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Comparative toxicological observations of Tivra gandha, Akarkara, Pushkarmool and Chichori indigenous biorational extractives for the management of okra aphid, *Aphis gossypii* Glover (Hemiptera: Homoptera: Aphididae) under laboratory trials

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Abstract
An experiment was conducted to assess the comparative toxicological biopotentency of certain asteraceous botanicals ie. Tivra gandha (*Chromolaena odorata*), Akarkara (*Acemella paniculata)*, Pyrethrum Daisy (*Tanacetum cinerariifolium*), Pushkarmool (*Inula racemosa*) and Chichori (*Cichorium intybus*) extractives were carried out under laboratory condition against nymph and adults of okra ahid, *Aphis gossypii.* The okra leaves were used as food for the nymph and adults of *A. gossypii.* Okra leaves were treated with different concentrations (0.5,1.0 and 2.0 per cent) for two minutes. The treated leaves were left under electric fan for about half an hour, to make a dry film of the extracts on the leaves for each set of extract and one control. The treated foods were kept in jar (23cm x 10cm) on moist filter paper. The untreated leaves were dipped in Benzene + emulsified water only. Ten starved aphids were released in each jar along with control. Three replicates per treatments were maintained. Number of aphids dead in treated food were recorded and mortality of aphids were calculated over control was estimated. It was seen that extract of Tivra gandha (*Chromolaena odorata*) possessed significant results. It killed 80.86 per cent aphids followed by followed by Akarkara (*Acemella paniculata)* (78.26 per cent), Pyrethrum Daisy (*Tanacetum cinerariifolium*) (66.59 per cent) Pushkarmool (*Inula racemosa*) (53.55per cent) > Chichori (*Cichorium intybus*) (46.42 per cent) aphid mortality, respectively. The insecticide Tivra gandha, *Chromolaena odorata* differs significantly from the remaining ones except Akarkara, *Acmella paniculata*.

Keywords: Tivra gandha, akarkara, pushkarmool, *aphis gossypii* glover

1. Introduction
Okra is a perfect villager's vegetable possesses protein and dietary fiber and vitamins. Okra, *Abelmoschus esculentus* fulfils the demand of vegetables during rabi and kharif season. Radake and Undirwade, 1981 reported that mucilaginous substance obtained from okra which is used in industrial and medicinal application [1]. Maramag 2013 stated that the fresh leaves, buds, flowers and pods are consumed by the human being as food in different ways [2]. Similarly, Mishra. 2002 reported that edible parts of okra have best nutritional quality and potential health promoting component. Okra immature fruits are consumed as vegetables in another way. The edible parts of okra have best nutritional values and potential health promoting component. So that okra‟s stems were also possessed fibers for economically importance (Mishra. 2002) [3]. Okra used in industrial application where it applicable in confectionary. However, okra has been considered as minor crop which requires further research to improve it‟s quality and quantity in production.
The unripe fruits of okra produce mucilage substances which binds bile acid and cholesterol. Adeboye and Oputa, 1996 reported that Okra seeds contained high amount of oil about 40.0% and protein with 47.4 % amino acid. Its immature fruits have mucilaginous consistency which used in several major human diseases like cardio vascular disease, cancer etc [4].
Calisir and Yildiz, 2005 reported that seeds of okra can be used as coffee. Okra is rich in magnesium, folate, fiber, antioxidant, with vitamin C and K, which is beneficial to the

pregnant women, heart and blood sugar patients. It also has anti-cancer properties.In brown sugar production its stem and roots are utilized in sugar cleaning [5].

The major insects-pest infesting on okra crop are as *Earias vittella* Fab. *Aphis gossypii* Glover, *Earias insulana* Biosduval, *Amrasca biguttula biguttula* Ishida. *Bemisia tabaci* Genn., *Dysdercus koenigii*, *Mylabris pustulata* and *Sylepta derogate* (Chaudhary and Dadheech, 1989) [6].

Some studies have been made for the management of okra major pest in agro-climatic condition of Kanpur. Among these insect pests, okra aphid, *Aphis gossypii* Glover and *E. vittella* are causing damage to okra marketable fruits, which are unfit for human consumption. Its larvae damaged 35% to crop yield (Chaudhary *et al.* 2012) [7].

The okra aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) is an important insect-pest infested enormously on okra crop in winter season. The aphids infested at the early stage of crop development. Leclant Deguine, 1994 reported that okra plant infested with nymphs and adults of aphid and reduced development of young leaves [8]. In the feeding behaviour, aphids excrete honey dew which seriously endanger causing fungal infection in reducing the okra yield (Dang *et al.* 2010) [9].

Chowdhury *et al.* (2012b) reported that the application of indiscriminate use of synthetic insecticides to ensure higher okra yield which causes adversely affect to environment, leading to the pollution in various ways [10].

The continuous application of chemical insecticide was effective in reducing the insect-pest population.viz; aphid. Jassid, fruit and shoot borer, and whiteflies etc. But they cause toxic hazardous, environmental pollutions and risk to human health (Park *et al.* 2011) [11]. Hence, the applications of synthetic insecticides are not allowed. Their side effects have forced to develop naturally occurring, eco-friendly, non-hazardous, biodegradable aphidicidal agents to control the insect pest of okra.

The naturally occurring indigenous plant extractives have ability to prevent okra insect-pest infestation using different formulations compared to a standard synthetic insecticide. The plant extractives as insecticides exhibited anti-insect properties for the control of insect-pest infesting on okra vegetable.

The research work on bio-rational herbal insecticides against agricultural various crops since last three decades. The extractives were used to control the many insect-pests of crop and vegetables. The research work on bio-rational, crude, refined plant extractives against a number of vegetables and crop insect–pest were used and reported considerable anti-insect properties which were found effective in controlling the insect pest infestation.

Various researchers tested nimbecidine (neem derivative) and imidacloprid (chemical insecticides) for the control of okra pests. Among them, nimbicidine gave significant result, yield percentage increases from 21.63 per cent to 69.91per cent.

Many research workers engaged on development of naturally occurring herbal products for their insect–pest toxicological compatibility, feeding deterrent activities against okra and other crop insect pest (Deshpande and Tipnis 1977, Dev and Koul, 1997 and Antonius and Hagazy 1987) [12, 13, 14]. Adhikary (1984) were used methanalic garlic, *Datura* and Neem (NSKE) extract against infestation of *Earias vittella* on okra crop under field trials. Out of them, *A. indica* seed kernel extract showed highest larval mortality (LD50 1322 ppm), followed by garlic (2018ppm) and Datura (2052 ppm) extract, respectively [15]. Sardana and Kumar (1989) tested 2.0 per cent neem, *A. indica* seed oil against *Earias vittella* under field trials which conrol the *E. vittella* infestation and increased the crop yield in comparison [16].

Shukla *et al.* (1996) tested the different concentrations of plant extract/oil as Neem product, Achook and chemical insecticides Fenvalerated and malathion against *Earias vittella* infesting on okra under field trials. Out of them Fenvalerate 20EC 0.005% gave significant result in controlling the pest insect and provided (70.75 q/ha) yield. [17]. Adiroubane and Letchoumanane (1998) reported *Ocimum sanctum*, *Adhatoda vesica*,*Vitex negundo*, endosulfan, carbaryl and their combination products were proved effective in controlling cotton jassid and fruit borer [18]. Borah (1995) conducted a experiment to test the certain synthetic insecticides against *E. vittella*, which produced effective okra yield [19].

Klocks (1989) reported that *Tagetes minuta* oil significantly control blowfly. The *Tagetes minuta* oil has been active phototoxic compound against larvae of mosquitoes and proved better larvicidal potentials [20].

Pascual-Villalobos and Robledo (1998) tested *Cichorium intybus* L. and *Reichardia tingitana* L. extract against *Rhizopertha dominica* Fabr. and reported that *C. intybus* and *R. tingitana* produced 70-100% of mortality [21]. Liu *et al.* (2006) tested root extract of *Inula racemosa* Hook. They isolated a derivative soalantolactone against stored grain weevil, *Sitophilus oryzae* (L.) and reported a strong insecticidal biopotency [22].

A number of plants like T. minuta showed significant repellent effect (IR = 0.04) to the red flour beetle (Padin *et al.* 2013) [23] and insecticide of bio potency to storage pest and pathogenic organism (Gbolade *et al.* 2011) [24].

In natural environment, there are various botanicals flora and their species and their varieties, which are not even touched by the insect-pest to consume. So that, such botanical must have certain rejectant biochemicals, which exhibit some anti insect feeding biopotential. Such botanicals are being utilized for management of insect-pest. The chosen asteraceous biorationals species was also found deterrent to the targeted insects of okra, *Abelmoschus esculentus* Linn. Moench (Senatore *et al.* 2004) [25]. The botanical extractives were selected due to following reason. Primarly, the botanical extractives are doubtlessly eco-friendly in nature. Secondly, they are mostly consumed by the human beings cattels and beneficial insects i.e. pollinator, predators and parasites. Tertiary, botanical extractives are relatively cheaper than synthetic insecticides. In the quest of recent investigations to insect pest management viz., exploration of cheap and effective insecticides, the repellent and antifeedants suit well as far as Indian conditions are concerned, where the mass of farmers inadequate funds and technical knowledge.

It is required that production of insecticides of botanical products should be encouraged in our nation. The use of these insecticides on crops, stored grains, vegetables and trees should be encouraged and popularized for the control of insect pest, where the vegetables are to be harvested for sale shortly after spraying. This will ensure the production of good quality vegetables for human consumption with safe limits of their residues.

2. Materials and Methods

Experiments were conducted in the Plant product laboratory and experimental field of Department of Zoology, D.B.S. College, Kanpur, U.P., India The present studies on bio-efficacy of aqueous extracts of different plant material against okra aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) were carried out during kharif season of 2008-09 with the view to find out the insecticidal toxicity and to find out the most effective ten plants extracts against okra aphid, *Aphis gossypii* Glover. The technique adapted and the materials used during the course of studies were as under.

2.1 Physiographic situation of Kanpur Nagar

Geographically, the Kanpur Nagar is located on latitudes 25.45° and 26.56° North and longitudes 19.31° and 84.34° East and at an elevation of about 127.117° meter above the mean sea level and mid north to Indo-Gangetic region. The area falls in the belt of semi-arid to sub humid and subtropical climatic conditions. The normal period for onset of monsoon in this region is the 3rd week of June which lasts up to the end of September and sometimes even up to the first week of October. The mean rainfall is 1100 mm recorded mostly from June to September.

2.2 Test Insect and Host Plant

In the present investigation, indigenous naturally occurring certain asteraceous plants extracts have been used for their biological efficacy against nymphs and adults of okra aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) on Okra plant was used in experimental procedure under laboratory condition. The larvae of *E. vittella* and nymphs and adults of *A. gossypii* were collected from on Okra fields of farmer at Fattepur Dakshin village, Kanpur Nagar for conducting the experiments. During the period of study, the feeding habits of larvae and nymphs were noted.

1. Okra aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae)
2. Host plant okra, *Abelmoschus esculentus* (Linn.) Moench (Malvales: Malvaceae)

2.3 Field collection of Test Insects

To obtain regular supply of aphid, *Aphis gossypii* for ivivo and *in-vitro* experimental trials, the culture of test insect were reared in laboratory with okra, *Abelmoschus esculentus* ver. Parbhani kranti leaves and unripe fruits as food materials. For rearing of aphid, *Aphis gossypii* were collected from research field and placed into rearing jars containing fresh okra leaves and fruits. The rearing jars were provided sand for pupation. The newly emerged nymphs and adults were separated service and released in fresh okra leaves and fruits bearing jars. The leaves and fruits having eggs and early as hatching started, the newly hatched aphids were transferred to another fresh jar with okra food.on moist filter paper.

2.4 Procurement of raw plant materials: The plant materials used in the present investigation were collected mainly from wasteland wild areas and some plants were collected from cultivated fields of the farmers. The collected materials were dried in shade, made into powder and the extracts were prepared with the help of soxhlet apparatus using petroleum ether or alcohol as solvent. The regular experiments of selected five asteraceious botanical soxhlet extractives regarding insecticidal bio-potentials were conducted on nymph and adults of *Aphis gossypii* under laboratory conditions.

2.5: Survey and Data collection of Indigenous Plants materials: I have surveyed several times in the vicinity of Kanpur and collected possible information regarding location geographical sites of asteraceous plant and their toxicological characteristics. Among all, only five asteraceous plant extracts viz., leaves of Tivra gandha (*Chromolaena odorata*) and Akarkara (*Acemella paniculata),* Aerial parts of Pyrethrum Daisy (*Tanacetum cinerariifolium*) and Chichori (*Cichorium intybus*), roots of Pushkarmool (*Inula racemosa*) were used for experimental purposes and are listed in table 1. The different concentrations of selected plant extractives were screened for their anti-insect bioefficacy against nymph and adults of *Aphis gossypii* in laboratory trials.

Table 1: List of Plant materials applied in present investigation

S.N.	Local Name	Scientific Name	Plant Prats
1.	Akarkara (Toothache Plant)	*Acmella paniculata* Well	Leaves
2.	Tivra gandha (Devil weed)	*Chromolaena odorata*	Leaves
3.	Pyrethrum Daisy	*Tanacetum cinerariifolium* (trev.) Vis.	Aerial parts
4.	Chichori (Coffee weed)	*Cichorium intybus* (L)	Aerial parts
5.	Pushkarmool (Pokharmul)	*Inula racemosa* Hook. f	Roots

2.6 Preparation of powder: Fresh collected plant parts (leaves, flowers and seeds, rhizomes etc.) were washed with distilled water and kept in the laboratory for 7 days and air drying followed by day by day sun drying before making powder, Electric grinder was used to have coarse powder then these were passed through a 60-mesh sieve to get fine powder. Powders were kept in polythene bags at room temperature and properly sealed to prevent quality loss (Chandel 2017) [26].

2.7 Preparation of botanical extracts: For the extraction, Soxhlet Apparatus was used; about 20 g powder from each category of powder were extracted with 300 ml of different solvent (petroleum ether and distilled water). Extraction of each category of powder was done in about 12 hrs. After soxhlet extraction, the material was run on rotary evaporator. The extracts were concentrated on rotary evaporator by removing the excess solvent under vacuum as per Chandel *et al.* 2018 [27]. After evaporation of solvent with rotary evaporator the remaining extracted material was kept on water bath for removing remaining solvent from the extracts. The extracts were stored at 4°C prior to application.

2.8 Apparatus used for experiment: Plastic jars (capacity 23cm × 10 cm), petri-dishes, muslin cloth, Soxhlet apparatus, electric grinder, fresh okra leaves, unripe fruits, solvents, selected plant extract etc were used in the present

investigation. All the laboratory equipments were sterlized before applications. The jars used for experiment were disinfected with alcohol.

2.9 Preparation of Stock Solution: For stock solution, 50ml, extract in each case was taken into reagent bottles and 50ml. benzene was added in it to dissolve the constituents of the materials. The mouth of the bottles were stopper with airtight corks after which, these bottles containing the solutions were kept in refrigerator.

2.10 The Insecticidal Formulations: Five concentrations (0.5, 1.0, 2.0 per cent) were used for experiments on insecticidal and repellent tests in the laboratory conditions. However, only three concentrations (0.5, 1.0 and 2.0 per cent) were used for insecticidal test in the laboratory and contact test in the field experiment. The different concentrations of the herbal extracts were prepared from the stock solution using benzene as solvent and Triton X-100 as emulsifier. The level of solvent and emulsifier were kept constant as per Bharti and Chandel 2017 [28].

2.11: Preparation of Various Concentrations:
To make various concentrations of extract the required quantity of the stock solution was calculated with the help of following formula.
The calculated amount of extracts to make different concentrations from the stock solution and amount taken are presented investigation.

$$\text{Amount of Stock Solution} = \frac{\text{Amount required} \times \text{Concentration required}}{\text{Concentration of Stock Solution}}$$

Table 2: Formulations of Extracts

Concentration (%)	Amount of Stock Solution (ml)	Amount of Benzene (ml)	Amount of Emulsifiable Water (ml)	Total Amount (ml)
0.50	5.00	20.00	475.00	500.00
1.00	10.00	15.00	475.00	500.00
2.00	20.00	5.00	475.00	500.00

1. **Bioassays:** The Soxhlet extractives were diluted with different solvent, (20mg/ml.). The extracts were topically applied. The solvent was allowed to evaporate at room temperature from treated leaves and fruits of nymph and adults of *Aphis gossypii* (15 male and 15 female) were released in the treated okra jars A. The jars used for experiment were covered with pieces of cloth size of jars with rubber band. For control no extract was applied on okra leaves, only the solvent of respective extract was applied on the treated food and allowed to evaporate. There was three replicates for each treatment and control.

A (b): Insecticidal (Feeding Toxicity) Test
The nymphs and adults of *Aphis gossypii* were used for experiment purpose. The insecticidal tests of the plants extract were performed by dry-film technique. One ml.of solution (selected plant extractives) was sprayed per petridish. Each concentration was tested in three replications. There was one control (Benzene + emulsified water). To record the mortality, the sprayed petri-dishes were gently shaken under an electric fan until the asteraceous 5 extracts liquid phase evaporated, leaving behind a uniform dry film of extract on the glass surface. Inside each pair of petri-dish, ten nymphs and adults of *Aphis gossypii* and selected beneficial insects were released and allowed to remain there for mortality in 6hr, 12hr and 24hr. The data were arranged in tabulated form and calculated their mean mortality per cent of the test organism. Similarly, the toxicity of asteraceous extractives against beneficial targeted insect were also assessed. The mortality percentage of nymph and adults of *Aphis gossypii* were converted into angular values ($\sin^{-1}\sqrt{}$ percentage.). The data were statistically analyzed to test the significance and compared the respective concentrations with control on the basis of percentage reduction of nymph and adults of *Aphis gossypii* as described in Abbott formula (Abbott's 1925) [29]. The results are summarized in Tables 3 to 4 and Figures1 to 6 for *Aphis gossypii*.

Table 3: *In-vitro* toxicological compatibility of botanicals against *A. gossypii*

Particulars	Conc. (%)	Average toxicity % after		
Periods/Treatments		H-1/ T-1	H-2/ T-2	H-3/ T-3
Akarkara	C1	[45.14] (50.2)	[65.99] (83.4)	[70.91] (89.3)
Akarkara	C2	[68.21] (86.2)	[85.91] (99.4)	[92.06] (100)
Akarkara	C3	[92.06] (100)	[92.06] (100)	[92.06] (100)
Tivra gandha	C1	[64.06] (80.9)	[68.98] (87.1)	[83.98] (98.9)
Tivra gandha	C2	[66.28] (83.8)	[83.98] (98.9)	[90.13] (100)
Tivra gandha	C3	[90.13] (100)	[90.13] (100)	[90.13] (100)
Pyrethrum Daisy	C1	[48.64] (56.3)	[52.57] (63.1)	[61.01] (76.5)
Pyrethrum Daisy	C2	[56.68] (69.7)	[63.72] (80.4)	[68.64] (86.5)
Pyrethrum Daisy	C3	[68.64] (86.7)	[89.79] (99.9)	[89.79] (99.9)
Chichori	C1	[34.22] (31.6)	[36.20] (34.9)	[40.03] (41.4)
Chichori	C2	[43.11] (46.7)	[45.10] (50.1)	[46.00] (51.9)
Chichori	C3	[55.80] (68.4)	[58.01] (72.0)	[69.42] (87.7)
Pushkarmool	C1	[43.00] (46.6)	[45.35] (50.6)	[46.90] (53.3)
Pushkarmool	C2	[45.00] (50.0)	[49.50] (57.8)	[53.80] (65.1)
Pushkarmool	C3	[64.44] (81.4)	[65.15] (67.3)	[67.85] (85.3)
Control		00.00	18.44	18.44

[ ] = figures in Parenthesis represent transform value
() = figures in Parenthesis represents Transformed Back Values

i)	Critical	difference for control vs. treated	=	4.1325
ii)	Critical	difference for insecticide means	=	3.9838
iii)	Critical	difference for concentration means	=	3.1275
iv)	Critical	difference for period means	=	1.9955

v) Critical difference for insecticide and conc. Means= 6.2210

The result indicated control versus treated" and "Control versus treatment was significant while Insecticides x concentrations was found non- significant.

Table 4: *In-vitro* toxicological compatibility of botanicals against *A. gossypii*

Botanicals	Average toxicity % after			GT
Periods/Treatments	H-1/ T-1	H-2/ T-2	H-3/ T-3	GT
Akarkara (Toothache Plant)	[68.47] (86.5)	[81.32] (97.2)	[85.01] (99.2)	[78.26] (95.1)
Tivra gandha (Devil weed)	[73.49] (91.9)	[81.03] (97.6)	[88.08] (99.8)	[80.86] (97.5)
Pyrethrum Daisy	[57.95] (71.8)	[68.69] (86.8)	[73.14] (91.6)	[66.59] (84.2)
Chichori (Coffeeweed)	[44.37] (48.9)	[46.43] (52.5)	[48.48] (56.01)	[46.42] (52.5)
Pushkarmool (Pokharmul)	[51.14] (60.6)	[53.33] (64.3)	[56.18] (69.0)	[53.55] (64.7)
Control	00.00	18.44	18.44	12.26

(Figures in TV represent mean percentage transformed values.)

1. Critical difference. for period means= 4.9936
2. Critical difference. for insecticide means = 5.0554

The results indicated in table 4 that mortality percentage of during 6hours, 12 hours and 24 hours period are described as:- After 6 hrs. period and three concentration the average mortality percentage of *A. gossypii* were recorded in descending order as: *C. odarata* (73.49) > *A. paniculata* (68.47) *C. cineraiefolium* (57.95) > *I. racemosa* (51.14) > *C. intybus* (44.37) and one control (0.00), respectively.:

After 12 hrs. period and three concentration the average mortality percentage of *A. gossypii* were recorded in the descending order as: *C. odarata* (73.49) > *A. paniculata* (68.47) > *M. duriaeri* (62.88) > *T. minuta* (62.29) > *S. undulata* (60.19) > *R. tingitana* (58.99) > *C. cineraiefolium* (57.95) > *R. acuale* (53.05) > *I. racemosa* (51.14) > *C. intybus* (44.37) and one control (0.00), respectively.

After 24 hours period and three concentration the average mortality percentage of *A. gossypii* were recorded in descending order as: *C. odarata* (*73.49*) > *A. paniculata* (68.47) > *M. duriaeri* (62.88) > *T. minuta* (62.29) > *S. undulata* (60.19) > *R. tingitana* (58.99) > *C. cineraiefolium* (57.95) > *R. acuale* (53.05) > *I. racemosa* (51.14), respectively.

Table 5: *In-vitro* toxicological compatibility of botanicals against *A. gossypii*

Concentration	Average toxicity % after			GT
Periods/Treatments	H-1/ T-1	H-2/ T-2	H-3/ T-3	
	TB-1	TB-2	TB-3	
0.5%	[46.73] (53.0)	[53.41] (64.5)	[61.09] (76.6)	[53.74] (65.0)
1.0%	[56.59] (69.7)	[65.78] (83.2)	[70.33] (88.7)	[64.23] (81.1)
2.0%	[73.80] (92.2)	[82.28] (98.2)	[84.92] (92.2)	[80.33] (97.2)
Control	00.0	18.44	18.44	12.26

[ ] = figures in Parenthesis represent transform value

() = figures in Parenthesis represents Transformed Back Values

i) Critical difference for period means	=	4.1321
ii) Critical difference for concentration means	=	3.0136

The table 5 indicates that all the three concentrations of all extractives were differing significantly from each other. 2.0 per cent concentration was superior to 1.0 and 0.5 per cent. The extract of all selected asteraceous plant extract with 2.0 per cent concentration killed the maximum percentage (80.33 per cent) of nymphs and adults followed by 1.0 per cent concentration (64.23 per cent) and 0.5 per cent (53.74 per cent) of nymphs and adults respectively.

Table 6: *In- vitro* toxicological compatibility of botanicals against *A. gossypii*

Concentration	Average toxicity % after			GT
Periods/Treatments	H-1/ T-1	H-2/ T-2	H-3/ T-3	
Extract	[59.04] (73.9)	[67.15] (84.8)	[72.11] (91.9)	[66.10] (83.4)
Control	0.00	10.00	10.0	4.25

[ ] = figures in Parenthesis represent transform value

() = figures in Parenthesis represents Transformed Back Values

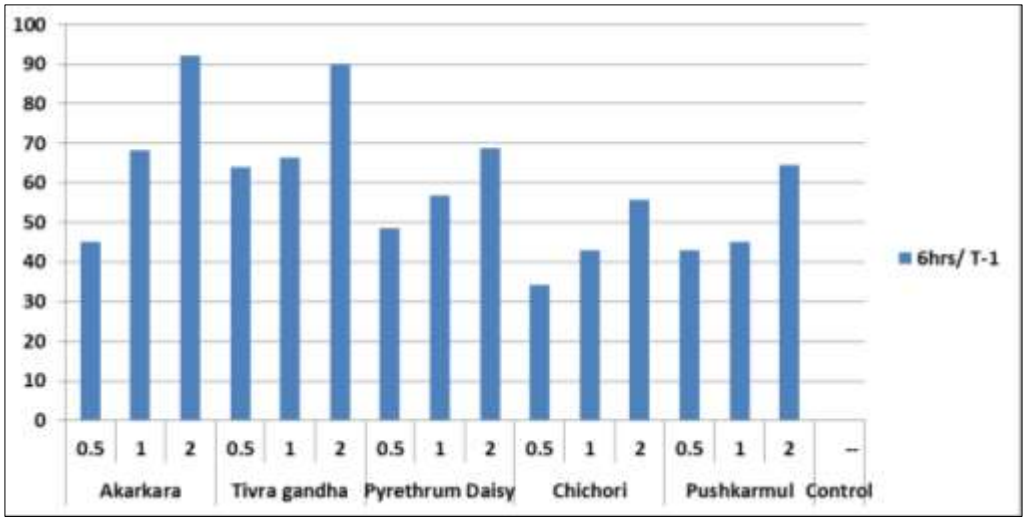

Fig 1: *In-vitro* meam mortality % of botanicals against *A. gossypii* After 6 hrs. exposure periods.

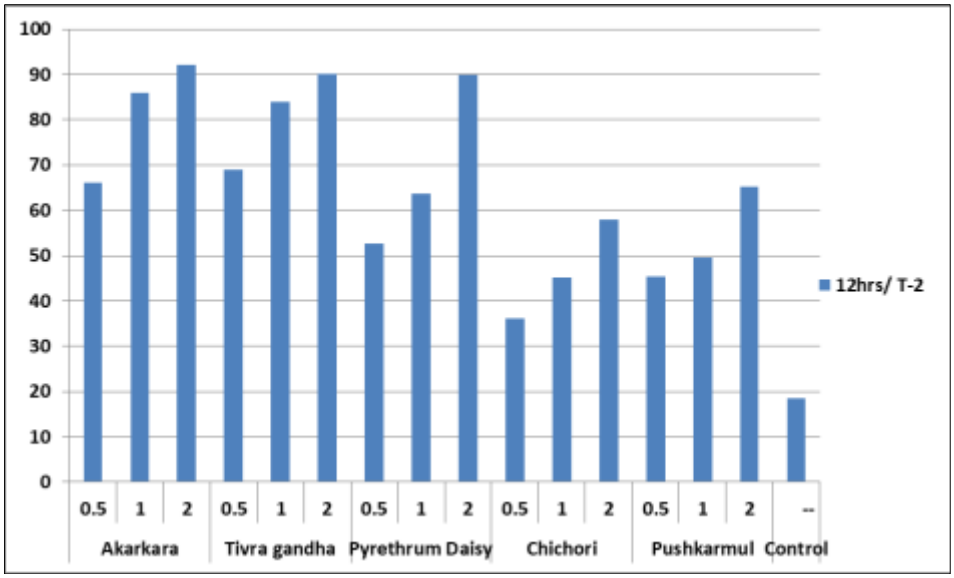

Fig 2: *In-vitro* meam mortality % of botanicals against *A. gossypii* After 12 hrs. exposure periods

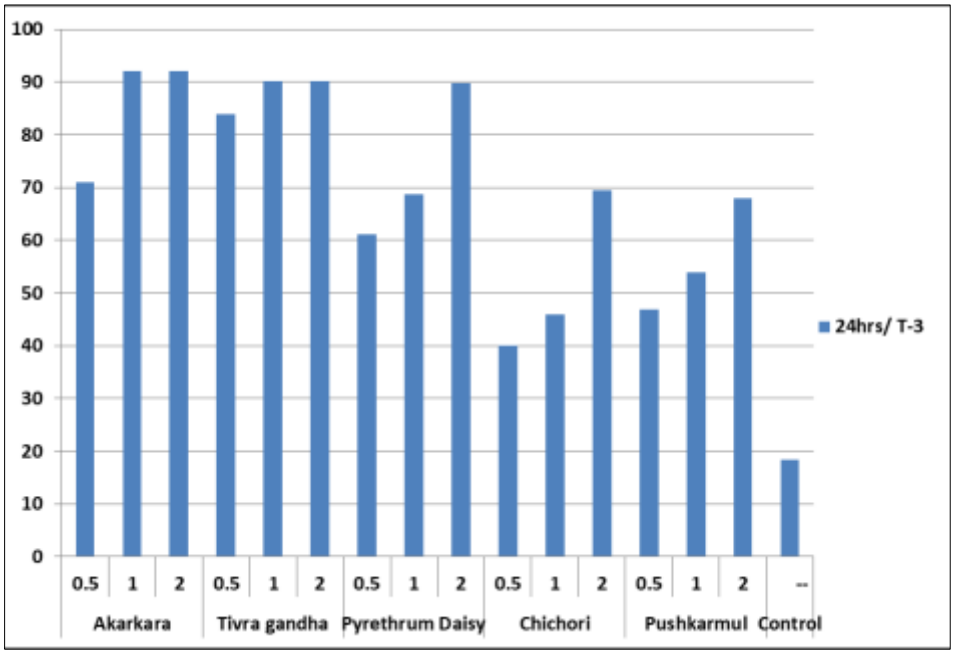

Fig 3: *In-vitro* meam mortality % of botanicals against A.gossypii After 24 hrs. exposure periods

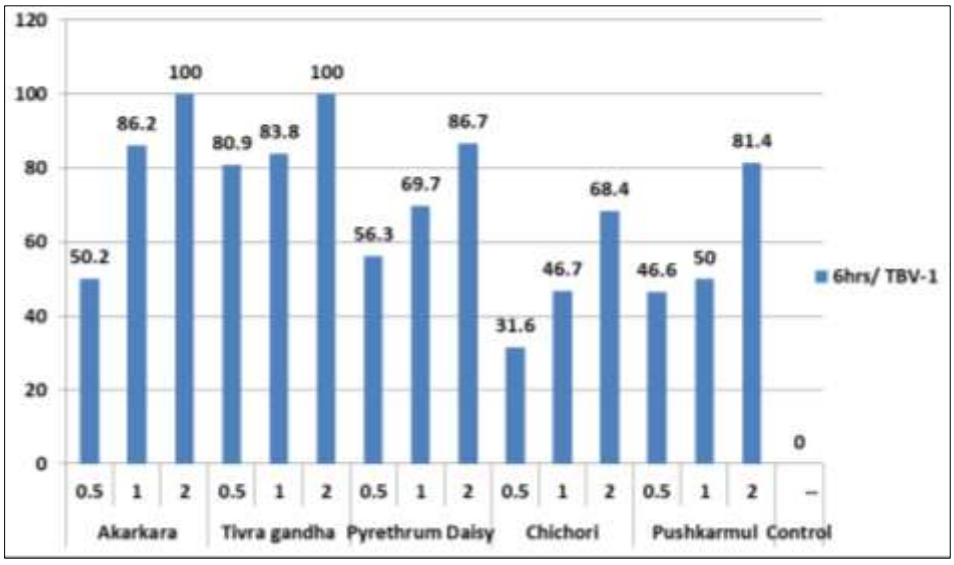

Fig 4: *In-vitro* meam mortality % (TBV) of botanicals against *A. gossypii* After 6 hrs. exposure periods

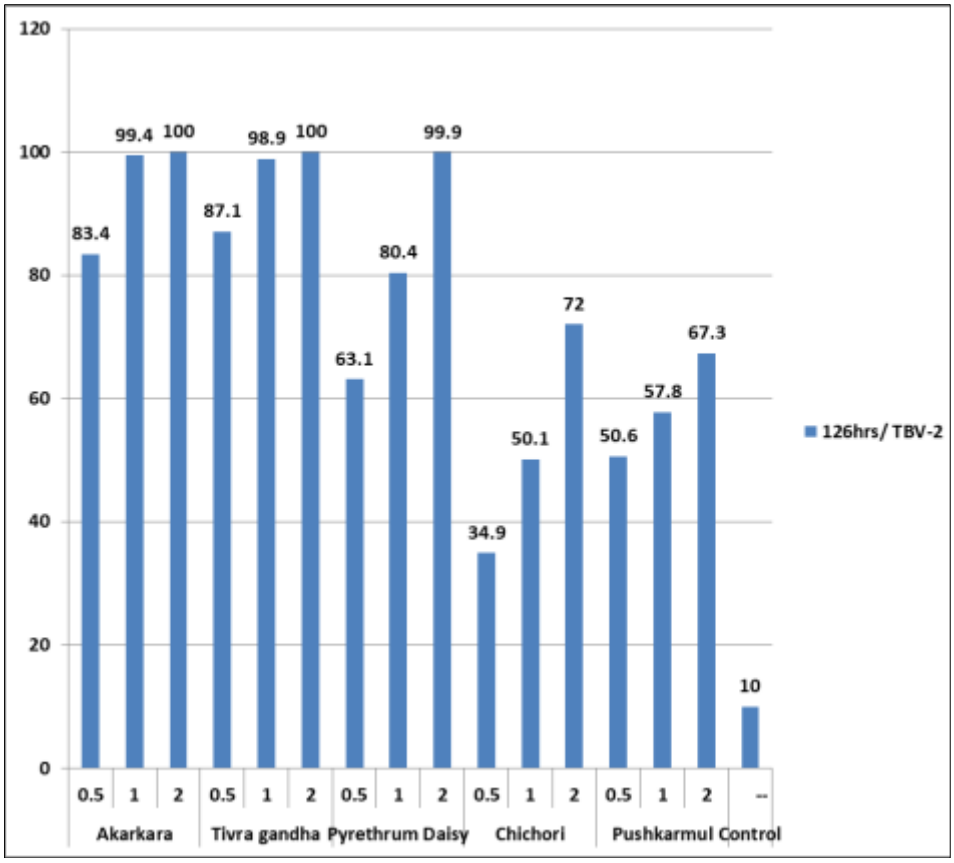

Fig 5: *In-vitro* meam mortality % (TBV) of botanicals against *A. gossypii* After 12 hrs. exposure periods

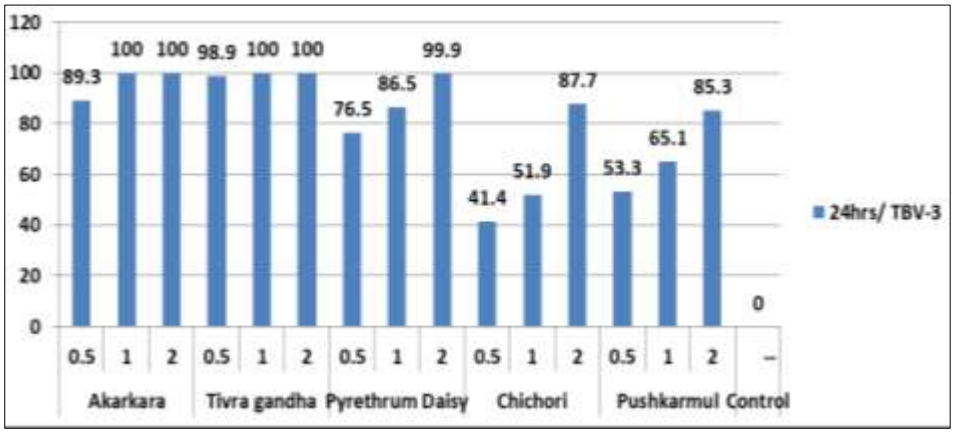

Fig 6: *In-vitro* meam mortality % (TBV) of botanicals against A.gossypii After 24 hrs. exposure periods

The table 6 indicated that the maximum percentage of larvae killed was after 24 hrs. (72.11 per cent) Similarly, the differences in percentage kill of larvae in period 12 hrs. (67.15 per cent) is greater than the after 6 hrs. (59.04 per cent) difference in percentage larvae kill in period 12 hrs and 6 hrs in all the three concentrations.

Conclusively, the data on mortality per cent reveals that maximum aphid mortality was observed in Tivra gandha (*Chromolaena odorata*) possessed significant results. It killed 80.86 per cent aphids followed by followed by Akarkara (*Acemella paniculata)* (78.26 per cent), Pyrethrum Daisy (*Tanacetum cinerariifolium*) (66.59 per cent) Pushkarmool (*Inula racemosa*) (53.55per cent) > > Chichori (*Cichorium intybus*) (46.42 per cent) aphid mortality, respectively. The insecticide Tivra gandha, *Chromolaena odorata* differs significantly from the remaining ones except Akarkara, *Acmella paniculata.* The present findings to the inconformity with those workers who has done works on use of ecofriendly naturally occurring indigenous asteraceous plant origin insecticides against various insect pest of crop and vegetable as per Gautam *et al.*2003, Owolabila *et al.* 2010, Chandel *et al.* 2011, Chandel *et al.* 2013, Uyi *et al.* 2014,Omokhua *et al.* 2016,Osariyekemwen *et al.* 2016 [30-36].

Osariyekemwen *et al.* (2017) tested root extract of *C. odorata* showed 74.0 per cent adult mortality to *Callosobruchus maculatus* Fabr and reported promising insecticidal biopotency [37]. Ahad *et al.* (2016) tested 1.0, 2.0, and 4.0 per cent extracts of certain plant extract. Among them, *Xanthium strumarium* extract showed cent per cent mortality to *C. chinensis* [38].

5. Conclusion

The present study reports the successful management of aphids. It was seen that extract of Tivra gandha (*Chromolaena odorata*) possessed significant results. It

killed 80.86 per cent aphids followed by followed by Akarkara (*Acemella paniculata)* (78.26 per cent), Pyrethrum Daisy (*Tanacetum cinerariifolium*) (66.59 per cent) Pushkarmool (*Inula racemosa*) (53.55per cent) > > Chichori (*Cichorium intybus*) (46.42 per cent) aphid mortality, respectively. The insecticide Tivra gandha, *Chromolaena odorata* differs significantly from the remaining ones except Akarkara, *Acmella paniculata*. Thus, there is possibility of developing as a source of alternate insecticidal agent for sustainable management of insect pests of economic importance and mosquito control. This will have the important benefit of helping to reduce the present excessive use of synthetic insecticides, which has been causing concern for sometime now.

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