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Full Length Research Article

Efficiency of Phytochemicals Obtained from Selected Invasive Weeds against Mustard Aphid (*Lipaphis erysimi*) Kalt.

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Abstract

Lipaphys erysimi Kalt is the most damaging pest of the mustard crop, as it affects the crop in diverse ways resulting in reducing the crop yield. In this study, invasive weeds like *Parthenium hysterophorus* L. and *Argemone mexicana* L. were used to check their insecticidal effectiveness against mustard aphid using leaf dip and film smear method in laboratory conditions. The bio-efficacy of aqueous extract of both the weeds was compared with efficiency of chemical pesticide Rogor (Dimethoate). The results revealed that, rogor showed the maximum mortality but *P. hysterophorus* L. showed highest efficiency than *A. mexicana* L. in both the bio-assays. The leaf dip method was more efficient than film smear method. The present study suggests that chemical pesticides can be replaced with bio formulations derived from these invasive weeds grown in the crop field, which indirectly can be the ecofriendly management of the invasive weeds.

***Key words*:** *Lipaphis erysimi,* Invasive weeds, Phyto-insecticide, *Parthenium hysterophorus* L, *Argemone mexicana* L.

Indian mustard (*Brassica juncea* L. Brassicacear) is one of the most important oil yielding crops after groundnut in India [18], [32]. After China, India is the second largest producer of Indian mustard [3]. In India, Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat are the primary producers of Indian mustard [27]. In addition to abiotic factors, biotic ones such as insect infestations reduce the productivity of Indian mustard. There are 38 pests are associated with Indian mustard [8] among them, Mustard aphid, *Lipaphis erysimi* (Kalt.) is the most devasting pest. Many studies have thoroughly estimated the yield loss due to mustard aphid. It causes 35.4 to 96% yield loss, 30.9% oilseed weight loss [8], [29] and 5-6% reduction in oil content [28]. The infestation rate at various stages of the crop may be the cause of this massive yield loss. The adult and nymph of mustard aphid predominantly feed on and suck the cell sap from leaves, young shoots, inflorescence, and young pods of mustard plant [17], [23]. Continuous feeding on plant sap ensuing yellowing, curling, shrivel and consequent drying of leaves, dwarf and stunted plant, which finally results in the formation of poor pods and undersized seeds [17], [20]. Severe infestation results into secretion of sticky honey dew like drops which promote the growth of sooty mold fungus which makes the leaves and pods dirty black [6], [23] which inhibits photosynthesis [30]. Ability of rapid reproduction, growth and wide adaptation of mustard aphid, cause resistance for chemical insecticides [14], also shows negative impact on bio agents as well as environment. In other hands use of phyto- insecticides is one of the convincing ways to control the insects.

Weed is a significant factor in affecting crop yield in addition to pest issues. There is a wide variety of weeds from different families that compete the mustard crop. *P. hysterophorus* L., Asteraceae, is a densely branching, annual herbaceous plant with an upright (erect) habit [21]. It is perennial, pre dominant weed in mustard crop field [11]. The upright annual herb *A. mexicana* L. has a tap root that is partly branched and can reach heights of 100 to 150 cm, grows in crop fields [24]. Cinnamic and benzoic acid, two allelochemicals found in *A. mexicana* L., prevent mustard seeds from sprouting and seedling vigour of mustard [22]. The present study was conducted to find out the effectiveness of phyto insecticide made from invasive weeds like *Parthenium hysterophorus* L. and *Argemone Mexicana* L against mustard aphid.

MATERIALS AND METHODS

The study was conducted both in field of Waghapur village (18°23'46.53" N and 74°08' 28.26" E.), Tal. Purandhar, Dist. Pune as well as in the lab of A. Kulkarni department of

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Biodiversity, Garware College. Invasive weeds were collected from the field and bio assays were carried out in the lab. The details of the experiment are as follows:

Collection of weeds

Various parts like leaves, roots and stem of invasive weeds, *Parthenium hysterophorus* L. and *Argemone mexicana* L. were collected from crop fields of Waghapur village, Purandhar Tahsil, District Pune. Collected invasive weeds were identified and confirmed from Botanical Survey of India, Pune. The materials were washed thoroughly with tap water, air shade dried and ground into respective fine powders.

Preliminary qualitative analysis of invasive weeds

All the tests were performed by standard physico-chemical methods as reported by [19], [26] for detection of various phytochemicals for their presence in the selected invasive weeds.

Preparation of phyto-pesticide

5 g powders were soaked in 100 ml DW to make 5% solution for 48 hours and filtered through muslin cloth. Similarly, 10%, 15% and 20% concentrations were made. Chemical insecticide Rogor i.e., Dimethoate (0.02%) was used for the comparison and water was used as a control.

Rearing of aphids

Mustard aphids *Lipaphis erysimi* (Kalt.) were reared on potted mustard plant under laboratory conditions at 25 ± 2˚C, relative humidity 60 ± 5% and a photoperiod of 16:8 hours (L:D). The aphids were identified from Department of Biodiversity, MES Abasaheb Garware College, Pune.

Laboratory assay

Among the various bioassay methods applicable for different toxicity tests, leaf dip and film smear methods are employed for checking the insecticidal toxicity of selected invasive weeds on mustard aphid. These contact toxicity methods are manageable under controlled laboratory conditions as they offer an exposure that is more comparable to what the insects would encounter in the field conditions.

Leaf- dip method

In the leaf-dipping method [15] with little modifications, mustard leaves were dipped in insecticide solutions diluted to the required concentration (5%, 10%, 15%, and 20%) for 30 seconds and air- dried. 10 adult aphids with camel pointed brush are then put on the treated leaves and observations taken after 1, 3, 6, 12 and 24 hours.

Film- smear method

This technique [9], includes insecticide solution is deposited on petri dish for evaluating insecticide efficacy. In this approach Petri dishes (9 cm diameter) are coated with 2 ml solution on their inner sides and the solution is allowed for uniform spreading in the Petri dish by swirling it gently and then dried at room temperature. 10 adult aphids are then released onto the film of the toxicant in the petri plate. Thereafter; the observations are taken after 1, 3, 6, 12 and 24 hours.

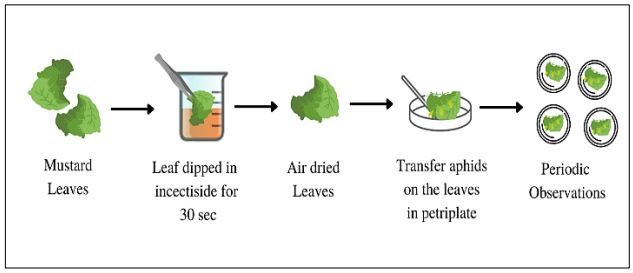

Fig 1 Illustrated procedure of leaf dip method

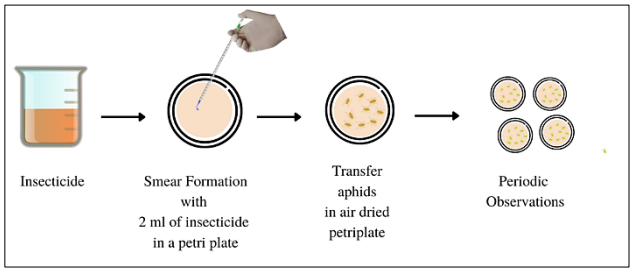

Fig 2 Illustrated procedure of film smear method

Statistical analysis

The corrected mortality was obtained by using Abbott's formula [1]. To calculate the lethal times, 50% (LT50), 90% (LT90) and 95% (LT95), serial time-mortality data from toxicity1 bioassays were analyzed by Probit analysis using SPSS software (SPSS, version 25). Mortality rates of *Lipaphis erysimi* Kalt**,** treated with aqueous extracts of *P. hysterophorus* L. and *A. Mexicana* L. were compared by one-way analysis of variance (ANOVA). The results of phytochemicals analyzed from aqueous extracts of these weeds and their effect on mustard aphid as insecticide are discussed in details.

RESULTS AND DISCUSSION

The aqueous extracts of both weeds were tested for the presence of phytochemicals in preliminary studies, which revealed the presence of carbohydrates, flavonoids, phenolic compounds, saponins, tannins, and alkaloids but not glycosides as shown in (Table 1). Both weeds are biologically important which indicates their contribution in terms of different properties viz. Antimalarial, Antibacterial, Cytotoxic ability, Molluscicidal, larvicidal, Insecticidal, Antifeedant, Fungitoxic, Antioxidant abilities are shown by *Argemone mexicana* L. [2], [12]. Likewise, *Parthenium hysterophorus* L. exhibits Antimalarial, Antibacterial, Cytotoxic ability, Antifeedant, Antioxidant, Antimalarial, Nematicidal,Antifungal abilities [25].

Table 1 Preliminary phytochemical screening of aqueous extracts of *Parthenium hysterophorus* L. and *Argemone mexicana* L.

S. No.	Preliminary test	*P. hysterophorus* L.	*A. mexicana* L.
1.	Flavonoids	+	+
2.	Saponins	+	+
3.	Tannins	+	+
4.	Glycosides	--	--
5.	Alkaloids	+	+
6.	Carbohydrates	+	+
7.	Phenol	+	+

Table 2 Comparison of LT-50, LT-90 and LT-95 of aq. extract of *P. hysterophorus* with Rogor and control by film smear method

Tr. No.	Treatments	Dosage	LT50	LT90	LT95
T_1	Aq. extract *P. hysterophorus* L	5%	20.03g	35.07e	39.33e
T_2		10%	18.04f	33.45e	37.81e
T_3		15%	13.58e	26.70d	30.42d
T_4		20%	9.35c	18.94c	21.66c
T_5	Aq. extract *A. Mexicana* L	5%	23.97f	39.48e	43.45e
T_6		10%	18.10e	31.36d	35.12d
T_7		15%	14.32d	26.31cd	29.71cd
T_8		20%	9.44c	18.74b	21.37b
T_9	Aq. extract *P. hysterophorus* L + Aq. extract *A. Mexicana* L	20%	11.04d	24.56d	28.43d
T_{10}	Rogor (Dimethoate)	0.02%	6.32b	13.95b	16.12b
T_{11}	Control	-	-	0.00	0.00

Table 3 Comparison of LT-50, LT-90 and LT-95 of aq. extract of *P. hysterophorus* L and Aq. extract *A. mexicana* L with Rogor and control by leaf dip method

Tr. No.	Treatments	Dosage	LT50	LT90	LT95
T_1	Aq. extract *P. hysterophorus* L	5%	23.11c	39.33b	43.93c
T_2		10%	21.24bc	37.51b	33.60bc
T_3		15%	14.97abc	29.48ab	33.60bc
T_4		20%	8.25ab	16.83a	19.26ab
T_5	Aq. extract *A. Mexicana* L	5%	26.71c	42.41c	46.86c
T_6		10%	20.87bc	35.28bc	39.37bc
T_7		15%	16.27abc	30.67abc	34.65bc
T_8		20%	9.37ab	20.46ab	23.60ab
T_9	Aq. extract *P. hysterophorus* L + Aq. extract *A. Mexicana* L	20%	10.58abc	22.85ab	26.33abc
T_{10}	Rogor (Dimethoate)	0.02%	5.77a	13.58a	15.79ab
T_{11}	Control	-	11.39abc	13.76a	14.43a

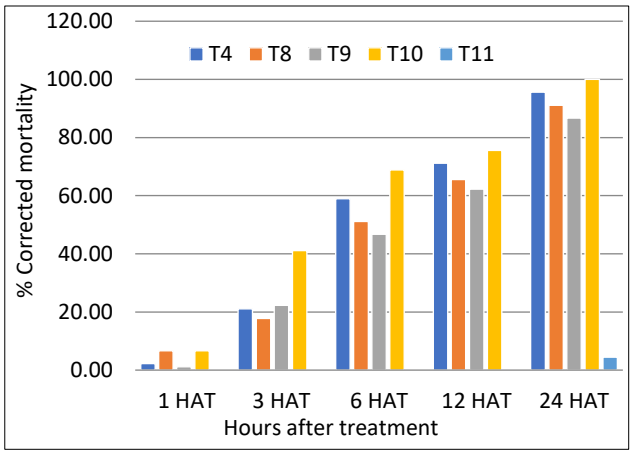

Fig 3 Graph representing the % corrected mortality by T_4, T_8 and T_9 as compared to T_{10} and T_{11} by leaf dip method

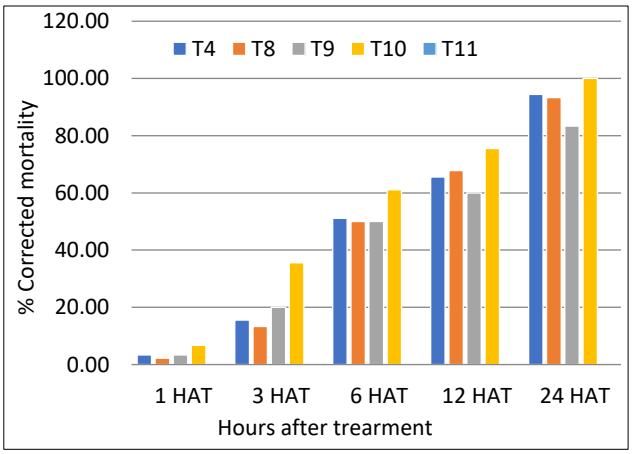

Fig 4 Graph representing the % corrected mortality by T_4, T_8 and T_9 as compared to T_{10} and T_{11} by film smear method

The study was conducted to test insecticidal activity of both weeds on mustard aphids. The tests were performed by leaf dip method and film smear method. The results of toxicity of *P. hysterophorus* L. and *A. mexicana* L. with the comparison of Rogor and control by film smear test are shown in (Table 2), whereas results of leaf dip method are shown in (Table 3).

In (Table 2), comparison of LT-50, LT-90 and LT-95 of aq. Extract of *P. hysterophorus* L. with *A. Mexicana* L., Rogor and control by Film smear method is shown by calculating LT50, LT90 and LT95 by probit analysis. LT50 values of T4, T8 and T9 are 9.35, 9.44 and 11.04 hours respectively. Considering the values of LT90 and LT95 for T_4, T_8 and T_9 are 18.94, 18.74 and 21.66 hours and 24.56, 21.37 and 28.43 hours respectively, T_4 showed effective significance as compared to T_8 and T_9. Comparatively LT50, LT90 and LT95 values for rogor are 6.23, 13.95 and 16.12 hours. In this manner as well for the leaf dip method as indicated in (Table 3), T_4, T_8 and T_9 have LT50 values of 8.25, 9.37, and 10.58 hours, respectively. T_4 demonstrated effective significance when compared to T_8 and T_9, with LT90 and LT95 values for T_4 being 16.83, 20.46, and 22.85 hours and 19.26, 23.60, and 23.60 hours, respectively. In terms of rogor, the LT50, LT90, and LT95 values are 5.77, 13.58, and 15.79 hours, respectively.

(Fig 3-4) depict corrected mortality by leaf dip method and film smear method, respectively. They show that mortality by 20% concentration of aq. extract of *P. hysterophorus* L. (T_4) is slightly higher than mortality by 20% concentration of aq. extract of *A. mexicana* L. (T_8) at 24 hours, while 20% concentration of combination of both plants (T_9) is showing slightly higher % mortality than T_4 (T_8). Rogor, however, has

the highest 24-hour death rate. Although the results from the two procedures are comparable, the leaf dip method was more successful than the film smear method.

The reported use of these invasive weeds as insecticide against aphids have shown significant effect. Petroleum ether extract of *P. hysterophorus* L. leaves showed significant decline in both the lifespan and the production of adult *Lipaphis erysimi* Kalt [31]. Likewise, its leaves extract showed efficient mortality against *Lipaphis erysimi* Kalt [13]. The population of mustard aphids *Lipaphis erysimi* Kalt was significantly reduced by the extract of *P. hysterophorus* L. on mustard [10]. The recent study [7], observed leaves extract of congress weed showed significant reduction of aphids on potato leaves. None the less, Parthenin showed more effective toxicity against *A. craccivora* [16]. In other hand, [4] tested the bio efficacy of *A. mexicana* L. on mustard aphid, *Lipaphis erysimi* (Kalt), resulting the highest % reduction in the population. Methanol extract of *A. mexicana* L. showed repellency at 5% against *A. gossyppi* Glover adults [5]. Therefore, the present study revealed that aqueous extract of *P. hysterophorus* L and *A. mexicana* L. showing insecticidal activity against mustard aphid effectively.

CONCLUSION

Chemical insecticides show highly hazardous results against aphids, simultaneously causing deleterious effects on the corresponding ecosystem. Therefore, bio-formulation is an efficient approach for overcoming environmental consequences of chemical pesticides. The current study was carried out to evaluate the usefulness of formulations made from invasive weeds against mustard aphid. *A. mexicana* L. and *P. hysterophorus* L. have demonstrated the efficacy of a wide range of phytochemicals on different bioactivities. Based on the effectiveness of their toxicity against aphids and the overall performance of pesticide made from aqueous extract the weeds, *P. hysterophorus* L. showed the operative results as compared to *A. mexicana* L. A mixed formulation of both these weeds showed results comparable to *P. hysterophorus* L. the result of the study suggest that, insecticide made from *A. mexicana* L. and *P. hysterophorus* L. can be applied on mustard aphids to get outcome as similar to chemical pesticide without disturbing the environment. For the production of bio pesticides, additional research is needed to examine the bio-efficacy of invasive weeds against the intended pests. Environmental risks can be readily avoided and invasive weeds also can be managed by using them as an insecticide.

Conflict of interest

The authors declare no conflict of interest.

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