SG (15.88) (1:7.9), Flubendiamide 20%WG (16.50) (1:7.6), Fipronil 5% SG (17.74) (1:5.5), Neem oil (19.23) (1:5.3) and untreated control (water spray) (26.03) (1:4.2).

Among the selected treatments, Spinosad 45% SC was found effective in controlling the shoot and fruit bore population which can be recommended for management of shoot and fruit borer on okra. The values obtained in the first and second spray are 5.28 and 5.63respectively. The results were similar to the findings reported by Pachole *et al.*, (2017) [10], Rajput and Tayde (2017) [11] and Sarkar *et al.*, (2015) [14]. The next effective treatment was Chlorantraniliprole 18.5SC in which the values obtained in first and second spray are 11.54 and 11.06 respectively. These findings were supported by Shrivastava *et al.*, (2017) [16]. The efficacy of Indoxacarb 14.5 SC in first and second spray are 13.86 and 13.74 respectively. These results are similar to the findings of Uma rao *et al.*, (2013) [17] and Wajid *et al.*, (2016) [18]. The next effective treatment Emamectin benzoate in first and second spray are 16.46 and 15.30 respectively. These results are similar to the findings of Bangar and Patel (2012) [1], Gadhiya *et al.*, (2014) [3] and Dash *et al.*, (2020) [20]. Flubendamid 20% WG was found to be next effective treatment and the values obtained in the first and second spray are 17.54 and 15.65 respectively. These findings were similar and supported by Rakshith *et al.*, (2017) [12] and Shirale *et al.*, (2012) [15]. This was followed by the next best treatment which is Fipronil 5% SG in which the efficacy values obtained 19.12 and 16.36 respectively which was supported by Gosalwad (2020) [44]. This was followed by next effective treatment Neem oil. These findings are supported by Kanchan *et al.*, (2013) [6]. Maximum cost benefit ratio (1:9.3) was obtained in spinosad 45% SC which was supported by Kumar *et al.*, (2017) [7] and Pachole *et al.*, (2017) [10] who reported that the Spinosad recorded the high yield. Cost benefit ratio of chlorantraniliprole was (1:8.2) and the results were supported by shirale *et al.*, (2012) [15]. The cost benefit ratio obtained in the treatment of Indoxacarb 14.5 SC (1:8.1) this was supported by Kumar *et al.*, (2017) [7] and Javed *et al.*, (2019) [5]. The cost benefit ratio obtained in the treatment of Emamectin benzoate (1:7.9) and Flubendamide (1:7.6) was supported by Dash *et al.*, (2020) [20] and Rakshith *et al.*, (2017) [12]. The cost benefit ratio of Fipronil (1:5.5) and Neem oil (1:5.3) which were supported by Naidu *et al.*, (2019) [9] and Kanchan *et al.*, (2013) [6].

The yield among the treatments was significant. The highest yield was recorded in Spinosad 45% SC (195.5q/ha) followed by Chlorantraniliprole 18.5SC (149.2q/ha), Indoxacarb 14.5 SC (140.2q/ha), Emamectin benzoate 5% SG (136.3q/ha), Flubendiamide 20%WG (133.2q/ha), Fipronil 5% SG (96.3q/ha) and Neem oil (92.4q/ha) as compared to T0 control (72.2q/ha). When the benefit cost ratio was worked out, interesting results was achieved. Among the treatment studied the best and most economical treatment was Spinosad 45% SC (1:9.3) followed by Chlorantraniliprole 18.5 SC (1:8.2), Indoxacarb 14.5 SC (1:8.11), Emamectin benzoate 5% SG (1:7.9), Flubendiamide 20%WG (1:7.6), Fipronil 5% SG (1:5.5) and Neem oil (1:5.3) as compared to control T0 (1:4.2).

Table 1: Tabular representation of evaluation of the field efficacy of different chemicals to control shoot and fruit borer (*Earias vitella*) of okra (First Spray): percent shoot infestation

Treatment		DBS	Percent infestation in number			
			3rd DAS	7th DAS	14th DAS	Mean
T1	Flubendiamide 20% WG	17.75	17.62	16.88	18.13	17.54
T2	Chlorantraniliprole 18.5% SC	16.47	11.73	10.47	12.16	11.45
T3	Indoxacarb 14.5 SC	17.26	13.27	12.92	15.39	13.86
T4	Spinosad 45% SC	16.02	4.06	3.81	7.9	5.28
T5	Emamectin benzoate 5% SG	19.48	16.44	15.39	17.56	16.46
T6	Fipronil 5%SC	20.24	19.32	18.31	19.74	19.12
T7	Neem oil 1500% PPM	20.02	19.40	18.63	21.21	19.74
T0	Control	20.54	23.93	25.79	27.41	25.71
	F-test	NS	S	S	S	S
	C.D.at 0.5%	6.05	2.60	1.75	1.53	1.96
	S.Ed. (+)	2.82	1.15	0.82	2.02	0.50

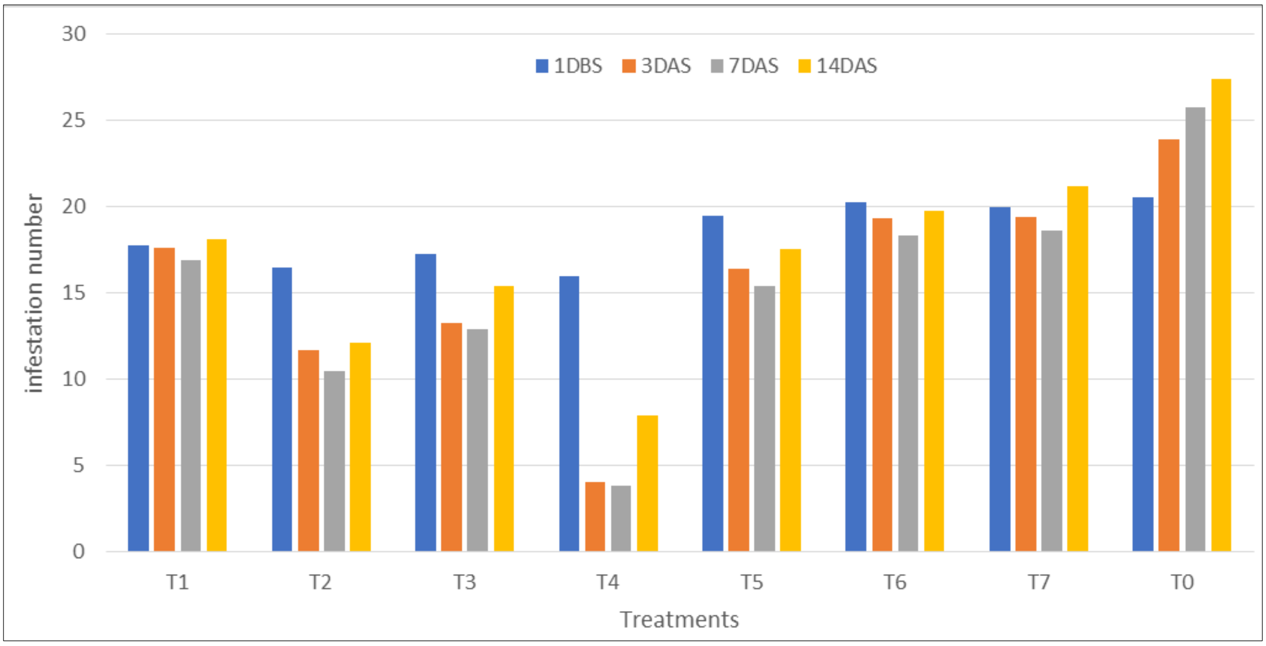

Fig 1: Graphical representation of field efficacy of different chemicals against shoot and fruit borer, *Earias vittella* (Fabricius) of okra (1st Spray)

Table 2: Table representation to evaluate the field efficacy of different chemicals to control shoot and fruit borer (*Earias vitella*) of okra (Second Spray): percent fruit infestation

Treatment		DBS	Percent infestation in number			
			3rd DAS	7th DAS	14th DAS	Mean
T1	Flubendiamide 20% WG	19.07	16.23	13.38	17.34	15.65
T2	Chlorantraniliprole 18.5%SC	19.07	12.50	7.76	12.93	11.06
T3	Indoxacarb 14.5 SC	16.08	14.10	12.30	14.83	13.74
T4	Spinosad 45% SC	13.76	5.39	3.75	7.76	5.63
T5	Emamectin benzoate 5% SG	17.26	15.89	13.35	16.67	15.30
T6	Fipronil 5%SC	19.48	16.70	13.98	18.42	16.36
T7	Neem oil 1500% PPM	20.24	18.87	17.90	19.43	18.73
T0	Control	21.21	23.14	26.38	29.58	26.36
	F-test	NS	S	S	S	S
	C.D.at 0.5%	5.73	1.94	0.83	1.93	1.56
	S.Ed. (+)	2.67	0.90	00.27	4.85	1.09

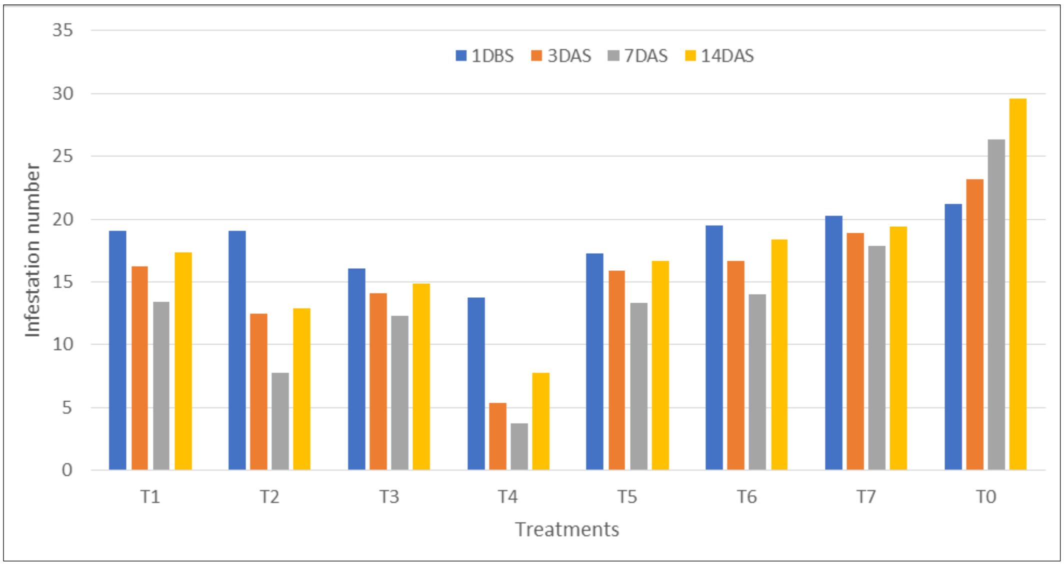

Fig 2: Graphical representation of field efficacy of different chemicals against shoot and fruit borer, *Earias vittella* (Fabricius) (2nd Spray)

Table 3: Table representation of field efficacy of different chemicals against shoot and fruit borer, *Earias vittella* (Fabricius) of okra (Yield q/ha)

Treatment		Yield (q/ ha)
T1	Flubendamid 20%WG	133.2
T2	Chlorantraniliprole 18.5% SC	149.2
T3	Indoxacarb 14.5 SC	140.2
T4	Spinosad 45% SC	195.5
T5	Emamectin benzoate 5% SG	136.3
T6	Fipronil 5%SC	96.3
T7	Neem oil1500% PPM	92.4
T0	Control	72.2

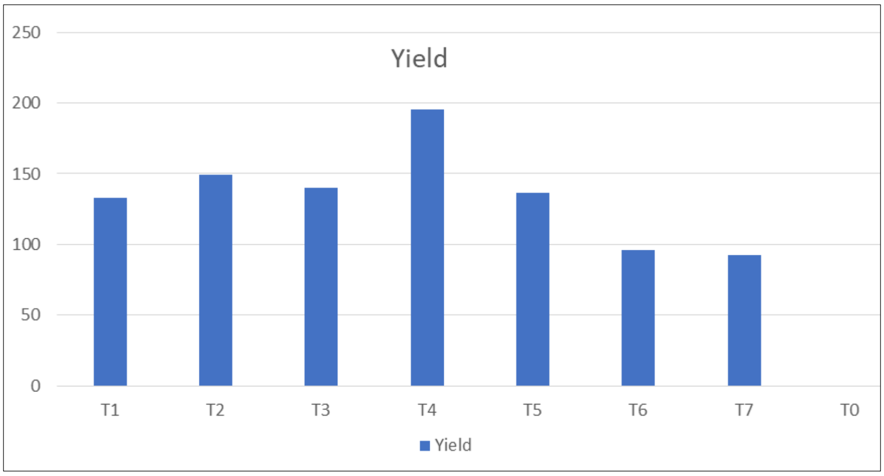

Fig 3: Graphical representation of field efficacy of different chemicals against shoot and fruit borer, *Earias vittella* (Fabricius) of Okra (Yield q/ha)

Table 4: Table representation of field efficacy of different chemicals against shoot and fruit borer [*Earias vittella* (Fabricius)] of okra on Economics and cost of benefit ratio of okra

Treatment Symbols	Yield (q/ha)	Selling price (RS/q)	Gross return (RS)	Total cost of cultivation (RS)	Net return (RS)	B:C Ratio
T1	133.2	2500	333000	43272	289728	1:7.6
T2	149.2	2500	373000	45078	327922	1:8.2
T3	140.2	2500	350500	43128	307372	1:8.1
T4	195.5	2500	488750	52228	436522	1:9.3
T5	136.3	2500	340750	43128	297622	1:7.9
T6	96.3	2500	240750	43328	197422	1:5.5
T7	92.4	2500	231000	43460	187540	1:5.3
T0	72.2	2500	180500	42728	137772	1:4.2

Conclusion

From the above discussion it was found that, spraying of insecticides significantly reduced the shoot and fruit borer percent infestation in okra. The present findings conclude that the new generation insecticides like T1 Flubendiamide 20%WG (0.3gm/lit), T2 Chlorantraniliprole 18.5SC (0.5ml/lit), T3 Indoxacarb 14.5 SC (500ml/ha), T4 Spinosad 45% SC (0.5ml/lit), T5 Emamectin benzoate 5% SG (0.45gm/lit), T6 Fipronil 5% SG (1ml/lit) T7 Neem oil 0.03% EC (2ml/lit) and untreated control plant T0 were found effective against shoot and fruit borer of okra *Earias vittella*. Further, it was observed that the cost benefit ratio was also high with T4 Spinosad 45% SC and T2 Chlorantraniliprole 18.5SC. Hence, it is suggested that the effective insecticides may be alternated in harmony with the existing Intergrated pest management programes in order to avoid the problems associated with insecticidal resistance, pest resurgence etc.

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