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To evaluate comparative efficacy of spinosad individual and in combination with botanicals against okra shoot and fruit borer *(Earias vitella* Fabricius)

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Abstract
To observe the comparative efficacy of spinosad individual and in combination with botanicals against okra shoot and fruit borer *(Earias vitella* Fabricius). In present study among all the treatments, minimum shoot infestation was recorded in treatment T_1- Spinosad @ 45 SC (4.42 %) and T_2- NSKE 5% + spinosad @ 45 SC.(4.55 %) which are most effective and significant to each other, and followed by T_4- Turmeric cured extract 3.5% + spinosad @ 45 SC (4.62 %), T_5 - Custard apple leaf extract + spinosad @ 45 SC (5.22 %), T_3- Karanj oil + spinosad @ 45 SC (5.42 %), T_7 -Garlic and chilli extract + spinosad @ 45 SC (5.49 %), T_6 - Neem oil + spinosad @ 45 SC (6.70 %) and minimum fruit infestation was recorded in treatment NSKE 5% + spinosad @ 45 SC (12.42 %), followed by Turmeric crude extract (3.5 %) + spinosad @ 45 SC (15.5 %), Karanj oil + spinosad @ 45 SC (17.03 %), T_1- spinosad@ 45 SC (17.17 %), Custard apple leaf extract + spinosad @ 45 SC (18.75 %), Garlic and chilli extract + spinosad @ 45 SC (18.97 %), Neem oil + spinosad @ 45 SC (19.9 %).

Keywords: Botanicals, *Earias vitella*, efficacy, okra

Introduction
Okra (*Abelmoschus esculentus* L.) belongs to family Malvaceae or Mallow, which is locally known as Bhendi and Lady's finger worldwide. Okra is considered a prized vegetable due to its high nutrient value 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) 660, Thiamine (mg) 0.20, Riboflavin (mg) 0.06, Niacin (mg) 1.00, Ascorbic acid (mg) 21.1 and Vitamin B6 (mg) 0.22] (Adeboye and Oputa, 1996) [1]. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malayasia, Brazil, Ghana, Ethiopia, Cyprus and the Southern United States. India ranks first in the world with 6.14 million tons (72% of the total world production) of okra produced from over 0.52 million hectare land with the productivity of 11.6 tons per hectare. In India, Andhra Pradesh is the leading okra producing state which has production of around 233.82 thousand tons from an area of 13.40 thousand ha, with the productivity of 17.45 ton/ ha.

Okra is grown for immature fruits, which are used as vegetables and mature fruits for seed purpose. The roots and stems of okra are used for clarification of sugarcane juice from which gur or brown sugar is prepared (Chauhan, 1972) [2]. Its ripe seeds are roasted, ground and used as a substitute for coffee in some countries. Mature fruits and stems containing crude fibre are used in the paper industry. Extracts from the seeds of the okra is an alternative source for edible oil. The greenish yellow edible oil has a pleasant taste and odour, and is high in unsaturated fats such as oleic acid and linoleic acid. The oil content of the seed is quite high at about 40%. Okra provides an important source of vitamins, calcium, potassium and other mineral matters which are often lacking in the diet in developing countries.

It is attacked by a number of insect pests during different stages of its growth, in this shoot and fruit borer, whitefly and jassids are the major constraints. There are about 13 major insect and non-insect pests species, which attack this crop at various stages of growth (Dhamdhere *et al.*, 1984) [3]. Among these okra shoot and fruit borer (OSFB), *Earias vittella* is the most serious pest which cause direct damage to tender shoots and fruits. It is reported that about 69% losses in marketable yield due to attack of this insect pest (Rawat and Sahu, 1973) [4].

Conventionally farmers are using various types of synthetic chemical insecticides to control okra shoot and fruit borer. But due to the unconscious and unjustified use of synthetic pesticides create several problems in agro-ecosystem such as direct toxicity to beneficial insects, fishes and man. The repeated use of systemic insecticides alone has resulted in the development of resistance in the insect pest, and disturbance to the agro ecosystem by affecting the non-targets (Dittrich *et al.*, 1990) [5].

Materials and methods

The experiment was conducted during the Kharif season 2017 at Central research field of SHUATS (Naini Agricultural Institute), Allahabad, Uttar Pradesh, India, which is situated at 25.41° North latitude 81.84° East longitude and at an altitude of 98 mt. above sea level. The climate is typically semi-arid and subtropical. The maximum temperature reaches up to 49° C in summer and drops down to 1.5° C in winter. The site selected was uniform and cultivable with typical sandy loam soil having good drainage.

With the aim to evaluate comparative efficacy of spinosad individual and in combination with botanicals against shoot and fruit borer *(Earias vitella* Fabricius) in field condition, the experiment was conducted with spinosad individual with the combination of 6 other botanicals viz. Garlic and chilli extract (5 ml/ltr) + Spinosad @ 45 SC (0.25 ml/ltr), Karanj oil (5 ml/ltr) + Spinosad @ 45 SC (0.25 ml/ltr), NSKE (15 ml /ltr) + Spinosad @ 45 SC (0.25 ml/ltr), Turmeric crude extract (5 ml/ltr) + Spinosad @ 45 SC (0.25 ml/ltr), Custard apple leaf extract (5 ml/ltr) + Spinosad @ 45 SC (0.25 ml/ltr), Neem oil (25 ml/ltr) + Spinosad @ 45 SC (0.25 ml/ltr) in three replications. The okra variety VNR- 22 (Komal) was sown @ 10 kg. ha^{-1} by dibbling method with spacing of 45 cm between row to row and 30 cm between plant to plant by placing 2-3 seeds per hill at depth of 4 cm. The sizes of plots were 2×2 m^2 and the crop was raised following all standard agronomical practices.

Data Analysis: The population of *Earias vittella* recorded 1 day before spraying and on 3rd, 7th and 14th day after insecticidal application. The population of shoot and fruit borer was recorded from 5 plants, randomly selected and tagged from each plot. The extent of the damage was computed by using the formula.

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

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

[Kumar *et al*. 2016] [6]

Results and discussion

First spray: Per cent shoot infestation

The statistical analysis of data on per cent shoot infestation of *Earias vittella* over control on mean after first spraying revealed that all the treatments were superior over control showed in Table-1. Among all the treatments minimum shoot infestation was recorded in treatment T_1- spinosad@ 45 SC (4.42 %) and T_2- NSKE 5% + spinosad @ 45 SC.(4.55 %) which are most effective and significant to each other, and followed by T_4- Turmeric cured extract (3.5 %) + spinosad @ 45 SC (4.62 %), T_5 - Custard apple leaf extract + spinosad @ 45 SC (5.22 %), T_3- Karanj oil + spinosad @ 45 SC (5.42 %), T_7 -Garlic and chilli extract + spinosad @ 45 SC (5.49 %), T_6 - Neem oil + spinosad @ 45 SC (6.70 %). Maximum infestation was recorded in T_0-Control (14.53 %) was least effective. Similarly Mane *et al*., (2010) [7] recorded that the significantly minimum fruit infestation was observed in spinosad 45SC. Sharma *et al.* [8] also reported that spinosad 45 SC was effective in controlling the shoot and fruit borer infestation. In this regard Devi *et al*., (2014) [9] revealed significantly minimum shoot and fruit infestation that Spinosad 45% SC followed by *Beauveria bassiana*, *Verticillium lecanii* and neem oil. And also Kumar *et al.* (2016) [6] reported that efficacy of spinosad treatment against shoot and fruit borer recorded fruit infestation and Imidacloprid was found to be most effective treatment against all insecticides and bio-pesticides treatments.

Second and Third spray: Per cent fruit infestation:

The statistical analysis of data on per cent fruit infestation of *Earias vittella* over control on mean after 2nd and 3rd spraying revealed that all the chemical treatments were superior over control Table-2 and Table-3. Among all the treatments minimum fruit infestation was recorded in treatment T_2- NSKE 5% + spinosad @ 45 SC (12.42 %) and T_4- Turmeric crude extract (3.5 %) + spinosad @ 45 SC (15.5 %) which are most effective but they were non-significant to each other, and fallowed by T_3- Karanj oil + spinosad @ 45 SC (17.03 %), T_1- spinosad@ 45 SC (17.17 %), T_5 - Custard apple leaf extract + spinosad @ 45 SC (18.75 %), T_7 -Garlic and chilli extract + spinosad @ 45 SC (18.97 %), T_6 - Neem oil + spinosad @ 45 SC (19.9 %), T_0-Control (30.87 %) was least effective. Similarly Chaudhary *et al.* (2016) [10] Reported the highest suppression of shoot infestation was Spinosad 3.32,and lowest, followed by Neem oil 4.47, NSKE 4.63, Karanj oil 4.90, Tobacco leaf extract 22.75, Cow urine 29.25 and Cow butter milk 29.37 effective treatments compared by control 37.14. Srivastava (2014) [11] also reported that Spinosad@ 0.3ml/l proved superior against the larval infestation of shoot and fruit damage per cent of fruit borer followed by imidacloprid 17.8% SL@0.3ml/l, as compared to other treatment due to *Earias vittella* Fab. comparison to untreated control. And also Dhar and Bhattacharya (2015) [12] recorded application of imidacloprid 17.8% SL followed by twice applications of Spinosad 45% SC gave maximum reduction in infestation of fruit borer in okra Table-4.

Table 1: Shoot infestation of okra after first spray

Treatments	% infestation				
	Before	3 DAS	7 DAS	14 DAS	Mean
T_0-Control	12.47	13.6^{a}	13.33^{a}	16.66^{a}	14.53^{a}
T_1- Spinosad@ 45 SC	8.8	2^{c}	3.13^{b}	8.13^{c}	4.42^{c}
T_2- NSKE 5% + spinosad @ 45 SC	8.2	4.17^{bc}	5.13^{b}	4.13^{e}	4.55^{c}
T_3- Karanj oil (5 ml/ lt) + spinosad @ 45 SC	7.6	4.13^{bc}	6.07^{b}	8^{c}	5.42^{bc}
T_4- Turmeric crude extract (3.5 %) +spinosad @ 45 SC	9.2	3.87^{bc}	5.0^{b}	6.13^{d}	4.62^{c}
T_5 - Custard apple leaf extract (5 ml /ltr) +spinosad @ 45 SC	11.87	4.18^{b}	5.8^{b}	7.06^{cd}	5.22^{bc}
T_6 -Neem oil (5%) spinosad @ 45 SC	8.07	6^{b}	6.4^{b}	10.73^{b}	6.70^{b}
T_7 -Garlic and chilli extract (5 ml /ltr) + spinosad @ 45 SC	8.18	4.53^{bc}	5.87^{b}	7.8^{cd}	5.49^{bc}
F- test	NS	S	S	S	S
S. Ed. (±)		1.322	1.751	1.379	0.921
C. D. (P = 0.05)		2.802	3.712	2.923	1.952

Table 2: Fruit infestation of okra after second spray.

Treatments	% infestation			
	Before	7 DAS	14 DAS	Mean
T_0-Control	26.82	28.23^{a}	29.79^{a}	29.01^{a}
T_1- Spinosad@ 45 SC	23.84	17.18^{cd}	21.13^{b}	19.16^{bc}
T_2- NSKE 5% +spinosad @ 45 SC	25.58	14.53^{e}	16.21^{c}	15.37^{d}
T_3- Karanj oil (5 ml/ lt) + spinosad @ 45 SC	18.44	16.81^{d}	17.73^{c}	17.27^{cd}
T_4- Turmeric crude extract (3.5 %) +spinosad @ 45 SC	22.9	16.25^{de}	22.81^{b}	19.53^{bc}
T_5 - Custard apple leaf extract 5 ml/ltr) +spinosad @ 45 SC	22.65	19.17^{b}	21.21^{b}	20.19^{bc}
T_6 -Neem oil (5%) spinosad @ 45 SC	22.84	19.52^{bc}	21.2^{b}	20.37^{bc}
T_7 -Garlic and chilli extract 5 ml /ltr) + spinosad @ 45 SC	25.2	20.16^{b}	21.37^{b}	20.77^{b}
F- test	NS	S	S	S
S. Ed. (±)		1.007	1.059	1.341
C. D. (P = 0.05)		2.135	2.244	2.842

Table 3: Fruit infestation of okra after third spray.

Treatments	Before	7 DAS	14 DAS	Mean
T_0-Control	26.82	31.20^{a}	34.26^{a}	32.73^{a}
T_1- Spinosad@ 45 SC	23.84	14.01^{cd}	16.32^{d}	15.17^{c}
T_2- NSKE 5% +spinosad @ 45 SC	25.58	8.66^{e}	10.26^{e}	9.46^{d}
T_3- Karanj oil (5 ml/ lt) + spinosad @ 45 SC	18.44	16.22^{bc}	17.35^{cd}	16.79^{c}
T_4- Turmeric crude extract (3.5 %) +spinosad @ 45 SC	22.9	11.28^{de}	11.63^{e}	11.46^{d}
T_5 - Custard apple leaf extract (5 ml / ltr) +spinosad @ 45 SC	22.65	15.22^{c}	19.37^{bc}	17.30^{bc}
T_6 -Neem oil (5%) spinosad @ 45 SC	22.84	18.88^{b}	19.98^{b}	19.43^{b}
T_7 -Garlic and chilli extract 5ml/ltr) + spinosad @ 45 SC	25.20	15.21^{c}	19.12^{bc}	17.17^{bc}
F- test	NS	S	S	S
S. Ed. (±)		1.469	0.962	0.986
C. D. (P = 0.05)		3.114	2.040	2.091

Table 4: Fruit infestation of okra after 2nd and 3rdspray overall mean.

Treatments	2nd spray	3rd spray	Overall mean
T_0-Control	29.01^{a}	32.73^{a}	30.87^{a}
T_1- Spinosad@ 45 SC	19.16^{bc}	15.17^{c}	17.17^{bc}
T_2- NSKE 5% +spinosad @ 45 SC	15.37^{d}	9.46^{d}	12.42^{c}
T_3- Karanj oil (5 ml/ lt) + spinosad @ 45 SC	17.27^{cd}	16.79^{c}	17.03^{bc}
T_4- Turmeric crude extract (3.5 %) +spinosad @ 45 SC	19.53^{bc}	11.46^{d}	15.50^{bc}
T_5 - Custard apple leaf extract (5 ml/ltr) +spinosad @ 45 SC	20.19^{bc}	17.3^{bc}	18.75^{b}
T_6 -Neem oil (5%) spinosad @ 45 SC	20.37^{bc}	19.43^{b}	19.90^{b}
T_7 -Garlic and chilli extract (5 ml / ltr) + spinosad *@ 45 SC*	20.77^{bc}	17.17^{bc}	18.97^{b}
F- test	S	S	S
S. Ed. (±)	1.341	0.986	2.942
C. D. (P = 0.05)	2.842	2.091	6.236

Conclusion

Keeping above finding in view it may be recommended that to reduce the harmful effect of chemical and increase the effectiveness of botanical, Chemical in combination with botanical are very effective to suppress the maximum pest population within less time.

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