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Short Research Article

Oviposition Deterrence and Egg Hatch Inhibition of Fruit Fly, *Bactrocera tau* (Walker) by Some Plant Products, Bio-pesticides and Clay

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Abstract

In laboratory studies, different concentrations of azadirachtin (0.005%, 0.01% and 0.015%), neem oil (1%, 2% and 3%, respectively), pongamia oil (1%, 2% and 3%), *Beauveria bassiana* (Daman 1% WP 0.1%, 0.5% and 1%) and clay (6%, 8% and 10%) were evaluated for oviposition deterrence against fruit fly, *Bactrocera tau* on cucumber. Azadirachtin (0.015%) followed by neem oil (3%), Daman (1%) and clay (10%) proved effective with 89.09%, 80.24%, 83.40% and 89.29% oviposition deterrence over control, respectively. *Beauveria bassiana* (Daman 1% WP), a formulation based on *Beauveria bassiana,* when used @ 0.1, 0.5 and 1.0% concentrations resulted in 6.65, 6.39 and 5.02 eggs female^{-1} with an oviposition deterrence values of 77.46, 78.23 and 83.40% over control, respectively. Cucumber slices when dipped in pongamia oil (1%, 2% and 3%) caused degradation in the tissues due to which further studies could not be carried out under laboratory conditions. Egg hatchability in different treatments was also worked out. The egg hatch also decreased with the increase in concentrations of test materials. Minimum egg hatch (32.75%) was recorded in azadirachtin (0.015%) treatment. The egg hatch in other treatments viz. Daman, neem oil and clay was 39.79, 59.47 and 61.00%, respectively at 1, 3 and 10% concentrations. Azadirachtin (0.015%), neem oil (3%), Daman (1%) and clay (10%) resulted in 32.75%, 59.47%, 39.79% and 61.00% egg hatch accounting for 2.5, 1.5, 2.2 and 1.5 times decrease over control.

1. Introduction

Fruit flies, *Bactrocera* spp. (Diptera:Tephritidae) occur throughout the tropics and subtropics (Weems and Heppner, 2001), and are considered as one of the most destructive pests of fruits and vegetables World over. Dacine fruit flies have been recognized as amongst the ten most serious pests of agricultural crops in Asia (Sardana et al., 2005) and the Pacific (Waterhouse, 1993; 1997). Direct fruit damage, fruit drop, and loss of export markets through quarantine restrictions are the mechanisms by which fruit fly infestation results in economic losses to the growers. Due to high mobility, dispersal capacity, fecundity and in some cases extreme polyphagy, the dacines are well documented invaders and rank high on target list of quarantine pests.

The fruit flies lay eggs in vegetables at tender stage and at ripening stage in fruits. On hatching, maggots bore their way to the interior and feed on the pulp. The affected fruits fall off from the plants and rot. Various methods have been suggested for the control of fruit flies, however each one of them seem to have its own limitations, thus, a successful control of the pest is still illusive. Further, application of pesticides poisons the fruits and affects environment and human health. So our main stress for fruit fly management is to prevent egg laying and to search for alternative ecofriendly methods for the management. Keeping above in view, the present studies were carried out to test the plant products, bio-pesticides and clay for ovipositor deterrence and also see the effect on egg hatch.

2. Materials and Methods

B. tau culture was raised from infested fruits of cucumber collected from field in specially designed rearing cages measuring 90×45×45 cm^3, at room temperature during the months June-August in the year 2012, in the fruit entomology laboratory of the Department of Entomology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India situated at 30°51.6´ N latitude, 77°09.9´ E longitude and at an elevation of 1262 m amsl. The adults were provided with their natural hosts for oviposition as well as a mixture of dry glucose and protein hydrolysate

(Protinex®, Pfizer Ltd.) in the ratio of 1:1 as per Gupta (1989) in a Petri-plate for feeding, and the diet was changed daily. The flies were reared for two generations in the laboratory. Further studies were carried out on those flies. Different test materials, namely azadirachtin, neem oil (*Azadirachta indica*), pongamia oil (*Pongamia pinnata,* commonly known as Karanj oil), Daman (*Beauveria bassiana*) and clay were evaluated against *B. tau* adults reared in the laboratory.

Neem oil (Neem Tel) (1%, 2% and 3.0%), Pongamia oil (Karanj Tel) (1.0%, 2.0% and 3.0%), Azadirachtin (Econeem 10,000 ppm) @ 0.005%, 0.01% and 0.015% a.i., Daman 1% WP (*Beauveria bassiana)* @ 0.1, 0.5% and 1.0% of the formulation containing 10^9 conidiospores g^{-1} and finely powdered clay @ 6.0%, 8.0% and 10.0% were evaluated. The piece of cucumber cut into thin transverse slices, keeping the skin of the fruit intact was dipped in the solution of desired concentration of the test material for 30 seconds; shade dried and kept in a Petri plate (dia-5 cm) inside a small cage. Five pairs of fruit fly, *B. tau* (8-day old) previously fed on artificial diet were introduced (one pair $cage^{-1}$) in the cage. The observations were recorded on the number of eggs laid in each treatment by observing the fruit slices daily and replacing them with freshly treated slices continuously for seven days (Gupta, 1989).

Further, each cage was also supplemented with artificial diet (protein hydrolysate and glucose in the ratio of 1:1) alongside treated fruit slices and the same was also changed daily after recording observations. The egg laying in each treatment was recorded daily up to 7 days from the day of initiation of egg laying.

Per cent deterrence was calculated using the following formula:

$$\text{Deterrence (\%)} = \frac{C-T}{C} \times 100$$

Where,

C: Total number of eggs laid in control.

T: Total number of eggs laid in treatment

The egg hatchability was also recorded in each treatment. The trial was laid out in a Completely Randomized Design (CRD) and significance of different treatments was worked out.

3. Results and Discussion

Azadirachtin at 0.005%, 0.01% and 0.015% concentration resulted in 67.75%, 87.78% and 89.09% oviposition deterrence over control, respectively wherein the cucumber piece was dipped only in water. The present results are in conformity with those reported by Chen et al. (1996), who suggested the role of non-volatile neem components detected by the ovipositor as a signal to reduce egg laying. The eggs recorded for 7 days on cucumber slices were also observed for hatching. Azadirachtin evaluated at three (0.005%, 0.01% and 0.015%) concentration showed considerable effect on egg hatchability ranging between 32.75% to 62.89%, when compared to control. The egg hatchability decreased with increase in concentrations of the test material. There was 1.3, 1.6 and 2.5 times decrease in hatchability at 0.005%, 0.01% and 0.015% concentrations, respectively when compared with control (Table 1).

The mean egg laying decreased with increase in test concentrations of neem oil from 1.0% to 3.0%. The egg laying was reduced from 11.11 eggs $female^{-1}$ to 6.68 eggs $female^{-1}$ indicating thereby that by increasing concentration by three times the corresponding increase in deterrence was about 14%. The present work finds support from the results reported earlier (Nadia and Schmidt, 1992; Nadia et al., 1995; Verma, 2002; Khan et al*.,* 2007; Khattak et al., 2009). These workers reported that neem oil has a significant effect on egg laying by fruit flies as they attributed it to repellent effect or locomotor suppressing effect of neem oil that inhibited the initial penetration by oviposition in the fruit tissues. However contrary to this, Singh and Srivastava (1983) reported complete deterrence in egg laying by *B. cucurbitae* on bitter gourd probably due to the higher (5.0%) concentration of neem oil used by these workers in their studies.When neem oil was tested at 1.0%, 2.% and 3.0% concentration to know the effect of oil on egg hatchability of *B. tau,* it was observed that there was 1.2, 1.3 and 1.5 times decrease in egg hatch at the three concentrations, respectively. The hatchability decreased from 74.48% (1.0%) to 59.47% (3.0%) indicating thereby that like azadirachtin, the per cent egg hatch reduced with increase in concentration of neem oil (Table 2).

Pongamia oil when tried at 1.0%, 2.0% and 3.0% concentration under laboratory conditions resulted in degradation of host tissue within 6–7 hrs of treatment. The flies rejected the

Table 1: Oviposition deterrence and egg hatch inhibition of fruit fly, *Bactrocera tau* by azadirachtin (Econeem 10,000 ppm)

Concentration (%)	Mean egg laying $female^{-1*}$ (±SE)	Deterrence over control (%)	*Average egg hatch (%)	Times decrease in egg hatch over control
0.005	9.54±0.18	67.67 (55.35)	62.89 (52.50)	1.3
0.01	3.69±0.29	87.78 (69.55)	51.51 (45.89)	1.6
0.015	3.05±0.35	89.09 (70.73)	32.75 (34.89)	2.5
Control (water)	29.59±0.50	-	83.02 (65.76)	-
CD (*p*=0.05)	1.59	(1.62)	(4.45)	

Figures in the parentheses are arc sine transformed values; *Average of five replicates degradated tissues for oviposition as no egg laying was recorded in the tissue. Though, the exact cause of degradation is not known, yet it is suspected that probably some components in the pongamia oil caused breakdown of tissues. So far no literature has been found to exist reporting phytotoxic nature of the pongamia oil or its constituents on any crop. Daman, a *B. bassiana* based formulation, tested at three (0.1%, 0.5% and 1.0%) concentrations in the laboratory revealed that the

Table 2: Oviposition deterrence and egg hatch inhibition of fruit fly, *Bactrocera tau* by neem oil

Concen-tration (%)	Mean egg laying female^{-1*} (±SE)	Deter-rence over control (%)	*Average egg hatch (%)	Times decrease in egg hatch over control
1.0	11.11±0.15	66.58 (54.68)	74.48 (59.86)	1.2
2.0	8.91±0.21	73.30 (58.89)	66.82 (55.19)	1.3
3.0	6.68±0.30	80.24 (63.61)	59.47 (50.55)	1.5
Control (water)	33.46±0.45	-	87.00 (69.06)	-
CD (*p*=0.05)	1.92	(1.44)	(7.79)	

highest concentration resulted in lowest (5.02 eggs female^{-1}) oviposition and maximum deterrency (83.40%). Same trend was also observed at other two concentrations as well. *B. bassiana*, Vuillemin (*Deuteromycotina Hyphomycetes*) has earlier been reported to be active against adults and pupae of *Ceratitis capitata* (Lacey et al., 2001; Ekesi et al., 2002; Dimbi et al., 2003; Almeida et al., 2007) however, its role as oviposition deterrent has not been extensively studied.Daman (*B. bassiana*) like other candidate materials also showed considerable reduction in egg hatching (39.79% to 60.15%) at the tested concentrations (0.1%–1.0%). There was 1.4 to 2.2 times reduction in egg hatching of *B. tau* when compared over control (Table 3). Maximum mean egg laying (6.65 eggs female^{-1}) was recorded at 0.1% concentration of clay which was statistically at par with 0.5% concentration (6.39 eggs female^{-1}); whereas minimum mean egg laying (5.02 eggs female^{-1}) was recorded at the highest dose (1.0%). All the concentrations proved superior over control. The table also reveals that with gradual increase in concentration there was corresponding increase in deterrent effect on oviposition as maximum deterrence (83.40%) over control was obtained at the highest concentration (1.0%) and minimum (77.46%) at the lowest (0.01%) concentration. The deterrence over control at 0.5 and 1.0% concentration was at par. With increase in concentration, there was corresponding decrease in oviposition. Clay being a physical deterrent for oviposition

Table 3: Oviposition deterrence and egg hatch inhibition of fruit fly, *Bactrocera tau* by Daman 1% WP (*Beauveria bassiana*)

Concen-tration (%)	Mean egg laying female^{-1*} (±SE)	Deter-rence over control (%)	*Average egg hatch (%)	Times decrease in egg hatch over control
0.1	6.65±0.11	77.46 (61.66)	60.15 (50.86)	1.4
0.5	6.39±0.09	78.23 (62.21)	46.90 (43.20)	1.9
1.0	5.02±0.18	83.40 (65.97)	39.79 (39.10)	2.2
Control (water)	29.96±0.33	-	87.11 (69.14)	-
CD (*p=0.05*)	1.27	(2.32)	(4.68)	

also showed slight inhibitory effect on egg hatchability which varied between 61.00 to 74.50% at three concentrations tested when compared over control (89.70%) (Table 4). No work so far seems to have been conducted on the inhibitory role of Daman (*B. bassiana*) and clay on egg hatching in any of the insect-pest species as no information has been found to exist in literature in support or against the present findings. Clay in the form of kaolin particle film in the name of various commercial products like surround WP has been used as an ovipositional deterrent by a large number of workers on various crops like cotton against pink boll worm (Sisterson et al., 2003); apples, nectarines and persimmons against med fruit fly, *C. capitata* (Mazor and Erez, 2004); olive against olive fruit fly, *B. oleae* (Perri et al., 2006); potato against potato psyllid, *Bactericera cockerelli* (Peng et al., 2011) and citrus against Mediterranean

Table 4: Oviposition deterrence and egg hatch inhibition of fruit fly, *Bactrocera tau* by clay

Concen-tration (%)	Mean egg laying female^{-1*} (±SE)	Deter-rence over control (%)	*Average egg hatch (%)	Times decrease in egg hatch over control
6.0	6.71±0.12	79.16 (62.86)	74.50 (59.75)	1.2
8.0	5.76±0.09	82.01 (64.93)	69.51 (56.62)	1.3
10.0	3.28±0.21	89.29 (70.91)	61.00 (51.50)	1.5
Control (water)	32.44±0.51	-	89.70 (71.94)	-
CD (*p*=0.05)	1.46	(2.69)	(7.01)	-

fruit fly (Verde et al., 2011). The results obtained by all these workers corroborate the findings obtained in the present work concluding that the clay particle film affected egg laying in all the cases due to considerable ovipositional deterrence.

4. Conclusion

Azadirachtin and *Beauveria bassiana* proved effective and can be incorporated in the module for integrated pest management against fruit flies. Clay needs to be further evaluated by using commercial formulation (Kaolin, Surround 50 WP) which has better adherence to surface and hence may prove better.

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