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Aphidicidal compatibility of certain ecofriendly asteraceous biorational extractives against okra aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) under field conditions

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Abstract
Plants products are increasingly used in the management of insect pest. They are superior to chemical pesticides because of their biodegradable nature and lesser environmental toxicity. Experiments were conducted in the Departmental Research Laboratory and experimental field of farmer affiliated to Department of Zoology, D.B.S. College, Kanpur, U.P., India. In the present investigation, indigenous naturally occurring ten biorational asteraceous plant extractives have been used for their aphidicidal bioefficacy against okra aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) on okra; *Abelmoschus esculentus* Linn. Moench (Malvaceae). Three concentrations viz. 0.5 per cent, 1.0 per cent and 2.0 per cent of each plant extract were selected and tested by dry film technique against nymphs and adults of *Aphis gossypii* on okra field. The results showed that maximum mean mortality was observed in extract of *Chromolaena odorata* (75.77%) against nymphs and adults of *Aphis gossypii* which is followed by *Acmella paniculata* (74.25%) > *Tagetes minutia* (69.32%) > *Chrysanthemum cinerariifolium* (68.69%) > *Ropanticum acaule* (66.80%) > *Scorzonera undulate* (66.46%) > *Mantisalca duriaeri* (66.20%) > *Reichardia tingitana* (53.84%) > *Inula racemosa* (53.55%) > *Cichorium intybus* (40.37%), respectively. The extracts of *C. odorata* differs from significant remaining once except *Acmella paniculata* and *T. minuta*, which does not differ significantly to one another. *Cichorium intybus* proved least toxic giving only 40.37 per cent mortality of the nymphs and adults of *Aphis gossypii*. This paper was aimed to use the biorational asteracious extractives for the ecofriendly management of okra aphid infesting on bhindi, *Abelmoschus esculentus* Linn.

Keywords: *Aphis gossypii*, chromolaena odorata, tagetes minuta and acmella paniculata

1. Introduction
Bhindi or okra, *Abelmoschusm esculentus* Linn. Moench is an economically important vegetable crop grown in all over India and tropical and sub-tropical phyto-geographical regions of the world (Kabissa *et al*. 1996) [1]. India ranks first in the world with 5, 784.0 thousand tonnes (72% of the total world production) of ladyfinger/okra. (Xia *et al*. 1999) [2]. It is followed by West Bengal (862.1 thousand tons from 74.00 thousand ha with 11.70 tons/ha productivity (Gupta and Misra, 2006) [3].

Okra is a nutritious vegetable which plays an important role to meet the demand of vegetables of the country when vegetable are scanty in the market. Okra is a powerhouse of valuable nutrients, nearly half of which is soluble fibre in the form of gums and pectins which help to lower serum cholesterol, reducing the risk of heart diseases. The other fraction of Okra is insoluble fibre, which helps to keep the intestinal tract healthy. Okra is also abundant with several carbohydrates, minerals and vitamins, which play a vital role in human diet and health. It contains large quantities of carbohydrate, protein and vitamin C (Adeboye and Oputa, 1996) [4]. Its mucilage is suitable for medicinal and used in pharmaceutical industries (Chaudhary and Dadheech (1989) [5]. Okra mucilage has medicinal applications when used as a plasma replacement or blood volume expander (Kumar *et al*. 2013) [6]. The mucilage of okra binds cholesterol and bile acid carrying toxins dumped into it by the liver. Okra seeds are a potential source of oil, with concentrations varying from 20% to 40%, which consists of linoleic acid up to 47.4%. Okra seed oil is also a rich source of linoleic acid, a polyunsaturated fatty acid essential for human nutrition (Konar and Rai, 1990) [7]. The roots and stems are used for clearing the cane juice from which gur or brown sugar is prepared (Radake and Undirwade 1981) [8].

The major insect pests of okra in Kanpur region include aphid, Aphis gossypii Glover, cotton jassid, *Amrasca biguttula* Ishida, whitefly, *Bemisia tabaci* Gen. and shoot and fruit borers, *Earias vittella* Fab and *Earias insulana* Boisduval (Rao *et al.*, 2003) [9] Among them the okra aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae), is a serious insect-pest of lady; s finger, *Abelmoschus esculentus* Linn. (Adiroubane and Letchoumanane, 1998) [10]. the nymphs and adults of *Aphis gossypii* usually found on the abaxial surface of leaves, feeding on the phloem (Murthy *et al.* 1996) [11]. As a result of feeding, plant yield is reduced. The secretion of honeydew contaminates plants, allowing associated fungi to grow and causing, in addition, more than 50 types of diseases in plants, due to the transmission of viruses (Obeng and Sackey 2003) [12].The field studies were made for the management of nymphs and adults of *Aphis gossypii* the major insect pests of okra, *Abelmoschus esculentus* Linn. Moench. In agro-climatic condition of Kanpur, Uttar Pradesh, India (Mann *et al.* 2001) [13].

The use of synthetic insecticides is not legally allowed in organic system, increasing the difficulty in management of okra aphid, *Aphis gossypii* (Sinha and Sharma 2007) [14]. These Synthetic Insecticides controlled the pest infestation but their excessive use contaminated in the environment that cause the discomforts or damage to the human and other living organism.

This work evaluated aphid control and the ability of products to prevent aphid infestation using natural insecticides compared to a standard synthetic insecticide (Patil *et al.* 2002) [15]. The natural products exhibited variable results with low protection against plant colonization throughout the evaluation period the risks to human health and environmental pollution (Pependic *et al.* 1986) [16]. The side effects have forced to look for naturally occurring ecofriendly indigenous herbal alternatives to chemical pesticides especially for vegetables like okra where fruits are plucked at an interval of every 2-3 days (Chitra *et al*., 1997) [17].

Plant product used to control aphid infestation by many workers (Park *et al.* 2011 Dang *et al.* 2010) [18, 19]. The biorational natural plant extractives exhibited variable results with considerable crop and grain protection against pest infestation. Botanical insecticides possess a spectrum of properties including insecticidal activities to pest of agricultural importance (Trivedi and Chandel, 2009) [20]. Biorational extractives have attention today for facing the *Aphid gossypii* infestation on okra field in an eco-friendly manner (Chandel and Singh 2017) [21]. The use of botanical pesticides is now emerging as one of the prime means to protect okra vegetable. Botanical pesticides can greatly decrease the use of conventional pesticides or can be used in rotation or in combination with other insecticides, potentially lessening the overall quantities applied and possibly mitigating or delaying the development of resistance in pest populations (Kamaraj *et al.* 2011) [22].

Hence, the objective of the present study was to determine to efficacy of asteraceous extract for controlling beetle infestation in storage pulse grains under the varied ecological conditions, an In view to combat the problem of pulses beetle infestation in storage pulse grains under the varied ecological conditions, An attempt has therefore, been made to evaluate relative mortality of ten asteraceous plant extract formulations against nymphs and adults of *Aphis gossypii* Glover.

2. Material and Method

2.1. Procurement of raw plant materials

The asteraceous plants materials used for extraction were surveyed, identified and collected mainly from wasteland and wild areas and some plants were collected from cultivated fields of the farmers. The investigations on the screening of various available indigenous naturally occurring asteraceous plant extracts viz., aerial parts of *Acemella paniculata* Well ex DC, *Chromolaena odorata* Linn., *Chrysanthemum cinerariifolium* (Trev.) Vis., *Cichorium intybus* (L.), *Inula racem*osa Hook. F., *Mantisalca duriaeri* birq. Et Cavill., *Rechardia tingitana* (L.) Roth, *Rhaponticum acaule* (L.) DC, *Scorzonera undulate* Vahl, and *Tagetes minuta* Linn. were screened for their aphidicidal compatibility against nymphs and adults of *Aphis gossypii* under field trials. For carrying out the present studies only ten selected asteraceous botanical soxhlet extractives were prepared in the departmental laboratory and assessed for their aphidicidal bio efficacy under field conditions.

2.2. Preparation of powder and their extraction

Fresh collected green plant parts (leaves, Flowers and seeds, roots etc.) were washed with distilled water and kept in the laboratory for 7 days for air drying in shade 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 and Sengar, 2018) [23]. For the extraction, Soxhlet Apparatus was used; about 20g powder of each category of powder were extracted with 300 ml of different solvents (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. 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.

2.3. Preparation of Stock Solution and Insecticidal formulations

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. Three concentrations (0.5, 1.0, 2.0 percent) were used for experiments on insecticidal and repellent tests in the laboratory conditions. However, only three concentrations (0.5, 1.0 and 2.0 percent) were used for insecticidal test in the laboratory and contact test in the field experiment. The different concentrations of the asteraceous 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.

2.4. Apparatus used for experiment

In the laboratory the soxhlet apparatus used for extraction. Ten rearing cages were used for rearing of nymphs and adults of *Aphis gossypii* Theses laboratory reared nymphs and adults were used under field trials. Many glass petridishes (15cm diameter) were used for the experiment, one laboratory sprey

tower and one hand compression poly sprayer was used. Ten meter muslin cloth was required for covering the treatments and replications bags and on ridges of plots either going or coming the nymphs and adults in the okra field.

3. Toxicity Bioassay: For field experiment the aphidicidal biopotency of ten asteraceous extractives against laboratory reared nymphs and adults of *Aphis gossypii* were released in different experimental plots treated with different (0.5, 1.0 and 2.0 percent) concentrations and covered with muslin cloth Now after half an hour ten aphids (5 nymphs +5 adults) were released in each muslin covered bag treated okra leaves and fruits on randomly selected plant. The mouth of each treated bag was closed with rubber band. Each treatment was replicated thrice including control. All treated muslin bags were left on plant under field condition for aphid mortality. After 24, 48 and 72 hours, dead and alive nymphs and adults of *Aphis gossypii* were counted and removed from each experimental bag. The aphidicidal efficacy of asteraceous biorational extractives as protectant of okra vegetable against nymphs and adults of *Aphis gossypii* was assessed considering mortality percentage. Thus data was collected on the number of nymphs and adults of *Aphis gossypii* were dead on treated bag and nymphs and adult's mortality over control was recorded. The data were arranged in tabulated form and graph formats. The mortality (%) was corrected by Abbotts's formula (Abbott, 1925) [24].

$$Pr = \frac{Po-Pc}{100-Pc} \times 100$$

Where, Po = Observed mortality, Pc = Control mortality. The data was analysed using (ANOVA) test.

Table 1: List of selected asteraceous biorational material used for extraction

Sr. No.	Scientific Name	Vernacular name	Faimly	Plant parts used
1.	*Acmella paniculata* (Wall ex DC.) R.K. Jansen	Toothache Plant	Asteraceae	Aerial parts
2.	*Chrysanthemum cinerariifolium* (trev.) Vis.	Daisy	Asteraceae	Leaves
3.	*Chromolaena odorata* Linn.	Siam weed	Asteraceae	Leaves
4.	*Cichorium intybus* (L.)	Chicory	Asteraceae	Roots
5.	*Inula racemosa* Hook. F	Puskarmul	Asteraceae	Aerial parts
6.	*Mantisalca duriaeri* Birq. Et Cavill.	Spach	Asteraceae	Roots
7.	*Rechardia tingitana* (L.) Roth	False sowthistle	Asteraceae	Flowers
8.	*Rhaponticum acaule* (L.) DC.	Coffee plum	Asteraceae	Flowers
9.	*Scorzonera undulate* Vahl	Black Salsify	Asteraceae	Flowers
10.	*Tagetes minuta* Linn.	Wild Marigold	Asteraceae	Leaves

Table 2: Mean mortality percentage of *Aphis gossypii* to the plant extracts irrespective of periods

Treatment (Plant extracts)	Mean Mortality percent After						
	24 hrs.		48 hrs.		72 hrs.		
	T1	T.B.V.$_1$	T_2	T.B.V.$_2$	T_3	T.B.V.$_3$ T	
A. paniculata	70.40	88.7	72.21	90.7	80.16	97.1	74.25
C. cinerariifolium	61.18	76.6	68.90	87.0	69.64	87.9	66.57
C. intybus	30.00	25.0	41.41	43.7	49.71	54.7	40.37
C. odorata	59.36	74.0	80.00	97.0	87.95	99.87	75.77
I. racemosa	51.14	73.7	53.33	64.3	56.18	69.0	53.55
M. duriaei	61.18	76.8	64.80	81.9	72.62	91.1	66.20
R. acaule	58.16	72.2	68.90	87.0	73.35	91.8	66.80
R. tingitana	50.47	59.5	53.36	64.4	57.69	71.4	53.84
S. undulata	62.49	78.7	65.21	82.4	71.71	90.2	66.46
T. minuta	58.16	72.2	70.54	88.9	79.76	96.9	69.32
Over all	56.254	69.74	63.866	78.73	69.877	84.99	63.31
Control	00.00	00.00	18.44	10.00	18.44	10.00	12.29

. (T_1, T_2, T_3 = Treatments and T.B.V.$_1$, T.B.V.$_2$, T.B.V.$_5$=Transformed Back Values)
C.D. for treatment x period means=0.078
C.D. for treatment means (plant extra=0.037
C.D. for treatment means (control) =0.162

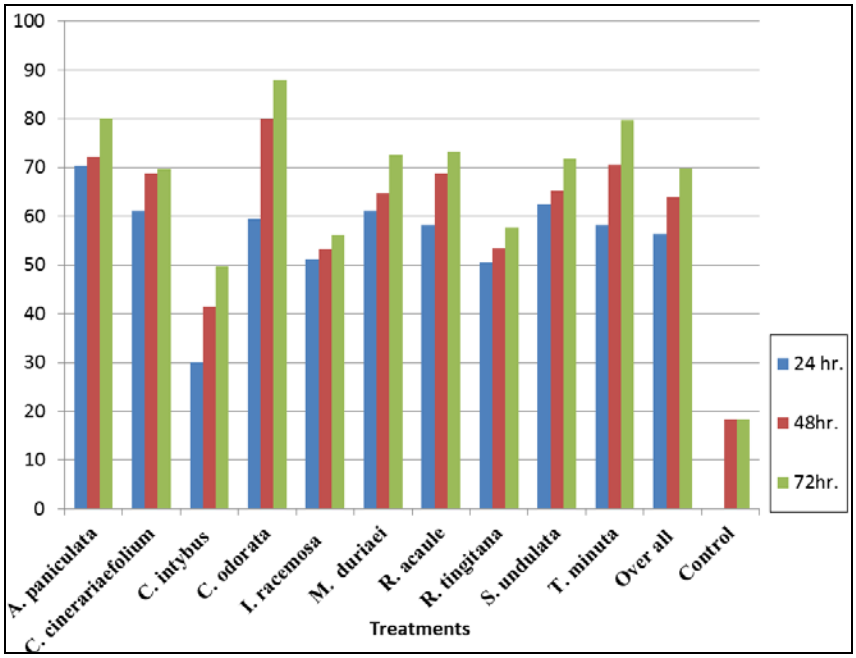

Fig 1: Comparative diagram of mean mortality % and TBV of *Aphis gossypii* to extractives irrespective of periods

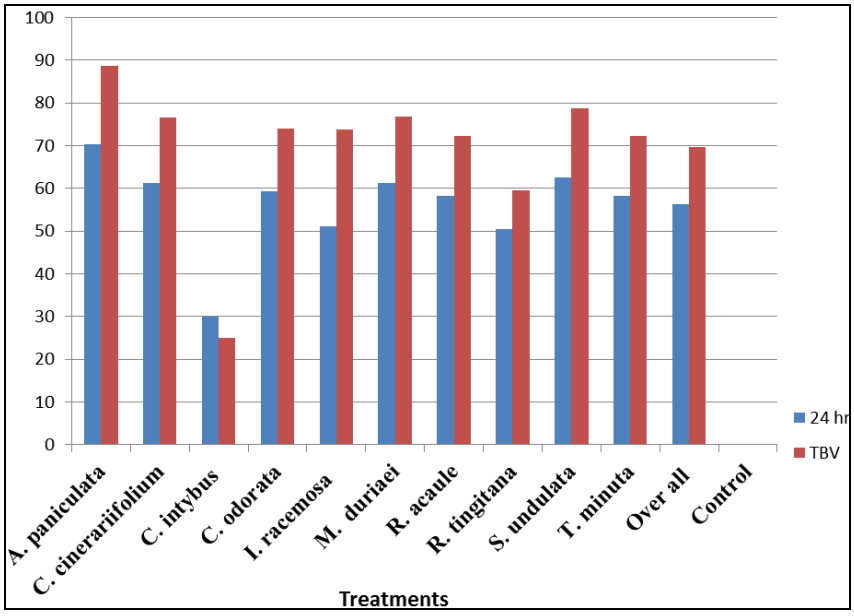

Fig 2: Mean mortality % and TBV of *Aphis gossypii* to the extractives irrespective of 24 hr period

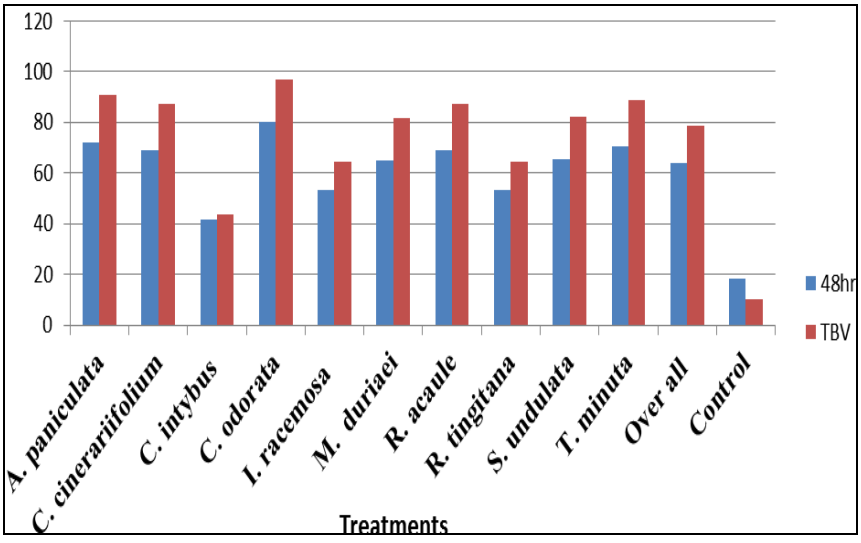

Fig 3: Mean mortality % and TBV of *Aphis gossypii* to the extractives irrespective of 48 hr period

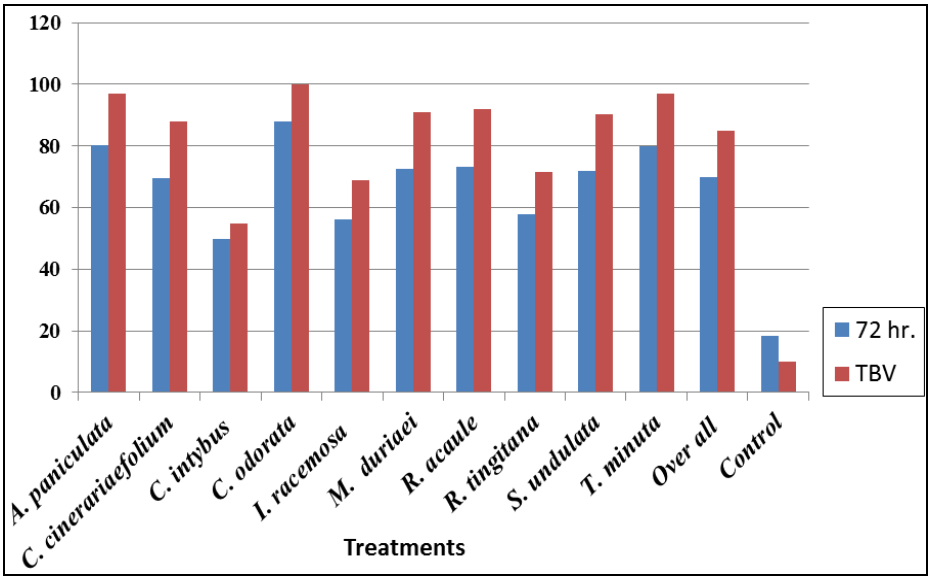

Fig 4: Mean mortality % and TBV of *Aphis gossypii* to the extractives irrespective of 72 hr period

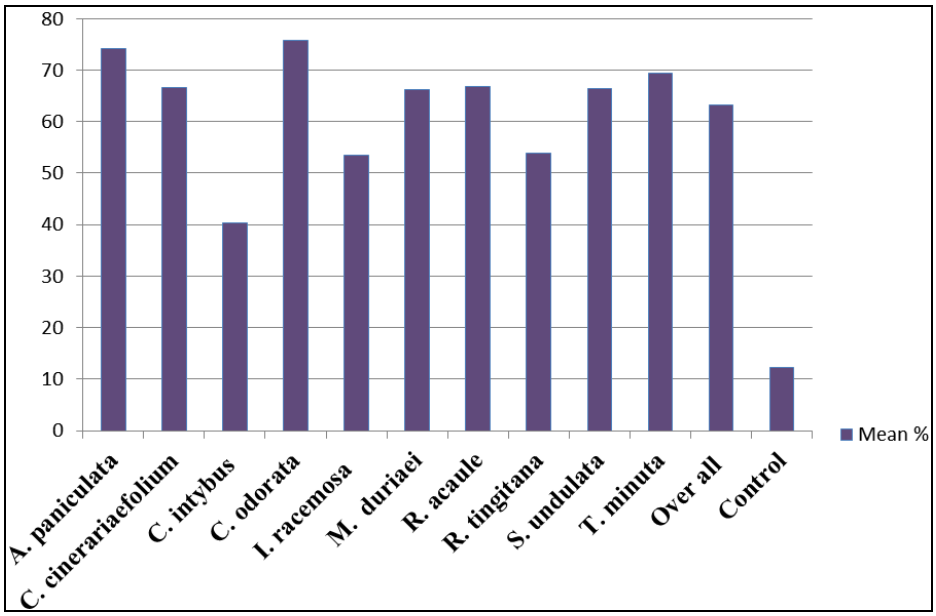

Fig 5: Mean mortality % and TBV of *Aphis gossypii* to all extractives irrespective and three period

Table 3: Mean mortality percentage and their TBV of *Aphis gossypii* to different asteraceous extractives

Treatment	Mean mortality %	Transform Back Values	Mortality ratio
A. paniculata	74.25	92.6	II
C. cinerariifolium	66.57	84.2	V
C. intybus	40.37	42.0	X
C. odorata	75.77	93.1	I
I. racemosa	53.55	64.7	IX
M. duriaei	66.20	83.7	VII
R. acaule	66.80	84.5	IV
R. tingitana	53.84	65.2	VIII
S. undulate	66.46	84.4	VI
T. minuta	69.32	87.5	III
Over all	63.31	78.16	-
Control	12.29	4.5	-

The table 1 and 2 reveals that toxicity of ten asteraceous bioactive plant extracts can be summarized based on their relative mortality as : *C. odorata* (75.77) > *A. paniculata* (74.25) > *T. minuta* (69.32) > *R. acaule* (66.80) > C. *cinerariifolium* (66.57) > *S. undulata* (65.46) > *M. duriaeri* (66.20) > *R. tingitana* (53.84) > *I. racemosa* (53.55) > *C. intybus* (40.37), respectively. The extracts of *C. odorata* differs from significant remaining once except *A. paniculata*, which does not differ significantly to one another. *C. intybus* proved least toxic giving only 40.37 per cent nymphs and adults mortality of *Aphis gossypii* Glover. The table 3 reveals that toxicity of ten asteraceous bioactive plant extracts can be summarized based on their based on aphid mortality relative transform back values (TBV) are as: *C. odorata* (93.1) > *A. paniculata* (92.6) > *T. minuta* (78.16) > *R. acaule* (84.5) > C. *cinerariifolium* (84.2) > *S. undulata* (84.4) > *M. duriaeri* (83.7) > *R. tingitana* (65.2) > *I. racemosa* (64.7) > *C. intybus* (42.0), respectively. The extracts of *C. odorata* differs from significant remaining once except *A. paniculata*, which does not differ significantly to one another whereas *C. intybus* proved least toxic to nymphs and adults mortality of *Aphis gossypii* Glover.

4. Result and Discussion

4.1. Result

The data depicted in Table-1-3 and Fig.1-3 that the toxicity of ten asteraceous bioactive plant extracts to nymphs and adults mortality of *Aphis gossypii* Glover are summarized based on their relative mortality in which *Chromolaena odorata* (75.77%) showed highest aphid mortality against nymphs and adults of *Aphis gossypii Chromolaena odorata* is followed by *Acmella paniculata* (74.25%) > *Tagetes minuta* (69.32%) >*Chrysanthemum cinerariifolium* (66.57%) > *Ropanticum acaule* (66.80%) > *Scorzonera undulate* (66.46%) > *Mantisalca duriaeri* (66.20%) > *Reichardia tingitana* (53.84%) > *Inula racemosa* (53.55%) > *Cichorium intybus* (40.37%), respectively.

The extracts of *C. odorata* differs from significant remaining once except *Acmella paniculata*, *Tagetes minuta*, *Chrysanthemum cinerariifolium*, *Ropanticum acaule*, *Scorzonera undulate*, and *Mantisalca duriaeri* (greater than 60.00% aphid mortality) which does not differ significantly to one another. *Cichorium intybus* proved least toxic giving only 40.37 per cent mortality of the nymphs and adults of *Aphis gossypii*. All the three concentration differed significantly to one another. The concentration 2.0 per cent is superior to concentration 1.0 and 0.5 per cent. It is also observed that the difference in the percentage kill of nymphs and adults of *Aphis gossypii* the concentration 2.0 per cent and 1.0 per cent is greater than the difference in concentration to kill the nymphs and adults of *Aphis gossypii* in 1.0 per cent and 0.5 per cent in all the three periods. Similarly the difference in percentage mortality of nymphs and adults of *Aphis gossypii* in 72 hours (71.14 per cent) and 48 hours (67.30 per cent) is greater than the difference in percentage beetle mortality in the period of 12 hours (67.30 per cent) and 24 hours (54.05 per cent).

5. Discussion

Many workers are reported the insecticidal activity of aphid infestations. (Pavela 2006 Kim *et al.* 2011, Rashid *et al.* 2013) [25, 26, 27].

Panickar *et al*. (2003) conducted an experiment in Gujarat, India during 1997-98 and 1998-99 to determine the efficacy of the botanical insecticide, 0.15% Achook, alone or in combination with 0.035% endosulfan against boll worms (Earias vittella) and sucking pests (*Aphis gossypii* and *Amrasca biguttula biguttula*) infesting okra cv. PB-57. Twice spraying of 0.035% endosulfan followed by twice spraying of 0.15% Achook at 4 ml/litre provided the highest control of the sucking pests and boll worms infesting okra [28].

Singh and Kumar (2003) tested the efficacy of neem [*Azadirachta indica*]-based pesticides against the Cotton jassid (*A. biguttulla biguttulla*). The treatments comprised endosulfan at 0.07%, Achook at 0.7%, Neemarin at 0.7%, neem seed kernel extract (NSKE) at 1%, NSKE at 3% and a control. Endosulfan, followed by Achook and NSKE (3%), was the most effective in controlling the okra jassid. Achook-treated plots gave the highest yield of 50.06 q/ha and was significantly superior to other treatments. However, on the basis of cost: benefit ratio, NSKE (3%) ranked first (1:10.70), followed by endosulfan (1:10.07) [29].

The table 3 and fig. 3 indicated that the maximum percentage of *C. chinensis* adults mortality after 24 hrs. (70.73 per cent) and minimum after 12 hrs (65.72 per cent). The period of 24hrs is significantly superior to period of 12 hrs. (65.72 per cent) and 06 hrs. (59.70 per cent) in both control and treated. The overall effect of all the treatments in killing the *C. chinensis* adults is greater than that of control in all the three periods.

Various biorational naturally occurring extractives as insecticides has been reported by several researchers against pulse beetle (Zygadlo *et al.* 1990, Ahmed and Ahmed, 1991; Perich *et al.* 1995, Olfa *et al.* 2008 and 2014) [30, 31, 32, 33, 34]. Different oils of neem, coconut, and castor was observed as surface protectants on green gram to check the pulse beetle and among them neem oil was the best surface protectant (Rajmohan, Logankumar, 2011) [35]. As the search for alternatives to synthetic medicine goes on, several plants have been identified as possible natural insecticides. The *Chromolema oderata* extracte and their derivatives was proved as strong insecticidal in action (Maradufu *et al.* 1978, Matur and Dayou, 2007; Gautam *et al.* 2003, Owolabi1a, *et al.* 2010) [36, 37, 38, 39].

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