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Biorational and Ecofriendly Insecticidal Approach of Asteraceous Plant Extract against Spotted Ballworm, *Earias vittella* Fabricius (Lepidoptera:Noctuidae) on Okra, *Abelmoschus esculentus* Linn. (Moench) in Kanpur Region

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Abstract
The synthetic chemical pesticides are efficiently control the insect infestation and their damage to vegetable and crop but they are causing hazardous to the human being and environment pollution. Botanical pesticides are good alternative of synthetic chemical pesticides for pest control in modern ecological technologies. Plant extractives have a number of advantages that make them preferable in modern organic agriculture. The range of these extractives are constantly expanding. A field experiment was conducted at field of farmer affiliated to biopesticide Laboratory, Department of Zoology, D.B.S.College, Kanpur to study the bio efficacy of ten asteraceous plant extractives obtained from aerial parts of *Acemella paniculata* Well ex DC, *Cichorium intybus* (L.), *Chromolaena odorata* Linn., *Chrysanthemum cinerariifolium* (trev.) Vis., *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 prepared under the laboratory conditions and tested against okra fruit borer, *Earias vittella* Fabricius, which are major polyphagous pest. The collected asteraceous plant materials washed with tap water, which were dried in shade and ground to fine powder and extracted them with help of soxhlet apparatus. They treated with 0.5, 1.0 and 2.0 % concentrations with three periods (24h, 48h and 72h) applied on laboratory reared 3rd instars larvae of *E. vittella* on okra field. Each treatment with three replication and three periods. Assessments has done according to number of larvae released and mean mortality percentage counts. It is observed that alcoholic extract of *C. odorata* registered highest mortality (78.21%) to the larvae of *E. vittella*, when compared to other plant extracts as: *A. paniculata* (73.55%), *T. minuta* (68.69%) *R. acaule* (66.76%), have registered encouraging (greater than 60% mortality) results having insecticidal properties. Consistently, remaining all these aforementioned plant extractives have revealed their insecticidal potential at various intervals.

Keywords: *Chrysanthemum cinerariifolium*, *Acemella paniculata* and *Earias vittella*

1. Introduction
Contemporarily, fulfillment of plant food requirements is still insufficient due to continuation of increasing the human population. Crop product loss in agriculture areas caused by biotic factors is estimated to be 35%, consisting of insect damage (14%), disease damage (12%) and weed damage (9%) (Rawat and Sahu, 1973) [1]. Okra, *Abelmoschus esculentus* Linn. [Moench], an important vegetable crop are growing all over India (Umamageswari *et al.* 2008) [2].
Occurrence of various insect pests under the Kanpur region (Uttar Pradesh) India was studied and avoidable losses estimated. The bhindi or okra crop are damaged by a number of insect pest like spotted ballworm, *Earias vittella* Fabricius, okra aphid, *Aphis gossypii* Glover, Okra jassids, *Amrasca biguttula biguttula* Ishida whitefly (*Bemisia tabaci* Gen.) and shoot and fruit borers *Earias insulana* (Boisduval) etc. (Butani and Verma, 1976; Mote, 1977 and Sarode and Lal, 1981) [3, 4, 5]. Among them, the spotted ballworm, *Earias vittella* Fabricius (Lepidoptera: Noctuidae) is one of the serious pest in okra,*Abelmoschus esculentus* grown in cultivated land of farmers in Kanpur region of Uttar Pradesh, India (Gandhale *et al.* 1987, Singh *et al.* 1998, Gowri *et al.* 2002, Mahla *et al.* 2002 and Sumathi and Balasubramanian 2002) [6, 7, 8, 9, 10].
India farmers are frequently using the chemical synthetic insecticides for the management of insect pest infesting on okra crop but their consistently use causing side effect in negative consequences (Chandel *et al.*, 2018) [11].

Although hazardous ill effect of pesticides on human health and environment is known, they are more preferred in pest control for reasons such as getting result as soon as possible, less knowledge requirement and easy usage (Panickar *et al.* 2003) [12].

Therefore, the interest of researchers shifted to studies which can be alternative to chemicals and less harmful on human health and environment. In this context, the use of plant based biopesticides and extractives have been raised. One part of research performed in order to increase the plant-based food production is about pesticide applications. The botanical pesticides are an alternative for control of pests in modern recent ecological technologies. Botanical extractives do not carry the threat for the environment. The spectrum of these products continuously expands that requires recognition of the mechanism of their action (Isman, 2006) [13]. A number of studies were conducted for establishment of the effectiveness of plant oils from *Sinapis alba* L., *Cannabis sativa* L. and *Achillea millefolium* L. in concentration 0.5% and 1.0% against the cotton insect pest (Zhou *et al.*, 2004) [14]. Insecticidal activities of certain neem, *Azadirachta indica* A. Juss extractives, products and derivatives on larvae of *E. vittella* was reported (Adhikary 1984, Sardana and Kumar 1989, Murthy *et al.* 1996, Shukla *et al.* 1996, Obeng and Sackey 2003, Rao *et al.* 2002, 2003, Singh and Kumar 2003, Sinha and Sharma 2007] [15, 16, 17, 18, 19, 20, 21, 22, 23]. Sakthivel *et al.* (2008), used *Vitex negundo and Adhatoda vasica* derivatives and their combination products in controlling Okra jassids, *Amrasca biguttula biguttula* and fruit-borers, *Earias* spp. by spraying them at 10, 25 and 40 days after sowing [24].

All the treatments suppressed both the jassid population and fruit borer incidence (Adiroubane and Letchoumanane, 1998 and Reena and Singh, 2007) [25, 26]. Many plant essential oils and extractives showed antifeedant, insecticidal and phago-repellent activities. These botanicals cover the criteria for "reduced risk" pesticides (Mateeva, 2000) [27]. These plant extractives are well accepted in the agricultural practice as "green pesticides" that could be effective enough particularly for biological foods production (Koul *et al*., 2008, Ebrahimi *et al.*, 2013) [28, 29].

The aim of the study was to establish the effectiveness of all these aforementioned asteraceous plant extractives have revealed their insecticidal potential at various intervals on *Earias vittella* Fabricius in bhindi, *Abelmoschus esculentus* grown in field of famers in Kanpur region were determined as hopeful according to results of the present study.

2. Materials and Methods

The present study was conducted in the post graduate Department of Zoology, Entomology, Biopesticides and Toxicological Laboratory, D.B.S. College, affiliated to CSJM University, Kanpur, India. The laboratory culture of okra fruit borers *Earias vittella* Fabricius was initiated from the eggs collected from fields of famers of Fattepur Dakshin village, Kanpur Nagar. As recommended by Chandel *et al.* 2001, Bajpai and chandel, 2010 [30, 31]. The insects were reared in the laboratory at 28 ± 2º C on a diet of okra. The collected eggs were placed in a well ventilated plastic container and okra leaves and fruits were provided to newly hatched larvae. The laboratory reared third instars larvae were used for the present investigation to evaluate the insecticidal efficacy of neem aforementioned asteraceous extractives.

2.1 Mass culturing of *Earias vittella* Fabricius

The larvae of *Earias vittella* Fabricius were obtained from the experimental fields of farmers of Fattepur Dakshin village, Kanpur Nagar and maintained in the laboratory on natural diets. The collected larvae were kept for at least 5 days in the laboratory to check, whether or not, there are any other infections before using them for experiments. Okra fruit borers *Earias vittella* Fabricius required for the study were mass reared on okra leaves and fruits in the laboratory. The mass culturing was initiated by confining 10 larvae of okra fruit borers, *E. vittella* in the plastic containers of 59 x 21 x 18 cm having green leaves and fruit, which were covered with muslin cloth and secured tightly with rubber band. Mass culturing of *Earias vittella* Fabricius larvae was done at 28 ± 2º C temperature in the plastic container and observed daily.

2.2 Procurement of raw asteraceous plant materials: In the present investigation ten asteraceous plant materials viz; aerial parts of *Acemella paniculata* Well ex DC, *Cichorium intybus* (L.), *Chromolaena odorata* Linn., *Chrysanthemum cinerariifolium* (trev.) Vis., *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 collected and used for their insecticidal effectiveness against third instar larvae of *Earias vittella* Fabricius in laboratory trials.

2.3 Preparation of Powder: Fresh collected asteraceous plant materials like aerial parts and leaves etc) were washed with tap water and kept in the laboratory for 7 days for shadow air 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 and Singh, 2016, 2017) [32, 33].

2.4 Preparation of botanical extracts: For the extraction, Soxhlet Apparatus was used; about 20g powder of each category were extracted with 300 ml of alcohol and distilled water). Extractions of each category of powder were 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.

2.5 Apparatus used for experiment: Many glass petridishes (15cm diameter) were used for the experiment, One hand compression poly sprayer and muslin cloth was required for covering the petri-dishes and ridges of plots either going or coming the larvae in the okra field.

2.6 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 selected asteraceous materials. The mouth of the bottles were stopper with airtight corks after which, these bottles containing the solutions were kept in refrigerator. The alcoholic extracts aforementioned plant material were tested under laboratory against third instar larvae of *Earias vittella*, which is noxious insect pest of okra vegetables and crop.

2.7 The Insecticidal Formulations: Three concentrations of asteraceous extractives (0.5, 1.0, 2.0 percent) were used for experiments on insecticidal tests in the field conditions. 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.

2.8 Field Collection and culture of third instar larvae of *Earias vittella*: Adults of *Earias vittella* was drawn from laboratory mass cultures reared in glass jars at ambient laboratory temperature. The third instars larvae of *Earias vittella* were used for experimentation under field conditions.

3. Experimental Protocol

The alcoholic extractives of selected asteraceous plant were tested under field condition against third instar larvae of *Earias vittella*, which are noxious insect pest of okra vegetables and crop. For testing the insecticidal biopotency the okra leaves and fruits were used as food against the third instar larvae of *Earias vittella* treated with different concentrations of ten selected extractives insecticides. The treated foods were covered with muslin cloths. Then third instar, 24 hours starved *Earias vittella* larvae were released in each set of extract and one control was introduced under field conditions. For control set the leaves and fruits were sprayed with Benzene + emulsified water only. After 24h, 48h and 72 hours of the release of larvae the data was collected on the number of larvae dead at each treated food set. Three replication of treatment were made. The insecticidal effect of all the asteraceous extractives was judged by counting the mortality of larvae after 24, 48 and 72 hours and the larval mortality percentage were adjudged over control. All the values were calculated as per Abbott formula (Abbott 1925) [34].

Table 1: List of selected asteraceous plants materials used for extraction

S. No.	Scientific Name	Vernacular name	Faimly	Plant parts used
1.	*Acmella paniculata* (Wall ex DC.) R.K.Jansen	Toothache Plant	Asteraceae	Aerial parts
2.	*Chromolaena odorata* Linn.	Siam weed	Asteraceae	Leaves
3.	*Chrysanthemum cinerariifolium* (trev.) Vis.	Daisy	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: 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

Table 3: Mean mortality percentage of certain asteraceous extractives against *E. vittella* Fabr irrespective of periods.

Treatment (Plant extracts)	Mean Mortality percent After					
	24 hrs.		48 hrs.		72 hrs.	
	T1	T.B.V.1	T2	T.B.V.2	T3	T.B.V.3
A. paniculata	62.72	79.0	71.38	89.8	86.55	96.94
C. cinerariifolium	56.21	69.1	60.44	75.6	66.62	84.3
C. intybus	51.14	60.6	53.33	64.3	56.18	69.0
C. odorata	67.44	85.3	79.26	96.5	87.95	99.87
I. racemosa	46.28	52.2	50.18	59.0	54.30	65.9
M. duriaei	46.59	52.8	64.57	81.6	68.00	86.0
R. acaule	57.23	70.7	69.57	87.8	73.49	91.9
R. tingitana	51.95	62.0	54.64	66.5	63.71	80.4
S. undulata	54.13	645.7	62.45	78.6	66.61	84.2
T. minuta	61.05	76.6	68.08	86.1	76.94	94.9
Over all	55.47	67.9	53.39	79.9	70.03	88.3
Control	00.00	00.00	18.44	10.00	18.44	12.29

(Figures within parenthesis represent the transformed back value).
C.D. for period means at the same plant extracts = 5.3317
C.D. for plant extract means at the same period = 4.9872

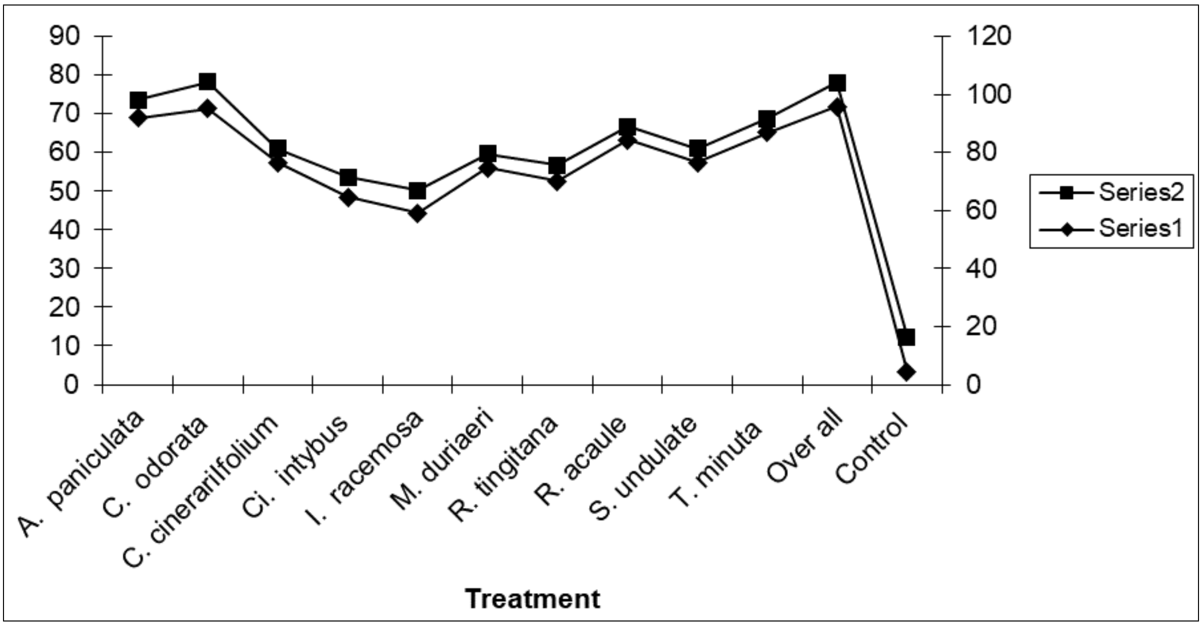

Fig 1: Mean mortality percentage Regression column of asteraceous extractives against *Earias vittella* Fabricius

Table 4: Mean mortality percentage of certain asteraceous extractives against *E. vittella* Fabr.

Vernacular name	Treatments	Mean mortality % after 72h	R.TBV
Toothache Plant	*Acmella paniculata* (Wall ex DC.) R.K.Jansen	73.55	92.0
Siam weed	*Chromolaena odorata* Linn.	78.21	95.1
Daisy	*Chrysanthemum cinerariifolium* (trev.) Vis.	61.09	76.6
Chicory	*Cichorium intybus* (L.)	53.55	64.7
puskarmul	*Inula racemosa* Hook. F	50.25	59.2
Spach	*Mantisalca duriaeri* Birq. Et Cavill.	59.72	74.6
False sowthistle	*Rechardia tingitana* (L.) Roth	56.76	70.0
coffee plum	*Rhaponticum acaule* (L.) DC.	66.76	84.4
Black Salsify	*Scorzonera undulate* Vahl	61.06	76.6
Wild Marigold	*Tagetes minuta* Linn.	68.69	86.8
Over all	Over all	78.0	95.7
Control	Control	12.29	04.5

(Figures within parenthesis represent in mean percentage the transformed back value).
C.D. for period means at the same concentration = 3.9967
C.D. for concentration means at the same period = 2.9811

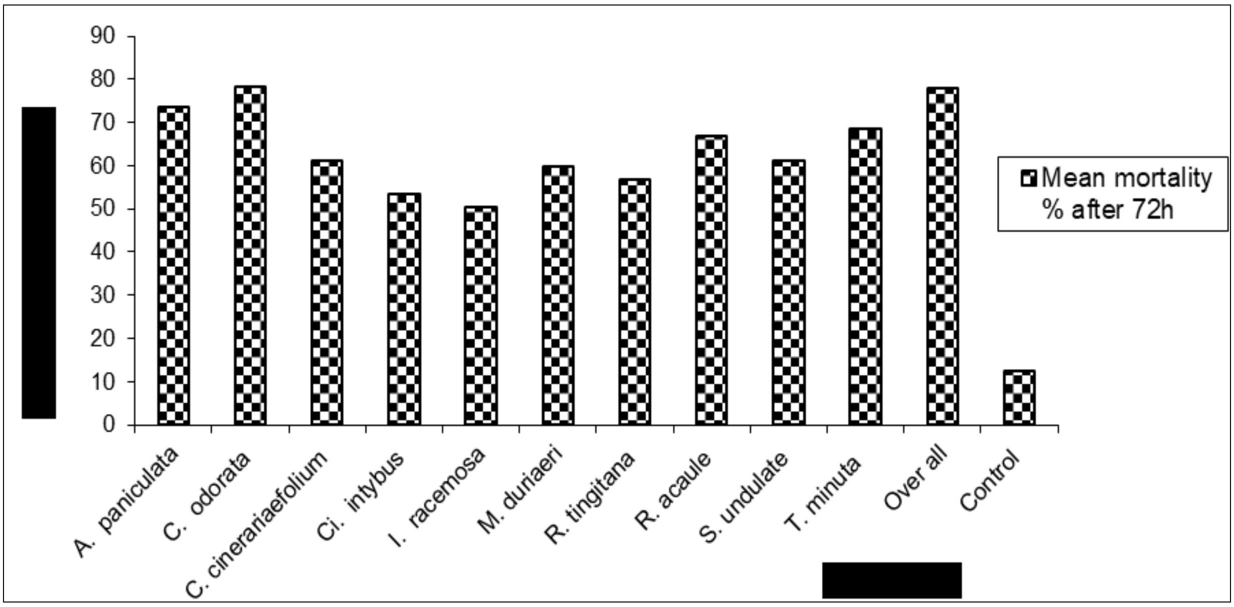

Fig 2: Mean mortality percentage Regression column of asteraceous extractives based on mean mortality against *Earias vittella* Fabricius

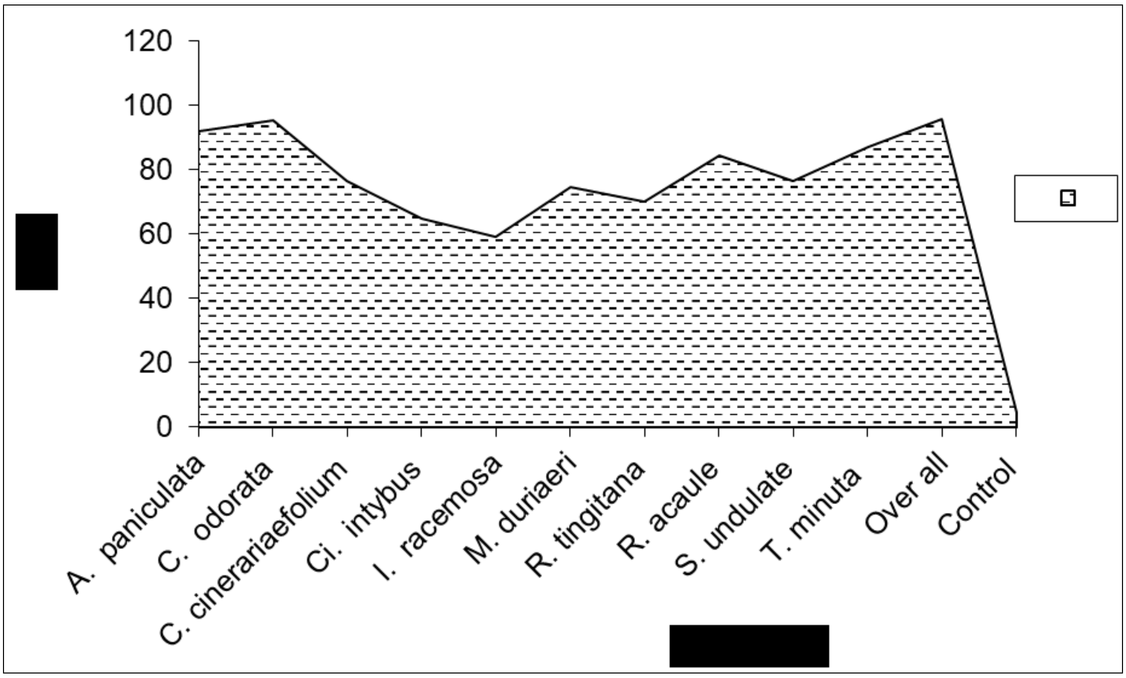

Fig 3: Mean mortality percentage Regression area of asteraceous extractives based on Relative Transfarm Back Values against *Earias vittella* Fabr.

4. Result and Discussion

The data depicted in table 4 and figure 1 results indicated that alcoholic extracts of *C. odorata* registered highest mortality (78.21%) to the 3^{rd} instars larvae of *E. vittella*, when compared to other plant extracts as: *A. paniculata* (73.55%), *T. minuta* (68.69%), *R. acaule* (66.76%), *C. cinerariifolium* (61.09%), *S. undulate* (61.06%) have registered encouraging (greater than 60% mortality) results having insecticidal properties. The remaining extractives have proved more or less larvicidal activities as: *M. duriaeri* (59.72%) > *R. tingitana* (56.76%) > *C. intybus* (53.55%) > *I. racemosa* (50.25%), respectively.

In the support of above findings several workers conducted in field studies to determine the efficacy of herbal based insecticides particularly neem for the control of *Earias vittella* and *E. insulana* infesting okra and reported that neem exhibited promising insecticidal biopotency (Gurnam *et al*. 1998) [35]. Thara and Kingsly 2001 tested the neem, *Azadirachta indica*, is one of the most effective insecticidal properties against third instar larvae of Bhindi vegetable [36]. This study confirms the insecticidal effect of neem oil and neem cake extract on *Earias vittella*. High level of feeding deterrence was exhibited at all concentrations of neem cake extract gainst *Earias vittella*. Gowri *et al*. (2002) studied the efficacy of some new neem formulations and conventional insecticide, endosulfan against okra fruit borer, *Earias vittella* (Fabricius) indicated that endosulfan (0.07%) and Nimbecidine (1.0%) were most effective in controlling the fruit borer, *E. vittella* and gave higher yield of okra fruits [37].

These results are in agreement with the scientist tested insecticidal biopotency of different concentrations of certain asteraceous extractives against *Callosobruchus chinensis* L. (pulse beetle) on stored gram, chickpea *Cicer arietinum* L. Kabuli variety Mexican white (ICC 106) and reported that *Chromolaena odorata* (83.08%) against early emerged pulse beetle, *C. chinensis* followed by *Chrysanthemum cinerariifolium* (74.26%) and *Tagetes minutia* (68.83%), respectively (Chandel, and Singh 2016, Chandel and Singh, 2017) [38, 39]. Researchers in different parts of world have been using plants for controlling pests including stored grain pests. Previous studies revealed that different plant compounds were used in controlling pest and they proved effective and eco-friendly. Many researchers investigated the compounds in plants that have a variety of properties including insecticidal activity, repellence to pests, antifeedant effects and in insect growth regulation. For the conformity of the above findings those workers as Tomova *et al.* 2005, Rajmohan and Logankumar 2011 studied suitability of six plants of compositae family viz., *Calendula officinalis*, *Chrysenthemum fratiscens*, *Chrysenthemum indicum Tagetes erectus* and *Zinnia elegans* in respect of mortality, among them *H. annus* extract caused 63.33 percent larval mortality [40, 41].

Certain asteraceous extractives like *Mantisalca duriaei Briq. et Cavill.*, *Rhaponticum acaule* DC and *Scorzonera undulata* Vahl extracts were tested insect contact toxicity against adults and larvae of *Tribolium confusum* (Coleoptera Tenebrionidae). Larval growth inhibition was significantly induced by methanolic and ethyl acetate extracts of *Mantisalca duriaei Briq. et Cavill.* and petroleum ether, chloroformic and methanolic extracts of *Rhaponticum acaule* DC. For all extracts, mortality was higher for larvae than adults. It reached respectively 83%, 77% by using petroleum ether and methanol extracts of *R. acaule*. These results suggest that *M. duriaei* and *R. acaule* may be used in grain storage against insect pests (Zygadlo *et al.* 1990, Manish Kumar *et al.* 2017) [42, 43]. Mansour *et al.* (2014) screened the toxicity of chicory, *Cichorium intybus* L. (Asteraceae), against larvae and adults of the mosquito (*Anopheles pharoensis*) and the housefly management [44]. The larvicidal activity of the ethanol extract of *Inula racemosa* Hook. f. (Compositae) roots against the larvae of the Culicidae mosquito *Aedes albopictus* and to isolate any larvicidal constituents from the extractactives exhibited strong larvicidal activity against the early fourth-instar larvae of *A. albopictus* with LC_{50} values of 21.86 μg/mL and 18.65 μg/mL, respectively (Olfa *et al.* 2008) [45]. From the present study, it is concluded that the selected asteraceous possess toxic principles with significant insecticidal effects and could be a potential biorational insecticides against ch*ickpea*, *Callosobruchus chinensis* L.

5. Conclusion
Conclusively, the present investigation revealed the appear prospects in selected asteraceous extractives, only *C. odorata* registered highest mortality (78.21%) to the 3rd instars larvae of *E. vittella* followed by *Chromolaena odorata*, *Acemella paniculata, Tagetes minuta Rhaponticum acaule, Chrysanthemum cinerariaefolium, Scorzonera undulate* registered promising mortality (greater than 60.00%), respectively. Overall, the selected and tested ecofriendly biorational extractives were effective to some degree of entomotoxicity and destruction of infesting insect pest of okra. More studies on major biochemical constituents responsible for insecticidal activity to the test insect on okra against larvae of *Earias vittella* Fabricius. need to be investigated. This study therefore opens a new line of investigation for the management of larvae of *Earias vittella* Fabricius under the biorationals and ecofriendly process with help of indigenous selected asteraceous plants rather the use of hazardous synthetic insecticides.

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