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Seasonal incidence and biorational management of fruit and shoot borer (*Earias vitella*) (Fab.) on okra

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Abstract
Incidence of shoot and fruit borer started at 31st standard meteorological week continued till harvest and its peak period during 36th standard week. It started declining after 37th standard week. lowest infestation (shoot and fruit infestation) and highest yield over control was observed in treatment of Spinosad 45 SC 0.01% (7.06%) shoot infestation, 18.40% fruit infestation on number basis and 18.63% fruit infestation on weight basis with 87.18 q/ha yield followed by, *Metarhizium anisopliae* CFU 1×108, *Verticillium lecanii* CFU 1×108, *Beauveria bassiana* CFU 1×10^8, Neem oil 2%, Neem Seed Extract 5% and Karanj oil 2%.

Keywords: *Earias vitella*, Biorational management, Okra

Introduction
Okra (*Abelmoschus esculentus* (L.)), crop is generally known as bhendi in India and ladies' finger. This crop is widely grown in Asia and India Also ranks first in its production. A total of 130 species of Earias were so far identified worldwide and found to attack many crops especially under Malvaceae family (Gautam and Goswami, 2004) [2]. Shoot and fruit borer, *Earias vitella* (Fab.), (Noctuidae: Lepidoptera) is the most noxious and destructive pest. Initially caterpillar gain entry into growing shoot tip then bud, flower and developing fruits and feed there. Consequently, there is dropping and drying of growing tips. The infested shoot die, the buds, flowers, fruits drop prematurely and affected fruits become unfit for human consumption, fetching less price in the market. This pest may cause 40-50% damage of fruit in some areas of south-east Asian countries Srinivasan and Gowder (1959) [4]. In India the damage due to Earias vitella is upto 35% of the total harvested yield. Chemical control measures for controlling insect pests in the field is the most common approach. However, their massive overuse and frequent misuse has led to problems like developing of insecticidal resistance, resurgence of secondary pests, elimination of natural enemies of pest, residual toxicity hazards to human beings, plants, domestic animals and wild life, contamination of soil, water and food chain and wholesome pollution of environment (Asokan *et al*., 2000) [1]. Hence, research workers have started searching out the effective, environmentally safe, eco-friendly and bio-intensive control measures which may keep the crop pest below ETL.

Material and Methods
The present investigation on *Earias vitella* carried out on Akola Bahar variety of Okra bydibbling method during kharif season 2018 in the field of Agricultural Entomology Section, College of Agriculture, Nagpur. There were eight treatments including control and each treatment was replicated thrice in the Randomized Block Design. The treatments were Neem oil @ 2%, Karanj oil @ 2%Neem Seed Extract (NSE) @ 5%, *Metarhizium anisopliae* (CFU 1× 108) @ 4g/lit, *Verticillium lacanni* (CFU 1× 108) @ 4g/lit, *Beauveria bassiana* (CFU 1× 108) @ 4g/lit, Spinosad 45 SC @ 0.01%, Control (Untreated). The observations were recorded on the number of infested shoots in each plot a day before first spray and 3, 7 and 14 days after each spraying on five randomly selected plants from each plot. The cumulative per cent shoot damage was worked out using the following formula.
Observations were also recorded on number of infested fruits and number of marketable fruits on five randomly selected plants from each net plot picking wise. In order to know the per cent fruit infestation on number as well as weight basis. The fruits were plucked from 5 selected plants, they were counted and weighed. Similarly, from those total fruits the infested fruits due to fruit borer were separated, counted and weighed. The data thus obtained were calculated to obtain yield in q/ha, so also all the data on different aspects were statistically

analyzed.

Results and Discussions

Incidence of shoot and fruit borer started at 31st standard meteorological week with 10.36% fruit infestation. It continued till harvest and its peak period during 36th standard meteorological week with (30.22% fruit infestation). It started decline after 37th standard meteorological week and observed 16.18% fruit infestation during 40th standard meteorological week (Table 1).

All the treatments were significantly superior over control on number based shoot and fruit borer (*E. Vitella*) infestation percentage (Table 2). Among these different treatments, Spinosad 45 SC 0.01% was found to be the most promising one, which consistently maintained lowest fruit infestation throughout the period of experimentation with the average of 18.40% infestation. The next promising treatment was of *Metarhizium anisopliae* CFU 1×108 (22.05%), *Verticillium lecanii* CFU 1×108 (22.63%) and *Beauveria bassiana* CFU 1×108 in which 23.68% infestation was observed. The remaining treatments in descending order of efficacy were, Neem oil 2% (24.29%) and Neem Seed Extract 5% (25.58%) which were comparable with each other in reducing per cent fruit infestation. The treatment Karanj oil 2% recorded 27.23% fruit infestation and this treatment was found least effective and superior over control where the infestation was 34.68%.

Cumulative per cent fruit damage of shoot and fruit borer on weight basis for all the treatments were significantly superior over control (Table 3). The most effective treatment was Spinosad 45 SC 0.01% which consistently maintained its efficacy in recording minimum fruit damage throughout the period of experimentation with average of 18.63% fruit infestation followed by the treatments of *Metarhizium anisopliae* CFU 1×108 (22.18%), *Verticillium lecanii* CFU 1×108 (22.56%) and *Beauveria bassiana* CFU 1×108 (22.64%).The next effective treatments were Neem oil 2% (24.99%) and Neem Seed Extract 5% (25.03%). Karanj oil 2% (27.19%) treatment was found to be less effective in management of okra fruit borer and recorded higher fruit damage but found superior over control where 34.68% infestation was observed.

Above results were comparable with that of the Tulankar *et al*., (2012) [5] found the effectiveness of spinosad among all botanicals and biopesticides. They recorded 20.96% fruit infestation in spinosad treated plot, 24.84% fruit infestation in neem oil treated plot and 26.49% fruit infestation in neem seed extract treated plot. Mohan sundaram *et al*., (2012) [3] conducted an experiment to study the efficacy spinosad and other botanicals and chemical insecticides.

Conclusion

Infestation of *E. vitella* started late in the season after sowing and continued till harvest and Spinosad 45 SC 0.01% was found superior on both number and weight based infestation calculation. Interpretation of the above results will help in timely management and proper use of the insecticide for treatment.

Table 1: Seasonal incidence of *Earias vitella* on Akola Bahar variety of okra on during Kharif 2018:

Standard Meteorological Week	% Fruit infestation by shoot and fruit borer
(July)27	0.00
(July)28	0.00
(July)29	0.00
(July)30	0.00
(Aug)31	10.36
(Aug)32	16.57
(Aug)33	29.24
(Aug)34	27.12
(Sept)35	25.84
(Sept)36	30.22
(Sept)37	22.16
(Sept)38	19.42
(Sept)39	18.02
(Oct)40	16.18

Table 2: Cumulative per cent fruit infestation by shoot and fruit borer (On number basis)

Treatments	R-I	R-II	R-III	Mean
Neem oil 2%	24.12 (29.41)	22.83 (28.54)	25.91 (30.59)	24.29 (29.52)
Karanj oil 2%	25.36 (30.23)	27.76 (31.79)	28.56 (32.30)	27.23 (31.45)
Neem Seed Extract 5%	24.65 (29.76)	25.41 (30.27)	26.68 (31.09)	25.58 (30.38)
Metarhizium anisopliae (CFU 1× 10^8)	21.17 (27.39)	21.43 (27.56)	23.56 (29.03)	22.05 (28.00)
Verticillium lecanii (CFU 1× 10^8)	21.89 (27.89)	22.13 (28.06)	23.87 (29.24)	22.63 (28.40)
Beauveria bassiana (CFU 1× 10^8)	22.56 (28.35)	22.84 (28.54)	25.63 (30.41)	23.68 (29.11)
Spinosad 45 SC 0.01%	18.23 (25.27)	18.12 (25.19)	18.86 (25.77)	18.40 (25.40)
Control (Untreated)	33.65 (35.45)	35.82 (36.76)	34.58 (36.01)	34.68 (36.07)
"F" test Sig.				
S.E.(m)± 1.54				
C.D at 5% 4.68				

Table 3: Cumulative per cent fruit infestation by shoot and fruit borer (On weight basis):

Treatments	R-I	R-II	R-III	Mean
Neem oil 2%	23.68 (29.11)	24.85 (29.90)	26.43 (30.93)	24.99 (24.99)
Karanj oil 2%	25.15 (30.09)	28.25 (32.10)	28.16 (32.05)	27.19 (31.42)
Neem Seed Extract 5%	24.56 (29.70)	25.45 (30.29)	25.09 (30.05)	25.03 (30.01)
Metarhizium anisopliae (CFU 1× 10^8)	21.15 (27.38)	22.51 (28.32)	22.87 (28.56)	22.18 (28.09)
Verticillium lecanii (CFU 1× 10^8)	21.36 (27.52)	22.76 (28.49)	23.55 (29.03)	22.56 (28.35)
Beauveria bassiana (CFU 1× 10^8)	23.01 (28.66)	23.92 (29.28)	23.98 (29.32)	23.64 (29.09)
Spinosad 45 SC 0.01%	18.01 (25.11)	18.92 (25.78)	18.98 (25.82)	18.63 (25.57)
Control (Untreated)	33.65 (35.45)	35.82 (36.76)	34.58 (36.58)	34.68 (36.07)
"F" test Sig.				
S.E.(m)± 1.54				
C.D at 5% 4.67				

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