

Original Research Article

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Plant Extract Approaches to the Management of Guava Fruit Fly *Bactrocera correcta* (Bezzi)

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ABSTRACT

Guava is an important fruit of India, rich in minerals and vitamin C. Fruit flies are one of the most noxious pest of guava which can cause tremendous loss to farmers due to its infestation. Since it is a well established fact that pesticides cause health hazards and damage the environment, experiments were laid out during the year 2011-12 and 2012-13 for evaluating bio-efficacy of indigenous plant extracts on guava fruit fly *Bactrocera correcta* (Bezzi) on its emergence and longevity by pupal treatment; as reproductive inhibitor by fruit treatment and effect on maggots of guava fruit fly by sandwich method under the laboratory conditions at departmental of Entomology. The present investigations deal with 10 indigenous plants such as *Azadirachta indica*, *Parthenium histophorum*, *Norium oleander*, *Annona squamosa*, *Cantharanthus roseus*, *Lantana camera*, *Pongamia pinnata*, *Ocimum sanctum*, *Datura stramonium* and *Apocynum cannabinum* used as methanol extract as possible management tools to manage population of guava fruit fly *B. correcta*. As indicated in various experiments; Neem *Azadirachta indica* possesses strong insecticidal and sterilent activity at higher concentration of 8 per cent followed *Lantana camera*, *Pongamia pinnata*, *Ocimum sanctum* and *Datura stramonium*. The effect of plant extracts as inhibitor of reproductive potential displayed a gradual decrease in fecundity with the increase of concentration. In this trial Neem treatment affected fecundity more than longevity, therefore, use of *Azadirachtin* based compound in insecticidal baits appeared possible especially when mixed with attractant substances.

Keywords

Guava fruit,
*Bactrocera
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Neem, Pupal
treatment

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Introduction

Guava (*Psidium guava* L.); a very productive, highly profitable fruit having wide adaptability with higher return per unit area and rich source of vitamin C (Ascorbic acid), is one of the most important fruit crops in India. Fruit flies (Diptera: tephritidae) are most economically important fruit pests

attacking fruits everywhere in the world. The genus *Bactrocera* Macquart, comprises 651 described species with at least 50 species considered to be important pests, many of which are highly polyphagous (Anonymous, 2015). Fruit fly is major limiting factor in production of rainy season guava. Infestation of fruit fly ranged 20-46% with annual crop loss of 16-40% in U.P., India (Haseeb

2005). The adult lays eggs in the fruit causing blemishes and discoloration and the larvae bore inside the fruit making it unfit for consumption. The guava fruit fly, *Bactrocera correcta* (Bezzi) (Diptera: Tephritidae) is one of the most destructive pests in the genus *Bactrocera* (Wang, 1996). The fly was first recorded in 1916 at Bihar, India (Bezzi, 1916) and is now distributed throughout most countries of south East Asia, including Pakistan, India, Nepal, Burma, Thailand, Sri Lanka, Vietnam and China (Wang, 1996; Drew and Raghu, 2002). *B. correcta* is listed as a quarantine pest by most countries worldwide (White and Elson-Harris, 1992).

Plant protection products (more commonly known as pesticides) are widely used in agriculture to increase the yield, improve the quality, and extend the storage life of food crops (Fernandez-Alba and Garc 2008). The use of chemical pesticides in fruit is still necessary to guarantee the worldwide food supply. However, the presence of residues in treated fruit with possible health risk to consumers is a global concern. Therefore, in the present research paper, an effort has been made to find out the bio-efficacy of indigenous plant extracts as eco-friendly and easily available botanical pesticides, against guava fruit fly *B. correcta*.

Materials and Methods

Cage experiments

Plant material

To study various plant extracts on fruit fly *Bactrocera correcta* on guava fruit, 10 plants of indigenous origin were selected to test the emergence, longevity, ovipositor and mortality of maggots in the laboratory of Department of Entomology at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India.

Insect material

Maintenance of culture

For maintenance of fresh culture, infested fruits of guava were collected from guava orchard at farmer's field. The collected fruits were kept in rearing cage 30x30x30 cm in departmental laboratory containing sterilized sand at the bottom of cage (10 cm.) for pupation. After the emergence of adults, males and females were transferred in cage for copulation and allowed egg laying on fresh fruit of guava. Protenex was provided to these adults for food. The eggs were laid by females in small cluster just under the skin of fruit with its ovipositor. These fruits were collected and transferred to another cage for hatching of the eggs. 10 cm sterilized sand was put at the bottom of the cage and water was sprinkled at regular intervals. After a few days the larvae inside the fruit pupated in sand. The temperature was maintained at $25\pm 3^{\circ}\text{C}$ and RH-75%.

Preparation of plant extract

Preparation of methanolic plant extract was done according to Kulkarni and Joshi (1997). The leaves of indigenous plants such as *A. indica*, *P. histophorum*, *N. oleander*, *A. squamosa*, *C. roseus*, *L. camera*, *P. pinnata*, *O. sanctum*, *D. stramonium* and *A. cannabinum* were collected, shade dried and powdered. Extracts were prepared using 100 ml of methanol added in beaker containing 20 gm of grinded powder of each plant. After about 24 hours, this mixture was passed through a coarse filter paper. The desired quantity of methanol was then added in to filtered plant material in order to make the volume of 100 ml. thus 20 per cent (w/v) stock solution of each plant extract was prepared. This stock solution was further diluted in distilled water for experimental uses.

For preparation of different concentrations of plant extracts following formula was applied:-

$$\text{Amount of formulation} = \frac{\text{Concentration required (\%)} \times \text{Quantity required}}{\text{Concentration of technical material}}$$

Pupal dipping

15 Healthy pupae were collected from fresh culture of fruit fly colony and dipped in 2, 5, and 8 per cent plant extract for 5 minutes. These were transferred to jars (1.5lit capacity) containing sterilized sand for emergence in three replications. The data was recorded at 8, 10 and 12 days for adult emergence and longevity. Uniform cultural practices were applied to all the treatments. Ripe fruits were kept for fresh infestation.

Egg laying inhibitor

Whole fruits were treated with plant extract by selecting guava fruit of equal size and spraying with 2, 5 and 8 percent plant extracts in three replications. These were kept in jars of 1.5 lit capacities with 5 cm sterilized sand at bottom. Four pairs of guava fruit fly were released in each jar for egg laying in treated fruit. Old fruit was replaced with fresh treated fruit after every 4th day. The fruit was examined for fresh eggs laid by examining the hatched larvae after 4, 6 and 8 days.

Effect on maggots

The experiment was conducted in laboratory with 11 treatments including control with three replications. Three consecutive instars (Ist, IInd and IIIrd) were tested by sandwich method. The fruit was cut into two halves and 1 ml solution of different plant extracts was sprayed on it. 15 maggots of three consecutive instars were released on the cut fruit and covered with the second halves. The data were recorded after 6, 8 and 10 days for their mortality.

Laboratory hygiene

High hygienic standards were maintained in the laboratory at all production stages. Whole fruit, fruit domes, and important rearing materials such as rearing cages, trays, sponges, racks etc. were frequently rinsed with 0.025% NaCl followed by several rinses in sterile distilled water to eliminate bacterial and fungal infection. The benches were disinfected by wiping with 70% ethanol every morning to prevent infestations by mite which are common causes for drastic reduction in adult emergence.

Statistical design

All experiments testing indigenous plant extracts on guava fruit fly were analyzed by following Completely Randomized Design with 11 treatments and 3 replications.

Results and Discussion

Emergence of adults from treated pupae

Various indigenous plant extracts were tested at 2, 5 and 8 per cent and it was observed that after 6, 8 and 10 days interval, minimum mean emergence of adults recorded was 13.33, 8.89 and 5.93 with 2, 5 and 8 per cent Neem leaf extract, respectively, which was statistically significantly superior among all treatments. This was followed by *P. histophorum*, *D. stramonium*, *P. pinnata* and *O. Sanctum* (Table 1).

Oak (*Apocynum cannabinum*) extract was found least effective in mean emergence of adult fruit flies with maximum 43.70, 40.00 and 36.30 per cent adults emerged at 2, 5 and 8 per cent plant extract, respectively, after 10 days of treatment. Longevity of adults was also maximum recording 61.48, 48.89 and 44.44 per cent mean survival at 2, 5 and 8 per cent concentration, respectively. It was

observed that 8 per cent plant extracts were found most effective. *Neem* leaf extract was found highly significant in reducing adult emergence (Table 2).

Longevity of adults

The longevity of guava fruit fly adult after emergence from treated pupae was assessed after 10, 15 and 20 days of emergence. The indigenous plant extracts at 2, 5 and 8 per cent were tested in the laboratory. *Neem* leaf extract at 8 per cent was found most effective with minimum 7.41 per cent survival of adults. *Parthenium*, *Dhatura* and *Karanj* were also significantly superior over rest of the treatments at 8 percent, with mean survival of 11.11, 13.33 and 16.30 per cent, respectively. As regards the overall impact of botanicals, 8 percent extract was most effective in minimising the longevity. *Neem* leaf extract was found highly significant in reducing adult emergence and longevity of adults of *Bactrocera correcta* (Bezzi) in guava fruits. *Oak*, *lantana* and custard apple were least effective as higher survival percentage was recorded (ranging 34.82-44.44 per cent survival) with them.

Reproductive inhibitor

Different plant extracts at 2, 5 and 8 per cent were tested as egg laying inhibitor by fruit treatment based on number of eggs hatched. 4 pairs of *B. correcta* adults were released in each jar for egg laying. Data were recorded after 4, 6 and 8 days of release of adults. Among all the concentrations tested, 8% per cent extracts were proved most promising in inhibiting reproductive capacity of adults as shown in Table 3. The egg fertility was lower in *Neem* leaf extracts where minimum egg fertility of 8.89, 6.67 and 4.44 per cent was recorded after 4, 6 and 8 days of release, respectively. In order of efficacy, *Parthenium* followed by *Dhatura* registered a mean of

8.89 and 11.11 per cent egg fertility after the total observation period. *Oak* (*A. Cannabium*) was proved least effective followed by *Lantana* (*L. camera*), registering 26.67 per cent and 24.4 mean egg fertility.

It is worth mentioning here that *Neem* and *Parthenium* extracts were statistically at par while *Dhatura* and *Karanj* did not show significance among themselves. Alcohol applied as standard showed highly deterrent effect on reproductive capacity of female as it was significantly superior in all other treatments. All the treatments were found significantly superior from control.

Effect on maggots

Different instars of larvae of *B. correcta* were fed on treated slice of guava by sandwich method. The concentrations used were 2, 5 and 8 per cent. Mortality of maggots was recorded at 6, 8 and 10 day intervals (Table 4) (Fig. 1, 2 and 3).

Among all the treatments, *Neem* leaf extract at 8 per cent imparted maximum mortality of I, II and III instar larvae, at 6, 8 and 10 days after treatment. The mean mortality was 47.41, 45.19 and 37.78 per cent for I, II and III instar larvae in *Neem* leaf extract at 8 per cent. *Oak* with minimum mortality per cent followed by *Lantana* and custard apple showed that their extracts were poor in causing high mortality in maggots. Among all plant extracts *Neem* formulation was found most effective and I instar larvae were more susceptible in comparison to II and III instar. This means that early, stage of maggot can be managed by indigenous plant extracts. However, alcohol as standard solvent caused maximum mortality, the sequence of intensity of different plant extracts was recorded as follows: *Neem*>*Parthenium*>*Dhatura*>*Karanj*>*Tulsi* >*Kaner*>*Vinca rosea*>*Custard apple*>*Lantana* and *Oak*.

The present investigation deals with the first attempt with indigenous plant extracts as possible management tools to manage population of guava fruit fly *Bactrocera correcta* aiming to reduce pesticide application. A viable crude plant extracts needs to be finely tested to be successful with the guava growers.

In controlled conditions, among ten plant extracts tested, Neem leaf extract was found most effective after 6, 8 and 10 days, followed by Parthenium and Dhatura with excellent results. Tulsi and Karanj also showed significant results. Oak was least effective with maximum mean emergence of adults which was closely followed by lantana at all concentrations. It is in line with the previous work by Stark *et al.*, (1990) who reported effect of Azadirachtin on metamorphosis, longevity and reproduction of three tephritid fruit fly species. The adult emergence was inhibited by 1440 ppm for *D. dorsalis* and 1010 ppm for *B. cucurbitae*. Karnataka *et al.*, (2007) determined effect of Tulsi (*O. sanctum*) leaf extract on the growth and development of *Spilarctia obliqua* and found lowest adult emergence with 10% leaf extracts. Agrawal and Saroj (2003) found that fresh Neem oil at 2 per cent showed pupal inhibition and inhibitory effect on adult emergence in the mustered sawfly *Athalia proxima* (Clug.). Shivayya and Kumar (2008) managed melon fruit fly *B. cucurbitae* (Coquillett) by using plant products and found that adult emergence was lowest in Neem oil treatment whereas highest per cent infestation was in custard apple seed extracts. Pupal dipping method of *B. Cucurbitae* was studied by Agrawal and Dev (2013a and 2015) who reported Neem and Parthenium extracts as most promising. These results are in conformity to the present investigation where Neem leaf extract performed best with minimum emergence while Oak *A. cannabium* resulted in higher emergence of fly from treated pupae.

In the present study longevity of guava fruit fly was minimum with 7.41 per cent survival. Parthenium, Dhatura and Karanj with survival of 11.11, 13.33 and 16.30 per cent were also significantly superior over rest of the treatments at 8 per cent concentration.

As regards reproductive inhibition by these plants, egg fertility was at par in NLE and Parthenium while *Dhatura* and *Karanj* did not show significance among themselves. Neem seed kernel extract had a deterrent effect on oviposition of the *Bactrocera dorsalis* (Hendal) as evaluated by Chien *et al.*, (1996) in laboratory on guava fruit fly. They found that concentration ranging 0.2 to 0.4 per cent reduced the number of eggs laid in treated guava. Hasan (1998) reported the repellency effect of NSKE at active ingredient 7% *Azadirachtin* by fruit dipping method and subsequently exposed to cage of adult fly, *Bactrocera tryoni* (Frogg). Khan *et al.*, (2007) confirmed that Neem can be effectively used as fecundity deterrent for the control of *Bactrocera* spp. These results indicate that plants may possess strong sterilant activity and are in conformity to the present findings. However, literature seems silent on other plant extracts used such as Parthenium, Dhatura and Karanj which cannot be overlooked as reproductive inhibitor.

Experiments conducted on larval mortality by sandwich method revealed that, again Neem leaf extract at 8 per cent was most suitable for mortality of I, II and III instar maggots (pooled 43.46%). Pooled data (Fig. 1, 2 and 3) revealed that Oak with minimum mortality of 16.05 percent, Lantana (19.01 per cent) and custard apple (21.73 per cent) showed that their extracts were poor in causing high mortality in maggots. Kulkarni *et al.*, (1997) reported antifeeding property of *Lantana camara* against teak skeletonizer *Eutectona machaeraelis* Walks. Fakhari and Murad (2004) reported efficacy of Neem product on forth instar nymph of red cotton bug, while

Ramesh *et al.*, (2006) reported larvicidal and repellent activity of *A. Indica* on *Culex quinquefasciatus*. All these results are very much similar to the present investigation where Neem leaf extracts (NLE) was found to be most effective. *Ocimum* leaf extract (Tulsi) was exploited by Karnatka *et al.*, (2007) against *S. obliqua* where highest larval mortality and lowest pupal weight and adult emergence with 10% *O. sanctum* leaf extract were noticed. Sharma and Rathore (2006) reported the efficacy of NSK, *Vinca rosea*, *Annona* and *Datura* leaf powder on development of *Challosobruchus chinensis* in pigeon pea and found that NSK and *Annona* seed powder gave complete protection against the pest. In the present investigations Tulsi, *O. sanctum* showed higher bio-efficacy against different instars of guava fruit fly but *Annona* was comparatively inferior.

Effect of plant extracts on different fruit flies infesting fruits and vegetables were explored by many workers such as Tiwari (2001) who reported that *P. pinnata* and *A. indica* significantly reduced the population of *B. cucurbitae* (Coquillett) and reduced transmission of cucumber mosaic virus by *B. cucurbitae* (Coquillett) in *Cucumis melo*

cultivar. Siskos *et al.*, (2007) worked on insecticidal activity of plant extracts of *Citrus aurantium* against olive fruit fly *Bactrocera oleae* (Gmll) and found that petroleum ether extract from seed showed insecticidal properties. According to Khan *et al.*, (2007) Neem leaf dust and commercial formulation compound affected the longevity of *B. cucurbitae* and *B. dorsalis* and confirmed that Neem can be effectively used as safe insecticide for control of *Bactrocera spp.* Mondal and Ghatak (2009) tested some indigenous plant product against *B. cucurbitae* and reported that NSKE and methanol extracts of *Annona squamosa* caused significant reduction in fruit damage. Kaur *et al.*, (2010) studied inhibitory effect of *Acacia auriculiformis* on *B. cucurbitae* (Coquillett) and reported that acetone extract was more toxic than water extract in controlling melon fruit fly.

Utilization of natural products derived from indigenous plants to control insect pest have been reported by different workers but a thorough scan of literature revealed that bio-efficacy of indigenous plant extracts against guava fruit fly. *B. correcta* (Bezzi) has not yet been explored.

Table.1 Different indigenous plants used for making extracts

Sl. No.	Common Name	Scientific Name
1	Neem	<i>Azadirachta indica</i>
2	Parthenium	<i>Parthenium histophorum</i>
3	Kaner	<i>Norium oleander</i>
4	Custard apple	<i>Annona squamosa</i>
5	<i>Vinca rosea</i>	<i>Cantharanthus roseus</i>
6	Lantana	<i>Lantana camera</i>
7	Karanj	<i>Pongamia pinnata</i>
8	Tulsi	<i>Ocimum sanctum</i>
9	Datura	<i>Datura stramonium</i>
10	Oak	<i>Apocynum cannabinum</i>

Table.2 Bio-efficacy of indigenous plant extracts on treated pupae of guava fruit fly *Bactrocera correcta* based on emergence and longevity of adults

Sl No.	Treatments	Percent mean emergence of adults			Percent mean longevity of adults emerged from treated pupae		
		2 percent	5 percent	8 percent	2 percent	5 percent	8 percent
1	<i>Azadirachta indica</i>	13.33(21.41)	8.89(17.34)	5.93(14.09)	14.07(22.03)	11.85(20.13)	7.41(15.79)
2	<i>Parthenium histophorom</i>	15.56(23.23)	11.85(20.13)	9.63(18.07)	17.78(24.93)	15.56(23.23)	11.11(19.47)
3	<i>Norium oleander</i>	29.63(32.97)	26.67(31.09)	22.96(28.63)	39.26(38.79)	29.63(32.97)	25.19(30.12)
4	<i>Annona squamosa</i>	37.04(37.48)	33.33(35.26)	30.37(33.44)	49.63(44.78)	39.26(38.79)	34.82(36.16)
5	<i>Cantharanthus roseus</i>	32.59(34.81)	29.63(32.97)	25.92(30.60)	45.18(42.23)	35.56(36.60)	29.63(32.97)
6	<i>Lantana camera</i>	40.74(39.66)	35.56(36.60)	32.59(34.81)	57.04(49.04)	44.44(41.80)	40.74(39.66)
7	<i>Pongamia pinnata</i>	22.96(28.63)	19.26(26.03)	16.30(23.81)	30.37(33.44)	20.74(27.09)	16.30(23.81)
8	<i>Ocimum sanctum</i>	25.92(30.60)	22.96(28.63)	19.26(26.03)	31.11(33.90)	24.44(29.62)	20.00(26.39)
9	<i>Dhatura stramonium</i>	18.52(25.48)	15.56(23.23)	20.74(27.09)	22.22(28.12)	17.78(24.93)	13.33(21.41)
10	<i>Apocynum cannabinum</i>	43.70(41.38)	40.00(39.14)	36.30(36.97)	61.48(51.63)	48.89(44.35)	44.44(41.80)
11	Alcohol	8.89(17.34)	6.67(14.96)	3.70(11.09)	10.37(18.78)	7.41(15.79)	4.44(12.16)
12	Control	88.15(70.70)	88.89(70.52)	85.93(67.96)	69.63(56.72)	65.19(53.84)	63.70(52.95)
	SE	(1.79)	(1.39)	(1.13)	(1.33)	(1.09)	(1.20)
	CD	(3.70)	(2.87)	(2.33)	(2.75)	(2.04)	(2.12)

Figures in parentheses are angular transformed values

Table.3 Mean per cent of hatched larvae after 8 days of fruit treatment.

Sl No.	Treatments	Mean percent of eggs hatched on treated fruit		
		2 percent	5 percent	8 percent
1.	<i>Azadirachta indica</i>	14.07(22.03)	11.11(19.47)	6.67(14.960)
2.	<i>Parthenium histophorom</i>	18.52(25.48)	13.33(21.41)	8.89(17.341)
3.	<i>Norium oleander</i>	32.59(34.81)	22.96(28.63)	17.78(24.936)
4.	<i>Annona squamosa</i>	37.04(37.41)	27.41(31.57)	22.22(28.129)
5.	<i>Cantharanthus roseus</i>	34.81(36.15)	26.66(31.08)	20.00(26.263)
6.	<i>Lantana camera</i>	40.74(39.66)	25.93(30.61)	24.44(29.621)
7.	<i>Pongamia pinnata</i>	25.18(30.11)	18.52(25.48)	13.33(21.419)
8.	<i>Ocimum sanctum</i>	28.15(32.04)	18.52(25.48)	15.56(23.234)
9.	<i>Dhatura stramonium</i>	22.22(28.12)	15.18(27.09)	11.11(19.472)
10.	<i>Apocynum cannabinum</i>	44.44(41.80)	33.33(30.11)	26.67(31.090)
11.	Alcohol	11.11(19.47)	7.40(23.81)	4.44(12.161)
12.	Control	65.93(54.32)	73.71(49.07)	63.70(52.952)
	SE	(1.33)	(0.96)	(1.38)
	CD	(2.75)	(1.99)	(2.84)

Figures in Parentheses are angular Transformed values.

Table.4 Bio-efficacy of plant extracts on different instars against guava fruit fly *Bactrocera correcta* by sandwich method based on mortality

Sl No.	Treatments	Mean mortality (%) of maggots of guava fruit fly <i>Bactrocera dorsalis</i> at different stages								
		1 st Instar			2 nd Instar			3 rd Instar		
		Concentration of extract			Concentration of extract			Concentration of extract		
		2%	5%	8%	2%	5%	8%	2%	5%	8%
1.	<i>Azadirachta indica</i>	37.04 (37.49)	44.45 (41.81)	47.41 (43.51)	31.85 (34.35)	41.48 (40.09)	45.19 (42.23)	26.67 (31.09)	33.33 (35.26)	37.78 (73.92)
2.	<i>Parthenium histophorum</i>	34.08 (35.71)	41.48 (40.09)	43.71 (41.38)	28.89 (32.51)	38.52 (38.36)	41.48 (40.09)	23.71 (29.13)	30.37 (33.44)	34.07 (35.71)
3.	<i>Norium oleander</i>	22.96 (28.63)	28.89 (32.51)	30.37 (33.44)	19.26 (26.03)	26.67 (31.09)	29.63 (32.97)	14.07 (22.03)	19.26 (26.03)	21.48 (27.61)
4.	<i>Annona squamosa</i>	17.04 (24.38)	22.22 (28.12)	24.44 (29.62)	13.33 (21.41)	20.74 (27.09)	23.70 (29.13)	9.63 (18.07)	14.07 (22.03)	17.04 (24.38)
5.	<i>Cantharanthus roseus</i>	20.00 (26.56)	25.18 (30.11)	27.41 (31.57)	16.30 (23.81)	23.70 (29.13)	26.67 (31.09)	11.85 (20.13)	16.30 (23.81)	19.26 (26.03)
6.	<i>Lantana camera</i>	12.59 (20.78)	18.52 (25.48)	21.48 (27.61)	10.37 (18.78)	18.52 (25.48)	20.74 (27.09)	7.41 (15.79)	11.85 (20.13)	14.82 (22.64)
7.	<i>Pongamia pinnata</i>	28.15 (32.04)	34.82 (36.16)	38.52 (38.36)	23.70 (29.13)	31.85 (34.35)	34.82 (36.16)	19.26 (26.03)	24.45 (29.63)	27.41 (31.44)
8.	<i>Ocimum sanctum</i>	25.92 (30.60)	31.85 (34.35)	35.56 (36.60)	21.48 (27.61)	28.89 (32.37)	32.59 (34.81)	16.30 (23.57)	21.48 (27.61)	24.45 (29.63)
9.	<i>Dhatura stramonium</i>	31.11 (33.71)	37.78 (37.84)	41.48 (40.09)	26.67 (30.99)	34.82 (36.16)	37.78 (37.92)	21.48 (27.61)	26.67 (31.09)	30.37 (33.44)
10.	<i>Apocynum cannabinum</i>	9.63 (18.07)	15.56 (23.23)	25.18.18.52 (13)	6.67 (14.96)	14.82 (22.64)	17.78 (24.93)	5.18 (13.15)	8.89 (17.34)	11.85 (20.13)
11.	Alcohol	42.22 (40.52)	51.11 (45.63)	54.82 (47.76)	35.56 (36.57)	44.44 (41.80)	48.89 (44.35)	29.63 (32.97)	36.29 (36.99)	40.74 (39.66)
12.	Control	2.96 (9.90)	2.22 (8.56)	2.96 (9.90)	1.48 (6.98)	0.74 (4.93)	10.37 (18.78)	0.74 (4.93)	2.22 (8.56)	0.74 (4.93)
	SE	1.48	(1.26)	1.42	1.16	(1.20)	(1.36)	1.12	(0.84)	(1.07)
	CD	(3.04)	(2.60)	(2.94)	(2.39)	(2.48)	(2.80)	(2.30)	(1.75)	(2.20)

Figures in parentheses are angular transformed values; Note: The data given in table 4 are the mean of mortality per cent of maggots after 6th, 8th and 10th days of spray of indigenous plant extract.

Fig.1 Mortality (%) of maggots of guava fruit fly *Bactrocera correcta* at 2, 5 and 8 per cent plant extracts on I larval instar stage

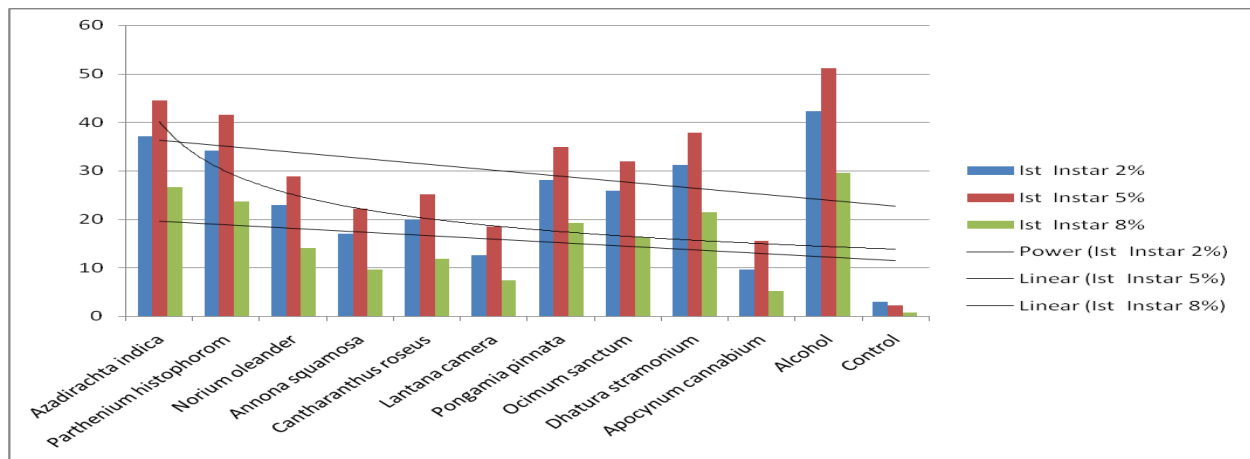


Fig.2 Mortality (%) of maggots of guava fruit fly *Bactrocera correcta* at 2, 5 and 8 per cent plant extracts on II larval instar stage

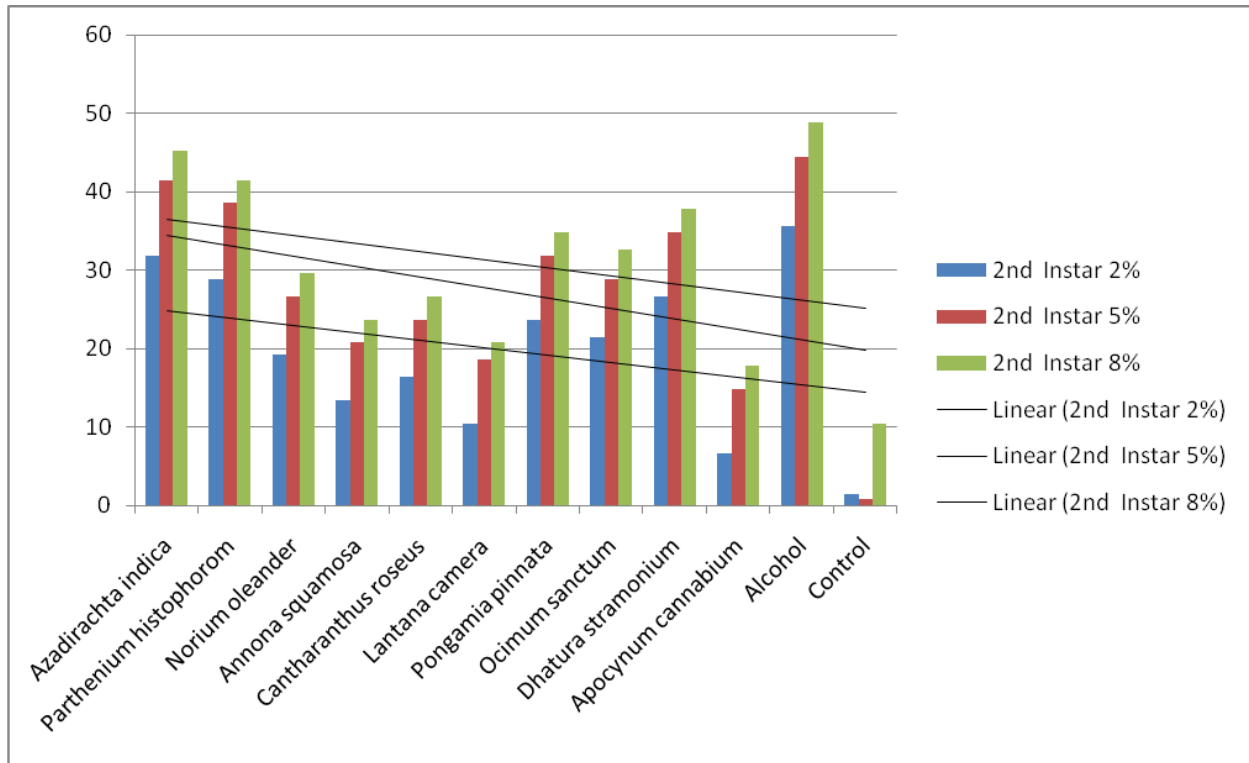
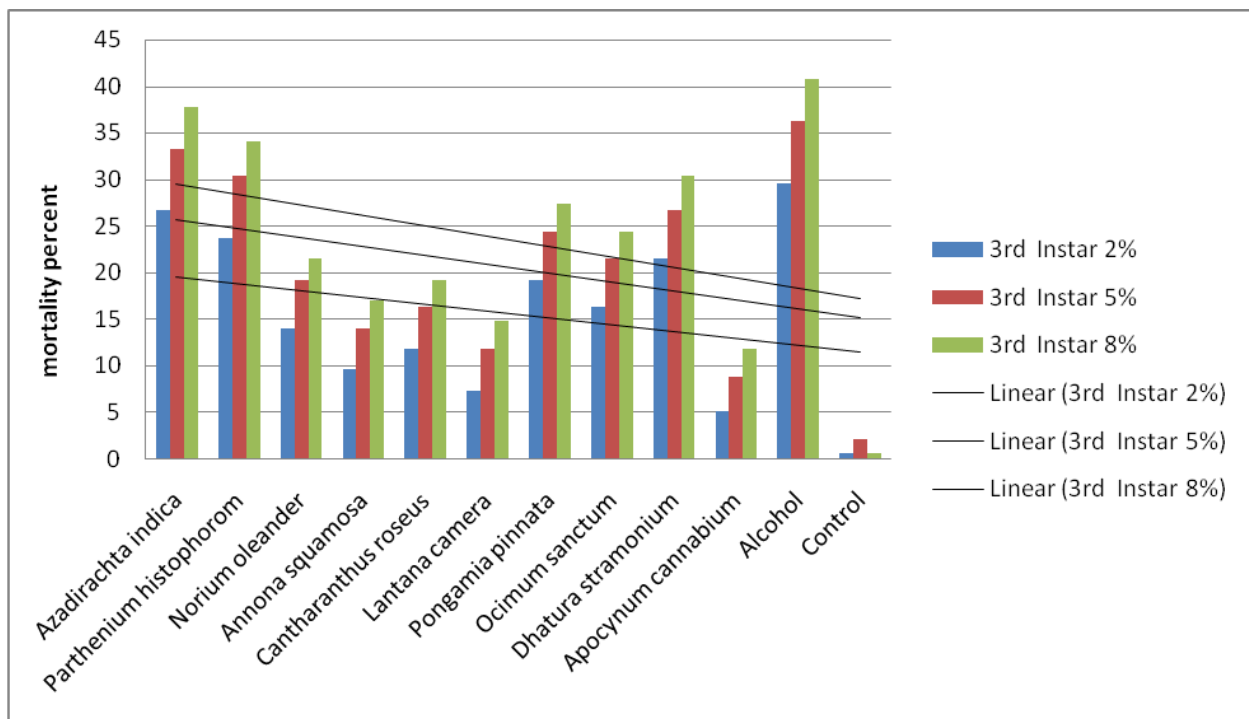


Fig.3 Mortality (%) of maggots of guava fruit fly *Bactrocera correcta* at 2, 5 and 8 per cent plant extracts on III larval instar stage



Our study clearly revealed the susceptibility of *B. correcta* to different indigenous plants as indicated by their deleterious effect on growth and development of guava fruit fly which could be more beneficial to farmers growing guava in India where it is known as poor man's 'apple', however, farmers need to be trained to be successful.

In conclusion, tropical countries have rich Bio-diversity of plants in which botanical pesticides are emerging as a fast and viable component of integrated pest management tools because of its eco-friendly nature. The toxic effect of plant extract is synergistic effect of secondary compounds which are postulated to have evolved for the plants defence. These compounds confirm protection to crop through reduction of fitness to insect herbivores. Neem and Parthenium are found more or less everywhere and they can be utilized as growth inhibitory tools in insect pest management. Although the plant extracts may be less toxic, they are relatively safe and eco-friendly.

Author contribution statement

NA suggested and formulated, comprehended and designed the experiments, SKV performed the experiments in laboratory as Ph.D. Scholar while RK developed the tables, graphs and computer application in statistical analysis and all authors wrote the manuscript. This technique can be applied to find other indigenous plants/botanicals to exploit their uses as growth regulator, egg laying inhibitor and may have insecticidal properties in the era of chemical pesticide that is becoming a health hazards in 21st century where people are very conscious to their health

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