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Assessment of different insecticides and economics against fruit damage by shoot and fruit borer of okra (*Abelmoschus esculentus* L. Moench)

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Abstract
An experimentation was done to observe the efficacy of some insecticides and economics against shoot and fruit borer, *Earias vittella* (Fabricius) of okra during *kharif* season 2015 at the Vegetable research farm, JNKVV, Jabalpur, Madhya Pradesh. The insecticidal treatments emamectin benzoate 5% SG @ 12 g a.i./ha was found to be most effective as it recorded minimum fruit damage (12.36%) followed by emamectin benzoate 5% SG @ 10 g a.i./ha (15.36%) and imidacloprid 17.8% SL @ 35.6 g a.i./ha (19.66%), difenthiuron 50 WP @ 300 g a.i./ha (23.22%). The next effective treatments were imidacloprid 17.8% SL @ 17.8 g a.i./ ha (26.80%) and thiamethoxam 25% WG @ 25 g a.i./ha (27.72%) both were found to be at par with each other, while NSKE 5% g a.i./ha (35.08%) was found least effective among all the insecticidal treatments. The highest net return was obtained from emamectin benzoate 5% SG @ 12 g a.i./ ha and the maximum cost benefit ratio was obtained in imidacloprid 17.8% SL @ 35.6 g a.i./ha (1:32.33) due to lower cost than others.

Keywords: Shoot and Fruit Borer, Emamectin benzoate, Imidacloprid, Difenthiuron, Okra.

1. Introduction
India is a major vegetable producing and consuming country, vegetables form an important dietary component. Among them okra, *Abelmoschus esculentus* L. Moench, is one of the popular and commercially cultivated vegetable crops is an important crop grown throughout the year. Besides India, okra is also grown in many tropical and subtropical parts of the world. Tender fruits are used as vegetables or in culinary preparations as sliced and dried pieces. It is also used for thickening of gravies and soups, because of its high mucilage content. The roots and stems of okra are used for cleaning cane juice (Chauhan, 1972) [4]. The matured fruits and stems containing crude fibre are used in paper industry. Okra is cultivated for its immature fruits to be consumed as a fresh and canned food as well as for seed purpose.
Vegetables constitute an important item of our food, supplying vitamins, carbohydrates and minerals needed for a balanced diet. Their value is important specially in under developed and developing countries like India. Okra (*Abelmoschus esculentus* L. Moench) popularly known as bhindi or lady's finger is an important vegetable crop grown in India.
Okra is widely cultivated in plans of the India with acreage of 524.0 mha. and production 6203.0 MT and productivity 11.83 MT/ha. In Madhya Pradesh, okra is grown in 26.51 mha. area with production of 305.90 MT and 11.5 MT/ ha productivity (Anonymous, 2014-2015) [2]. (Singh and Brak, 1994) [12] reported 32.06-40.48 per cent losses in okra due to Shoot and fruit borers (*E. vittella*). The productivity of okra is low due to many factors and one of the most important constraints in production is the attack of insect pests. Aphid (*A. gossypii*), shoot and fruit borer, *Earias insulana* (Boisduval) and *E. vittella (fabricius)* and Jassid, *A. biguttula biguttula (Ishida)* are most serious pests of okra and cause 45.00-57.10% damage to fruits (Shrinivasan and Krishna Kumar, 1983) [13] and (Nderitu *et al.*, 2008) [9]. The idea of controlling pests by using various agro-techniques in combination with selective use of insecticides making compatible with other components of the management of okra pests are gaining importance as the most effective measure.
The present investigation done to observe the assessment of different insecticides and

economics against fruit damage by shoot and fruit borer of okra (*Abelmoschus esculentus* L. Moench).

2. Material and Methods

The present findings entitled, "Assessment of Different Insecticides and Economics against Fruit Damage by Shoot and Fruit Borer of Okra (*Abelmoschus esculentus* L. Moench)" was carried out at the Vegetable research farm, JNKVV, Jabalpur, Madhya Pradesh during *kharif* season 2015.

2.1. Method of observation of Shoot and Fruit borer, *Earias vittella* (Fabricius) pest was recorded as detailed below

- Pretreatment observations were recorded 24 hours before spraying and post treatment observation were taken 1st, 5th, 7th, and 10th day after application of treatment.
- Observations on fruit borer, *Earias vittella* (Fab.) was recorded per-plot percent fruit infestation was worked out at each picking. Marketable fruit yield/plot was recorded at each picking. The percentage data on damaged fruits was transformed to arcsin transformation.

Fruit infestation by *E. vittella* was judged by counting the healthy fruits and fruits damaged by *E. vittella*, and the per cent fruit borer infestation was computed as follows:

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

2.2. Observation for avoidable losses:

Avoidable losses were calculated by comparing protecting and unprotected:

$$\% \text{ Avoidable losses} = \frac{\text{Yield protected plots} - \text{Yield unprotected plots}}{\text{Yield protected plots}} \times 100$$

Table 1: Treatment details of Insecticides

Treatment code	Treatments	a.i. g/ha	Dose g/ml/ha
T_1	NSKE 5%	750	15000
T_2	Difenthiuron 50 WP	300	600
T_3	Imidacloprid 17.8% SL	17.8	100
T_4	Imidacloprid 17.8% SL	35.6	200
T_5	Thiamethoxam 25% WG	25	100
T_6	Emamectin benzoate 5% SG	10	200
T_7	Emamectin benzoate 5% SG	12	240
T_8	Control	-	-

3. Results and Discussion

3.1. Per cent shoot and fruit damage by fruit borer and fruit yield

On the basis of overall mean fruit damage, all the insecticidal treatments recorded significantly less fruit damage as compared to control (39.58%). Among the treatments emamectin benzoate 5% SG @ 12 g a.i./ha was found to be most effective as it recorded minimum fruit damage (12.36%) followed by emamectin benzoate 5% SG @ 10 g a.i./ha (15.36%) and imidacloprid 17.8% SL @ 35.6 g a.i./ha (19.66%), difenthiuron 50 WP @ 300 g a.i./ha (23.22%). The next effective group of treatments were imidacloprid 17.8% SL @ 17.8 g a.i./ha (26.80%) and thiamethoxam 25% WG @ 25 g a.i./ha (27.72%) both were found to be at par with each other, while NSKE 5% g a.i./ha (35.08%) was found least effective among all the insecticidal treatments (Table 2).

In accordance with the present findings (Aarwe *et al.*, 2015) [1] also reported that emamectin benzoate 5% SG @ 12 g a.i./ha recorded lowest fruit damage (13.61%). Followed by emamectin benzoate 5% SG @ 10 g a.i./ha (16.90). Similarly (Patidar, 2006) [10] also reported that minimum damage of shoot and fruit borer (5.6%) was recorded in emamectin benzoate 5% SG @ 20 g a.i./ha.

On the basis of cumulative healthy marketable fruit yield, all the insecticidal treatments recorded significantly higher fruit yield as compared to control (24.83 q/ha). Among the insecticidal treatments emamectin benzoate 5% SG @ 12 g a.i./ha recorded significantly highest fruit yield (69.01 q/ha), followed by emamectin benzoate 5% SG @ 10 g a.i./ha (65.45 q/ha), and imidacloprid 17.8% SL @ 35.6 g a.i./ha (61.83 q/ha), difenthiuron 50 WP @ 300 g a.i./ha (55.25 q/ha). The another insecticidal treatments imidacloprid 17.8% SL @ 17.8 g a.i./ha (46.36 q/ha) and thiamethoxam 25% WG @ 25 g a.i./ha (45.81 q/ha) both were found to be at par with each other. Treatment NSKE 5% g a.i./ha (38.65 q/ha) was found to be least effective (Table 2).

In conformity with the present findings, (Aarwe *et al.*, 2015) [1] also reported that highest yield (58.20 q/ha) was recorded with the treatment emamectin benzoate 5% SG @ 12 g a.i./ha followed by emamectin benzoate 5% SG @ 10 g a.i./ha (52.00 q/ha). Similarly (Govindan *et al.*, 2012) [6] also reported that emamectin benzoate 5% SG @ 11 g a.i./ha and 13 g a.i./ha were highly effective in reducing the fruit damage per cent of shoot and fruit borer and increasing the healthy fruit yield of okra, further (Patra *et al.*, 2007) [11], (Aulakh *et al.*, 2012) [3] and (Dhanalakshami and Mallapur, 2010) [5] reported that emamectin benzoate 5% SG @ 15 g a.i./ha, 5% SG @ 150, 170, & 200 g/ha and 5% SG @ 0.2/l respectively were found significantly effective in reducing the per cent fruit damage and increasing the healthy fruit yield against shoot and fruit borer in okra. However, (Harinkhere, 2014) [7] found that emamectin benzoate 5% SG @ 25 g a.i./ha and thiamethoxam 25% WG @ 25 g a.i./ha were the most effective treatment with lowest fruit damage and highest healthy fruit yield in okra.

3.2. Economics of treatments

Maximum increase in fruit yield over control was registered in emamectin benzoate 5% SG @ 12 g a.i./ha (44.18 q/ha) this was followed by emamectin benzoate 5% SG @ 10 g a.i./ha (40.62 q/ha), imidacloprid 17.8% SL @ 35.6 g a.i./ha (37.00 q/ha), difenthiuron 50 WP @ 300 g a.i./ha (30.42 q/ha), imidacloprid 17.8% SL @ 17.8 g a.i./ha (21.53 q/ha), thiamethoxam 25% WG @ 25 g a.i./ha (20.98 q/ha) and NSKE 5% g a.i./ha (13.82q/ha).

Maximum net profit was registered in emamectin benzoate 5% SG @ 12 g a.i./ha (Rs. 81880) this was followed by emamectin benzoate 5% SG @ 10 g a.i./ha (Rs.75600), imidacloprid 17.8% SL @ 35.6 g a.i./ha (Rs.71780), difenthiuron 50 WP @ 300 g a.i./ha (Rs.57528), imidacloprid 17.8% SL @ 17.8 g a.i./ha (Rs.41230), thiamethoxam 25% WG @ 25 g a.i./ha (Rs.39920) and NSKE 5% g a.i./ha (Rs.21700 q/ha).

Maximum cost benefit ratio was obtained in imidacloprid 17.8% SL @ 35.6 g a.i./ha (1:32.33) this followed by imidacloprid 17.8% SL @ 17.8 g a.i./ha (1:22.55), thiamethoxam 25% WG @ 25 g a.i./ha (1:19.56), difenthiuron 50 WP @ 300 g a.i./ha(1:17.36), emamectin benzoate 5% SG

@ 10 g a.i./ha (1:14.40), emamectin benzoate 5% SG @ 12 g a.i./ha (1:12.65) and NSKE 5% g a.i./ha (1:3.65).

It showed that spraying of imidacloprid 17.8% SL @ 35.6 g a.i./ha on okra crop gave maximum cost benefit ratio, however its cost was low as compared to, thiamethoxam 25% WG @ 50 g a.i./ha, difenthiuron 50 WP @ 300 g a.i./ha, emamectin benzoate 5% SG @ 12 g a.i./ha and emamectin benzoate 5% SG @ 10 g a.i./ha, respectively (Table 3).

In accordance with the present findings, (Konar *et al.*, 2013) [8] also reported that highest net return was obtained from emamectin benzoate 5% SG @ 18 g a.i./ ha in okra. Similarly (Harinkhere, 2014) [7] found that highest net return was obtained from emamectin benzoate 5% SG @ 25 g a.i./ ha but the cost benefit ratio was lowest (1:4.1) among all the insecticides in okra. Whereas Laichattiwar and meena (2014) reported that emamectin benzoate was found most effective with highest healthy fruit yield (89.16 q/ha) but maximum cost benefit ratio was obtained with fipronil (1:11.76) followed by spinosad (1:8.77).

Table 2: Efficacy of insecticides against shoot and fruit borer percent damage, fruit yield and percent avoidable losses on okra

Treatment code	Treatment detail	Dose g a.i./ha.	Mean percentage fruit damage by shoot and fruit borer*	Fruit yield (q/ha)	Per cent avoidable losses
T_1	NSKE 5%	750	35.08 (36.30)	38.65	35.75
T_2	Difenthiuron 50 WP	300	23.22 (28.79)	55.25	55.05
T_3	Imidacloprid 17.8 SL	17.8	26.80 (31.16)	46.36	46.44
T_4	Imidacloprid 17.8 SL	35.6	19.66 (26.31)	61.83	59.84
T_5	Thiamethoxam 25 WG	25	27.72 (31.75)	45.81	45.79
T_6	Emamectin benzoate 5 SG	10	15.36 (23.06)	65.45	62.06
T_7	Emamectin benzoate 5 SG	12	12.36L (20.57)	69.01H	64.01
T_8	Control	-	40.08H (39.26)	24.83L	-
SEm±			0.93	0.21	
CD at 5%			2.84	0.61	

*Mean of 12 pickings, ( ) Figures in parentheses are arcsin transformed value, L= Lowest **H=** Highest

Table 3: Economics of different insecticides on fruit yield of okra

Treatment Code	Treatment Details	Dose G a.i./ha.	Fruit yield (q/ha)	Increase in yield over control	Cost of treatments	Cost increased yield over control @ Rs. 2000/- per quintal	Net Profit (Rs/ha.)	Cost benefit ratio
T_1	NSKE 5%	750	38.65	13.82	5940	27640	21770	1:3.65
T_2	Difenthiuron 50 WP	300	55.25	30.42	3312	60840	57528	1:17.36
T_3	Imidacloprid 17.8 SL	17.8	46.36	21.53	1830	43060	41230	1:22.55
T_4	Imidacloprid 17.8 SL	35.6	61.83	37.00	2220	74000	71780	1:32.33
T_5	Thiamethoxam 25 WG	25	45.81	20.98	2040	41960	39920	1:19.56
T_6	Emamectin benzoate 5 SG	10	65.45	40.62	5640	81240	75600	1:14.40
T_7	Emamectin benzoate 5 SG	12	69.01	44.18	6480	88360	81880	1:12.65
T_8	Control	-	24.83	-	-	-	-	-

Cost involve during the experiment

1. Rate of labour per day Rs. 240/- (2 labours required for spraying 1 ha okra crop in 1 day)

2. Cost of insecticide /ha.

Thiamethoxam 25 WG = Rs. 2000/Kg
Imidacloprid 17.8 SL = Rs.1300/Litre
Emamectin benzoate 5 SG = Rs. 7000/Kg
Difenthiuron 50 WP = Rs. 1040/kg
NSKE 5% = Rs. 100/kg

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