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Bio- efficacy of selected botanicals against cotton Mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in Okra

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Abstract
Okra *Abelmoschus esculentus* L. (Moench), an important vegetable crop grown in tropical and sub-tropical parts of world. Where India ranks first in its production. It's an important component of human diet, as it is rich in many nutrients. Also it is used in medical industry, paper industry, preparation of brown sugar, etc. But reduction in yield of Okra is noticed widely, due its pests and diseases. In which cotton Mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) gaining more importance in agricultural and horticultural crops including okra. For controlling this pest many insecticides are used by farmers, which are also harmful to environment. Hence botanical control of pests is gaining importance now a days. Here for testing bio-efficacy two botanicals namely, Knicker nut (*Caesalpinia bonducella*) and Tulsi (*Ocimum sanctum*) leaves of different concentration viz, 1%, 2%, 4%, 8% and 10% in methanol, ethanol and aqueous solvents were tested against *Phenacoccus solenopsis* for percent mortality and repellency at 12, 24, 48 hours in laboratory condition. In which 10% ethanol extract of *O. sanctum* at 48 hours shows 100% mortality and the highest percent repellency recorded was in the treatment with 10% ethanol extract of *C. bonducella* (97.56%) at 48 hours. Hence both the botanicals were showed positive effect on *Phenacoccus solenopsis* for its control.

Keywords: Okra, cotton Mealybug, botanicals, *Caesalpinia bonducella*, *Ocimum sanctum*, bio-efficacy

Introduction
Okra *Abelmoschus esculentus* L. (Moench), is an economically important vegetable crop belonging to family Malvaceae and grown in tropical and sub-tropical parts of the world. This vegetable is considered as the important component of human diet. It contains carbohydrates, proteins, fat, vitamin A, vitamin C, vitamin B6, folic acid, calcium, magnesium, potassium, iron, zinc, β carotene, riboflavin and fibre (Gopalan *et al*., 2007; Farinde *et al*., 2007; Dilruba *et al*., 2009; Saifullah and Rabbani, 2009; Varmudy, 2011) [7, 5, 4, 19, 26]. Besides okra being used as in diet, it is also used for thickening gravies and soups, because of its high mucilage content. Matured fruits and stems containing crude fibre are used in paper industry. The roots and stems of okra are used for clarification of sugarcane juice from which gur or brown sugar is prepared. Okra is said to be very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery. Its medicinal value has also been reported in curing ulcers and relief from hemorrhoids.

The global area and production under okra is reported to be 1148.0 thousand ha and 7896.3 thousand tons respectively. Largest area and production is in India (72% of the total world production) followed by Nigeria. In India the land under cultivation of okra is about 501.00 ha and production is about 5783.00 tons (2016-2017). In India the productivity is about 11.60 mt/ha. In Tamil Nadu area under cultivation is 11 thousand ha and the production is 75.4 thousand tons (2014-15). Major okra producing states in India includes Andhra Pradesh, Assam, Bihar, Chhattisgarh, Maharashtra, Jharkhand, Gujarat, West Bengal and Orissa.

While considering the pest status of different crops sucking pests like Mealybug, aphids, white flies were gaining importance. Presently, a Mealybug species, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae), has emerged as a major pest of cotton, vegetables and fruits (Tanwar *et al*., 2008) [24]. Both nymphs and adults cause damage by sucking the plant sap from the growing points resulting the infested plants to lose their vitality, remain stunted, leaves turning yellow, dry up and finally death of plants in case of heavy infestation.

In India, *P. solenopsis* has been reported on many crops (Suresh & Kavitha, 2008) [23] and is found to cause economic losses in various states including Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh and Tamil Nadu (Nagrare *et al*., 2009) [13]. HencetThere is a need for undertaking adaptive strategies against this pest to lessen the yield losses and safeguard the interest of crop growers (Babasaheb *et al*., 2014) [1].

In an intention to manage the insect pest, farmers mostly rely on insecticides (Saeed *et al*., 2007) [18]. No doubt they are providing hopeful results in eradication of insects and pests but they are also killing useful organisms present in soil due to which the fertility of the soil is rapidly declining (Isman *et al*., 2006) [9]. Thus there is renewed interest in the application of botanical pesticides for crop protection. Botanical pesticides are biodegradable and their use in crop protection is a practical sustainable alternative. It maintains biological diversity of predators, and reduces environmental contamination and human health hazards. Therefore the present study attempts to evaluate the efficacies of some native botanicals against cotton mealybugs in okra. They induce fumigant and topical toxicity as well as antifeedant or repellent effects. They are toxic to adults but also inhibit reproduction. Although mechanisms depend on phytochemical patterns and are not yet well known, this widespread range of activities is more and more being considered for both industrial and household uses for controlling insect pests.

Materials and Methods

The present study entitled as "Bio-efficacy of selected botanicals against Cotton Mealybug, *Phenacoccus solenopsis* L. (Pseudococcidae: Hemiptera) on okra" was carried out during 2016-2018 in the Department of Entomology, Faculty of Agriculture, Annamalai Nagar, Chidambaram, Tamil Nadu. The following are the description about the materials and methods performed to conduct the study.

Collection on plant materials

The plant materials were collected from different places of Tamil Nadu. The leaves of Knicker nut (*Caesalpinia bonducella*) were collected from Virudhachalam (11.50°N 79.33°E) Tamil Nadu. The leaves of Tulsi (*Ocimum sanctum*) were collected from Theni (10.009°N 77.47°E) Tamil Nadu. The collected materials were packed in separate zip-lock pouches and were labeled and stored under cool, dry condition in room temperature 27 ± 2 °C and 75% relative humidity.

Extraction of plant material

The collected plant materials were washed with water and shade dried for duration of about five to seven days. Then the shade dried samples were powdered using the Willey mill. 50 g of powdered botanicals from each was weighed and transferred to a cellulose extraction thimble. These powders were loaded in Soxhlet apparatus and refluxed with ethanol, methanol and water for 8 hours and the extracts were decanted from the flask separately. The extracted solvents were evaporated in a hot plate. The final extracts were elucidated with corresponding solvents and used for the evaluation of experiments. Further dilutions were made for further experiments (Prishanthini, 2013) [16].

Storage and packing of plant extracts

The botanical extracts were stored in tight, light- resistant containers and were avoided from exposure to sunlight and excessive heat. These extracts were placed under refrigerated condition at 4 °C in separate bottles for maximum of three days. Freshly prepared extracts were utilized for each batch of bioassay. Labeling was done to indicate the name of the plant part used and the names of the solvents used in extraction.

Culturing of test insect

The test insect cotton Mealybug (*Phenacoccus solenopsis)* were collected from infested plants of okra and were ensured that the plants were not treated with pesticides and had no residues of chemicals. The Mealybugs were then introduced to a pumpkin that was well ripe and had prominent grooves in them. To ensure multiplication of Mealybug the grooves were given slight cuts and honey solution was dripped in the grooves. Before the introduction of the test insect on the pumpkin, the pumpkin was sterilized using 1% bavistine solution and the cage (45 cm x 40 cm x 40 cm) into which the pumpkin was placed was sanitized. The cage was wrapped with sheets of paper to ensure shade for the multiplication of the Mealybugs. In the laboratory, the maximum and the minimum temperature and relative humidity of the study area ranged from 25.6 to 36.5 °C and 23.4 to 25.5 °C, and 40.5 to 92.5% RH respectively.

Transferring the Mealybugs from infested plants to pumpkin was done using a camel hair brush (No.1). After introduction of test insect on the pumpkin, the emergences of ovisacs were witnessed in a couple of weeks. Observations on survival and molt of the crawlers were recorded daily under stereoscopic microscope.

Evaluating the Biocidal properties of plant extracts against *Phenacoccus solenopsis*

Laboratory bioassay: On-plant assay for Mortality Assessment

The test insects (crawlers and adults) were transferred to fifteen days old seedlings of okra (*Abelmoschus esculentus*) separately at 10-15 insects/plant and allowed to settle. After 24 hours, artificially infested plants were treated with various doses of various plant extracts separately. Three replications were maintained for each treatment. Observations were made on the mortality of crawlers and adults after 12, 24 and 48 hours of treatment. The doses of plant extracts tested under on-plant bioassay were 1, 2, 4, 8, and 10% per plant. The mealybug that lacked mobility was considered dead and taken into account. The mortality records for all treatments were obtained in percentage values.

Percent corrected mortality was calculated by following formula described by Schneider-Orelli's (1947) and Puntener (1981) [21, 17].

$$\% \text{ mortality over control} = \frac{\% \, mortality \, in \, treatment - \% \, mortality \, in \, control}{100 - \% \, mortality \, in \, control} \times 100$$

Laboratory bioassay: For Repellency Assessment

This bioassay was conducted to determine the repellency property of the selected botanical extracts and untreated check at five different concentrations such as 1, 2, 4, 8, and 10 percent respectively against cotton Mealybugs on okra.

A promising variety of okra (*Arka anamika*) was selected as a test variety for this study. About 15 days old saplings under greenhouse condition was developed with necessary culture practices. The botanical plant extracts were treated with

means of an atomizer on the okra plant. It was allowed to dry for a while in the normal greenhouse temperature. About 20 second instar Mealybug nymphs were released on the treated plant and were examined for its repellent movement.

The plant extracts of different dose levels (1, 2, 4, 8, and 10%) were treated on the okra plants. The repellent effect of the botanical leaf extracts were calculated by repellent movement of these Mealybugs away from corresponding treated okra plant. Appropriate observations were recorded at 24 and 48 hours after insect release on the okra plants. The experimental treatments were replicated thrice and subjected to the statistical analysis for its significance among various botanical leaf extract treatments (V. Sathyaseelan and V. Bhaskaran, 2010) [25].

Percentage repellency (PR) values were computed using the formula suggested by Singh *et al* (2012) [22]:

$$PR = [(NC - NT)/ (NC+NT)] \times 100$$

Where NC = no. of insects present on control
NT = no. of insects on the treated plant

Statistical analysis

The recorded data in the experiments were subjected to analysis of variance (ANOVA) under Completely Randomized block design by adopting the procedures described by Gomez and Gomez (1984) [6]. Necessary data transformation was made before analysis and the computer based on OPSTAT package was used for the calculation.

Results and Discussion

The bioassay was conducted with two botanicals namely *Caesalpinia bonducella* and *Ocimum sanctum* were tested for biocidal and repellence property against *P. solenopsis* in laboratory conditions. All the extracts i.e. methanol, ethanol and aqueous extracts showed both biocidal and repellence effect against the test insect. In the results of percent mortality, among the methanol extract at 48 hours 10% leaf extract of *Caesalpinia bonducella* shows maximum mortality of (90.17%) followed by 10% leaf extract of *O. sanctum* (88.96%). At 48 hours 10% Ethanol leaf extract of *O. sanctum* revealed maximum mortality (100%) followed by 10% leaf extract of *Caesalpinia bonducella* (87.91%). Within the aqueous extracts at 48 hours the maximum mortality was observed in 10% aqueous leaf extract of *O. sanctum* (97.21%) followed by 10% leaf extract of *C. bonducella* (81.59%). Overall peak mortality effect was revealed in treatment 10% ethanol extract of *O. sanctum* at 48 hours. The percent mortality as recorded as 100% for the above botanical extract. This was followed by 10% aqueous extract of *O. sanctum* that showed 97.21% mortality of test insect and the least performance was by 10% aqueous extract of *C. bonducella* that recorded 81.59% mortality.

In relevance to repellency among the methanol extracts of botanicals the best results regarding the repellency of *P. solenopsis* was observed with 10% leaf extract of *O. sanctum* (92.43%) followed by 10% leaf extract of *C. bonducella* (89.02%) at 48 hours. In ethanol extracts highest repellence effect as exhibited by 10% leaf extract of *C. bonducella* (97.56%) followed by 10% leaf extract of *O. sanctum* (88.34%) at 48 hours. The 10% aqueous leaf extract of *O. sanctum* (84.52%) shows maximum repellency followed by 10% leaf extract of *C. bonducella* (79.03%) at 48 hours. The highest percent repellency recorded was in the treatment with 10% ethanol extract of *C. bonducella*. The percent repellency was 97.56% in 48 h interval after treatment with extract. It was followed by 10% methanol extract of *C. bonducella* (89.02%). The least repellent activity was revealed in treatment with 10% aqueous extract of *C. bonducella* (79.03%).

Saravanan *et al.* (2007) [20] reported mosquito larvicidal properties of various extract of leaves and fixed oil from seeds of *C. bonducella* (L.) Roxb. A preliminary laboratory trial was undertaken to determine the efficacies of petroleum ether, ethanol, and aqueous extracts of dried leaves and fixed oil from the seeds of *C. bonducella* (L.) Roxb at various concentrations against the fourth instar larvae of *Culex quinquefasciatus.* Hundred percent mortality was observed in 1% concentration of petroleum ether and ethanol extract of leaf, whereas it was 55% in 2.5% concentration of aqueous extract and 92.6% in 2.5% concentration of fixed oil. In the current study, the ethanol extract of *C. bonducella* showed 87.91% mortality at 10% concentration in 48 h after treatment when used against the test insect *P. solenopsis*.

Backiyaraj *et al.* (2014) [2] stated the bioefficacy of *Caesalpinia bonducella* against *Helicoverpa armigera* and also claimed that the methanol extract of *C. bonducella* was found to be effective. The methanol extract of *C. bonducella* was reported to exhibit maximum larvicidal activity. In contradiction, it was claimed that choloroform extract of *Caesalpinia bonducella* was effective against *Helicoverpa armigera.* Maximum pupicidal activity and also antifeedant property was observed when the larvae were treated with 1000 ppm of the extract (Kathirvelu *et al.*, 2018) [11].

Alike the above studies conducted with extracts of *C. bonducella*, the present study revealed that the methanol extract of *C. bonducella* exhibited about 90.17% mortality with 10% concentration in 48 h against the cotton mealybug (*Phenacoccus solenopsis*) in okra plants. The aqueous extract of *C. bonducella* was considered least effective when paralleled with other two extracts of *C. bonducella.*

Though *C. bonducella* extracts were moderate mortality rate than other extracts, the repellency effect of the ethanol leaf extract of *C. bonducella* was effective and resulted in 70.4%, 96.09% and 97.56% repellency in 12h, 24h and 48 h respectively.

Sathyaseelan and Bhaskaran (2010) [25] found the higher repellency by *O. basilicum* L. (90.1%) methanol leaf extract after 48 h of release of against *Maconellicoccus hirsutus* Green. which was a major pest of mulberry crop. Similarly the present study showed 92.43% repellency in 48 h at 10 % concentration.

The study about botanical extract against *Maconellicoccus hirsutus* revealed that the percent repellency was noted as 88.4% and 90.1% (Sathayaseelan and Bhaskaran, 2010) [25] at 10% concentration of the methanol extract of *O. sanctum* in 12h and 24 h observations and similar results like the previous study was seen in the present study of interest. The percent repellence was 88.24% at 24 h and 92.43% in 48h interval with highest concentration of 10%.

Oladimeji and Kannik (2010) [15] found that *O. basilicum* L. leaf extract were not phytotoxic but increase in concentrations increased its effectiveness against *Podagrica* spp. Jac and its treated field yield was higher when compared to the treated synthetic pesticides in okra fields. Okigbo *et al*. (2010) [14] recorded that 100% mortality to *Culex* larva species after 24 h at a concentration of 40% whereas, 100% mortality was seen at 50% concentration of *Ocimum gratissimum* L. after 24 h.

Inang and Emosairue (2005) [8] found good repulsion and antifeedant activity of aqueous solution of *O. gratissimum* L. leaves against banana weevil *Cosmopolites sordidus* Germar in Nigeria.

In addition to the findings of the *E. globules* being a repellent against storage pests, Bhuwan *et al.* (2012) [3] suggested that *Ocimum* species also serves as a repellent to storage insects and its efficacy increases with concentration.

In a study conducted by Singh *et al.* (2012) [22] reported that the repellence effect of methanol extract of *O. basillicum* against *P. solenosis* was moderately effective when compared with the methanol extract of *E. globules i.e.* the former study depicts that the percent repellency was 64.67% at 10% concentration in 12 h and 93% at 10% concentration in 24 h with regards to *E. globules* and on the other hand it was 54% in 12 h and 88% in 24 h at 10% concentration with regards to *O. basillicum*. This was also the case in the current study. The methanol extracts of *E. globules* performed moderate in concern with repellence effect than the methanol extract of *O. sanctum.* The maximum repellency effect unveiled by the methanol extract of *O. sanctum* was 58.34% in 12 h and 88.28% in 24 h intervals whose effect was less compared to *E. globules.*

According to the study conducted by Prishanthini and Vinobaba (2013) [16] the ethanol extract of *O. sanctum* achieved maximum level of percent mortality hen tested with various botanicals both in laboratory and field level trials. The percent mortality of the *P. solenopsis* was recorded to be 91.67% and 100% at 1% and 2% concentration in 24 hours in laboratory conditions. More or less parallel results were obtained in the present study with application of ethanol extract of *O. sanctum* against *P. solenopsis.* The percent mortality was 100% at 10% concentration in 48 h in laboratory conditions.

The preceding study also stated that the extracts of *O. sanctum* were found effective and known to achieve maximum effect with increase in the exposure of intervals. In the foregoing study the mortality effect of the extract of *O. sanctum* shown significant hike in intervals.

Alike the pervious study, Manzoor and Haseeb (2015) [12] stated that the aqueous leaf extract of *O. sanctum* at 5% concentration was effective against the nymphs of *P. solenopsis* on okra. The extract showed 57% mortality in 24 h after the treatment. The same study found that the aqueous extract of *O. sanctum* proved to have insecticidal property against *Dysdercus cingulatus* (Red Cotton Bug) and resulted in 28.80% mortality.

In the current study the aqueous extract of *O. sanctum* ranked third in acting effective against the *P. solenopsis* and resulted in 74.5%, 94.39% and 97.21% mortality.

Among all the extracts the repellency effect was maximum in using methanol extract of *A. paniculata* (99.02) > Ethanol extract of *A. paniculata* (97.73) > Ethanol extract of *Caesalpinia bonducella* (97.89). Regarding the percent mortality or biocidal activity the maximum results were achieved by Methanol extract of *A. paniculata* (100%) > Ethanol extract of *O. sanctum* (100%) > Aqueous extract of *O. sanctum* (97.21%).

Table 1: Efficacy of different Extracts of *Caesalpinia bonducella* against *Phenacoccus solenopsis* on Okra (Mean Percentage Mortality @ Different Time Interval)

S. No	Treatment Concentration (%)	Methonal			Ethanol			Aqueous		
		12 h	24 h	48 h	12 h	24 h	48 h	12 h	24 h	48 h
1	1%	13.32 (21.40)	36.34 (37.06)	38.84 (38.37)	10.40 (18.80)	44.75 (41.97)	47.50 (43.54)	11.50 (19.82)	36.84 (37.35)	44.74 (41.96)
2	2%	24.24 (29.48)	43.36 (41.17)	45.18 (42.14)	28.08 (32.03)	50.99 (45.54)	53.04 (46.72)	23.64 (29.08)	46.07 (42.73)	58.71 (49.99)
3	4%	36.36 (37.07)	57.54 (49.32)	58.19 (49.59)	39.38 (38.85)	68.23 (55.67)	71.49 (57.70)	35.88 (36.78)	56.5 (48.71)	61.48 (51.61)
4	8%	47.13 (43.33)	72.38(58.27)	72.70 (58.35)	56.77 (48.88)	75.23 (60.12)	79.23 (62.86)	47.51 (43.55)	72.39 (58.28)	73.87 (59.23)
5	10%	56.08 (48.47)	90.03 (71.56)	90.17 (71.69)	65.13 (53.78)	86.21 (68.17)	87.91 (69.45)	55.58 (48.18)	77.67 (61.23)	81.59 (64.57)
6	Control	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
	SE (d)	0.048	0.070	0.063	0.231	0.275	0.133	0.130	0.309	0.154
	CD	0.107	0.153	0.139	0.509	0.606	0.292	0.287	0.681	0.338

*Mean of three replications

Values in parentheses are arc sine transformed

Table 2: Efficacy of Different Extract of *Ocimum sanctum* against *Phenacoccus solenopsis* on Okra (Mean Percentage Mortality @ Different Time Intervals)

S. No	Treatment Concentration (%)	Methonal			Ethanol			Aqueous		
		12 h	24 h	48 h	12 h	24 h	48 h	12 h	24 h	48 h
1	1%	16.23 (23.75)	38.93 (38.59)	47.13 (43.33)	35.41 (36.50)	56.25 (48.57)	67.52 (55.23)	14.47 (22.35)	46.51 (42.98)	50.42 (45.22)
2	2%	26.61 (31.04)	51.31 (45.73)	56.04 (48.46)	47.34 (43.46)	68.54 (55.86)	79.43 (63.00)	22.61 (28.38)	64.64 (53.49)	70.32 (56.96)
3	4%	39.59 (38.97)	64.18 (53.21)	66.91 (54.86)	72.74 (58.50)	88.87 (70.48)	89.27 (70.85)	56.59 (48.76)	78.11 (62.07)	82.94 (65.58)
4	8%	50.58 (45.31)	73.37 (58.81)	74.22 (59.24)	86.32 (68.26)	95.47 (77.68)	100 (90)	65.6 (54.06)	73.01 (75.67)	94.99 (77.04)
5	10%	61.07 (51.37)	89.04 (70.63)	88.96 (70.56)	99.20 (84.86)	99.95 (89.15)	100 (90)	74.50 (59.64)	94.39 (79.01)	97.21 (80.35)
6	Control	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
	SE(d)	0.297	0.172	0.432	0.266	0.506	0.101	0.092	0.129	0.116

	CD	1.146	0.473	1.148	0.585	1.114	0.223	0.203	0.283	0.255

*Mean of three replications
Values in parentheses are arc sine transformed

Table 3: Efficacy of different Extracts of *Caesalpinia bonducella* against *Phenacoccus solenopsis* on Okra (Mean Percentage Repellency @ Different Time Interval)

S. No	Treatment Concentration (%)	Methonal			Ethanol			Aqueous		
		12 h	24 h	48 h	12 h	24 h	48 h	12 h	24 h	48 h
1	1%	11.13 (19.48)	34.18 (35.76)	37.27 (3.60)	16.28 (23.79)	54.93 (47.81)	57.93 (49.54)	9.17 (17.62)	34.43 (35.91)	42.41 (40.62)
2	2%	22.15 (28.06)	41.45 (40.05)	44.51 (41.83)	34.37 (35.91)	62.19 (52.03)	64.88 (53.73)	21.31 (27.48)	43.7 (41.39)	56.51 (48.70)
3	4%	34.02 (35.67)	55.40 (48.08)	56.66 (48.80)	44.11 (41.59)	79.41 (82.99)	83.72 (66.18)	33.55 (35.38)	54.17 (47.37)	59.26 (50.31)
4	8%	45.01 (42.11)	69.86 (56.67)	71.21 (57.52)	61.61 (51.70)	86.85 (68.71)	89.52 (71.08)	45.29 (42.28)	69.36 (56.87)	71.54 (57.73)
5	10%	53.43 (47.23)	88.04 (69.74)	89.02 (70.93)	70.40 (57.02)	96.09 (78.40)	97.56 (80.98)	53.25 (46.84)	74.54 (59.67)	79.03 (62.91)
6	Control	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
	SE(d)	0.075	0.058	0.173	0.159	0.778	0.170	0.137	0.145	0.147
	CD	0.164	0.128	0.382	0.350	1.714	0.375	0.301	0.319	0.323

*Mean of three replications
Values in parentheses are arc sine transformed

Table 4: Efficacy of Different Extract of *Ocimum sanctum* against *Phenacoccus solenopsis* on Okra (Mean Percentage Repellency @ Different Time Intervals)

S.no	Treatment Concentration (%)	Methonal			Ethanol			Aqueous		
		12 h	24 h	48 h	12 h	24 h	48 h	12 h	24 h	48 h
1	1%	15.47 (23.15)	38.18 (38.14)	45.40 (42.34)	11.05 (19.41)	34.24 (35.80)	41.27 (39.96)	11.20 (19.57)	44.28 (41.70)	46.28 (42.85)
2	2%	27.02 (31.30)	28.08 (31.98)	56.34 (48.62)	22.34 (28.19)	41.13 (39.83)	52.32 (46.31)	24.23 (29.47)	54.41 (47.51)	57.97 (49.95)
3	4%	38.16 (38.14)	38.92 (38.58)	64.54 (53.43)	34.24 (35.79)	55.29 (48.01)	60.2x0 (50.86)	36.07 (36.89)	63.21 (52.63)	66.55 (54.64)
4	8%	48.96 (44.37)	87.61 (69.06)	76.45 (60.92)	45.11 (42.17)	70.31 (56.96)	73.30 (58.86)	65.87 (53.87)	78.11 (62.07)	79.45 (63.01)
5	10%	58.34 (49.77)	88.28 (69.95)	92.43 (76.87)	54.22 (47.40)	88.31 (69.97)	88.34 (70.00)	73.29 (58.85)	82.32 (65.11)	84.52 (66.81)
6	Control	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
	SE(d)	0.177	0.249	1.636	0.135	0.120	0.098	0.165	0.167	0.153
	CD	0.391	0.548	3.603	0.297	0.265	0.216	0.363	0.368	0.338

*Mean of three replications
Values in parentheses are arc sine transformed

References

1. Babasaheb B Fand, Sachin Suroshe S. The invasive mealybug *Phenacoccus solenopsis* Tinsley, a threat to tropical and subtropical agricultural and horticultural production systems - A review. Crop protection. 2014; 69:34-43.
2. Backiyaraj M, Elumalai A, Dhamodaran K, Mathivanan T, Krishnappa K, Elumalai K. Bioefficacy of *Caesalpinia bonducella* extracts against tobacco cutworm, *Helicoverpa armigera* (Hub). (Lepidoptera: Noctuidae). Journal of Coastal Life Medicine. 2014; 3(5):382-388.
3. Bhuwan Bhaskar M, Tripathi SP, Tripathi CPM, CPM. Repellent effect of leaves essential oils from *Eucalyptus globulus* (Mirtaceae) and *Ocimum basilicum* (Lamiaceae) against two major stored grain insect pests of Coleopterons. Nature and Science. 2012; 10(2):68-69.
4. Dilruba S, Hasanuzzaman M, Karim R, Nahar K. Yield response of okra to different sowing time and application of growth hormones. J Hortic Sci Ornamental Plants. 2009; 1:10-14.
5. Farinde A, Owolarafe O, Ogungbemi I. An overview of production, processing, marketing and utilization of "Okra" in Egbedore local government area of Osun State, Nigeria, Agricultural engineering. 2007; 4:1-17.
6. Gomez KA, Gomez AA. Statistical procedure for agricultural research.2nd edition. A willey inter-science publication, John Wiley and sons, New York, 1984, 680p.
7. Gopalan C, Rama Sastri BV, Balasubramanian S. Nutritive Value of Indian Foods. National Institute of Nutrition (NIN), ICMR, 2007.
8. Inang UE, Emosaiure SO. Laboratory assessment of repellent and antifeedant properties of aqueous extract of 13 plants against the banana weevil *Cosmopolites sordicus* Germar (Coleoptera: Curculionidae). Tropical and sub-tropical agroecosystem. 2005; 5:33-44.
9. Isman BM, Cristina MM. Pesticides based on plant essential oils: from traditional practice to commercialization. Advances in Phtomedicine. 2006; 3:29-44.
10. Kabir MH, Hasan N, Rahman MM. A survey of medicinal plants used by the Deb barma clan of the Tripura tribe of Moulvibazar district, Bangladesh. Journal of Ethnobiology and Ethnomedicine. 2014; 10(1):article

19.
11. Kathirvelu B, Maheshwaran R, Maria P, Ignacimuthu S. Toxicity and antifeedent activity of *Caesalpinia bonducella* extracts and fractions against *Helicoverpa armigera* Hub. Physiological and molecular plant pathology. 2018; 101:69-74.
12. Manzoor U, Haseeb M. Laboratory evaluation of different botanicals against the red cotton bug, *Dysdercus cingulatus* (Fabricus) and cotton mealbug, *Phenacoccus solenopsis* (Tinsley) in okra. IJRSI. 2015; 2(2):28-32.
13. Nagrare VS, Kranthi S, Biradar VK, Zade NN, Sangode V, Kakde G *et al*. Widespread infestation of the exotic Mealybug species, *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae), on cotton in India. Bull. Entomol. Res. 2009; 99:537-541.
14. Okigbo RN, Okeke JJ, Madu NC. Larvicidal effects of *Aadirachta indica, Ocimum gratissimum* and *Hyptis suaveolens* against mosquito larvae. Journal of agricultural technology. 2010; 6(4):703-719.
15. Oladimeji A, Kannik MA. Larvicidal effect of Azadirachta indica, *Ocimum gratissimum* and *Hyptis suaveolens* against mosquito larva. J. Agric. Technol. 2010; 6(4):703-719.
16. Prishanthini V, Vinobaba M. Efficacy of some botanicals extracts against the cotton mealybug *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae). Int. J. of scientific and research publications, 2013.
17. Puntener W. Manual for field trials in plant protection. 2nd edition. Ciba-Geigy Limited, 1981, 205p.
18. Saeed S, Arif MJ, Abbas G. Cotton in danger. (DAWN) Pakistan: Pakistan Herald Publication. 2007; 2:23 -24.
19. Saifullah M, Rabbani MG. Evaluation and characterization of okra (*Abelmoschus esculentus* L. *Moench*) genotypes. SAARC J. Agric. 2009; 16:587-592.
20. Saravanan KS, Periyanayagam K, Ismail M. Mosquito larvidal properties of various extract of leaves and fixed oil from the seeds of *Caesalpinia bonducella* (L.) Roxb. Journal of Pharmacology. 2007; 39(3):153-157.
21. Schneider-Orelli O. Entomologisches Pratikum. HR Sauerlander and Co, Aarau, 1947.
22. Singh A, Kataria R, Kumar D. Repellence property of traditional plant extracts against *Aphis gossypii* and *Phenacoccus solenopsis*. Afr. J. of Agric. Research. 2012; 7(11):1623-1628.
23. Suresh S, Kavitha P. Seasonal incidence of economically important coccid pests in Tamil Nadu. In: Proceedings of the XI International Symposium on Scale Insect Studies, Oeiras, Portugal: ISA press, 2008, 24-27.
24. Tanwar RK, Bhamare VK, Ramamurthy VV, Hayat M, Jeyakumar P, Bambawale OM. Record of new parasitoids on mealybug, *Phenacoccus solenopsis*. Indian J Entmol. 2008; 70(4): 404-405.
25. Sathyseelan V, Bhaskaran V. Efficacy of some native botanical extracts on the repellency property against the pink mealybug, *Maconellicoccus hirsutus* (Green) in mulberry crop. Recent research in science and technology. 2010; 2(10):5-38.
26. Varmudy V. Marking survey need to boost "Okra" exports. Department of economics, Vivekananda College, Puttur, Karnataka, India, 2011.