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Seasonal infestation of mango leaf cutting weevil and its response to some weed extracts

Md. Masum Al Helal, Md. Adnan Al Bachchu*, Hasan Fuad El Taj, Most. Zannatul Ferdushe Shilpi
Md. Harun-Ur-Rashid

Department of Entomology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh

Corresponding email: adnan@hstu.ac.bd

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Abstract

The seasonal abundance of mango leaf cutting weevil (*Deporaus marginatus* Pascoe) was studied on nine varieties of mango viz. Amropali, Harivanga, Mallika, Surjapuri, Gopalvog, Langra, Fazli, Ashwina and Guti during October 2016 to September 2017 in the orchard of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. In this study toxicity of some weed extracts namely black nightshade, wild tobacco, leucas, lantana, goatweed and raan tulas were evaluated on the weevil. Rresults showed that the highest percentage of infestation was found in Surjapuri (average 52.6%), and the lowest in Ashwina (average 33.4%). In regards to month, maximum infestation was found in August (77.5%) at surjapuri and minimum was in February **(**7.9%) at Mallika. No infestation was observed on the mango leaves during December and January. The highest toxicity effect (average mortality 78.3 %) was found in rann tulas at 5.0 % concentration, whereas black nightshade showed the lowest toxicity effect (average mortality 10.8 %) at 1.25 % concentration. On the basis of mortality, the order of toxicity of the plant extracts were found rann tulas > wild tobacco > lantana > goat weed > leucas > black nightshade. Adult's mortality were directly proportional to different concentration levels and hours after treatments (HAT). The lowest LD_{50} values (3.3, 2.3 and 1.8 mg/ml at 24, 48 and 72 HAT) of rann tulas indicated its highest toxicity effects against *D. marginatus*. The present study revealed that synthetic pesticides can be replaced with botanicals for the management of *D. marginatus* in order to save the environment.

Keywords: *Deporaus marginatus*, damage incidence, weed extracts, toxicity, LD_{50}

Introduction

Mango is widely cultivated in the tropical and subtropical countries like India, Pakistan, Mexico, Brazil, China, Haiti, Philippines and Bangladesh (Alexander 1989). A large number of superior varieties of mangos are grown in Bangladesh and are wide demand in the market which is commercially important. Presently, mango cultivable land has increased of the country about an area of 306274.32 acres with a production of 1482937.04 m. tons and is now an increasing trend in area (BBS 2023). But the production of mango is hindered by various abiotic and biotic factors like insect pests, mites, diseases etc.

Mango leaf cutting weevil is considered as a important pest (Hill 1983) which cause extensive damage to the foliage (Amin 2020). Once upon a time it was treated as a minor pest but recently it turned into major pest. Mostly young trees (2 to 5 years old) suffer more than the older one. The female makes small cavities on either side of the midribs on upper surface of tender pinkish leaves which are then cut by the weevils near the base. The damage to some mangoes by leaf cutting weevil was reported 23.9% to 57.4% defoliation (Rafiquzzaman *et al.* 1999) and cause damage as much as 53% on grafted plants (Uddin *et al.* 2003). By the attack of mango leaf cutting weevils, ultimate result of delay growth of root stock and poor success of new grafts as well as failure of fruit setting and therefore on the yield (Singh 2014).

However, to develop an integrated pest management program of *D. marginatus*, in-depth understanding and knowledge of the infestation rate and incidence caused by the pest is a prerequisite. Despite many extensive studies on the seasonal infestation and incidence of different mango variety in regards to Bangladesh are reported but detail information on temperature dependent development and infestation caused by *D. marginatus* is surprisingly limited and maximum data were not in a useful for the modelling of management purposes. On the other hand, it is vital to understand the seasonal infestation and incidence in respect of time on various mango varieties despite its

economic importance and worldwide distribution an eco-friendly and suitable management is utmost necessary.

Pesticide application is a recommended control practice of mango leaf cutting weevil when young leaves become 3 cm wide (Singh 2014). However, the use of synthetic insecticide is not environmentally safe for animal and beneficial insects. When it is used in heavy amount accumulation of residues in the harvested produce becomes hazardous (Prakash *et al.* 2008). Botanical pesticides have long been practiced as effective alternatives to synthetic insecticides as green pesticide for mango leaf cutting weevil, because it have low toxicity and low persistence in environment, biodegradable, nontoxic to animals and humans but have moderate effect on insect due to multiple modes of action (Koul *et al.* 2008, Gurjar *et al.* 2012). In the context of biochemical studies of Black nightshade (*Solanum elaeagnifolium*) it was found a secondary metabolite which has insecticidal activity and toxic alkaloids (Mkula 2006). Various types of compounds including alkaloids, cumarins, flavonoids, chromenes, benzofurans, sterols and terpenoids etc. are found in Goat weed (*Ageratum conyzoides*) which have pharmacological and insecticidal activities (Kambooj and Saluja 2008). *Solanum nigrum* contain flavonoids which is used in commercial crops to manage many agricultural pests like thrips (*Frankliniella occidentalis*) mite (*T. urticae*), aphid (*Shizaphis graminum*) etc. (Muthuvel *et al.* 2014). Therefore, the present study was designed primarily to find out the leaf infestation and seasonal incidence of *D. marginatus* on different mango verities different month of the year. As a part of management program, attempt was also made to find out the toxicity effect of six weed extracts based on adult mortality of *D. marginatus.*

Materials and methods

Variety selection and experimental design: Nine mango varieties viz. Amropali, Harivanga, Mallika, Surjapuri, Gopalvog, Langra, Fazli, Ashwina and Guti were selected to estimate the seasonal infestation and damage incidence by mango leaf cutting weevil. The experiment was designed in randomly completely block design (RCBD) with three replications. Therefore, the total number of plants was 27. For taking data, five new twigs were tagged randomly from each mango plant.

Rearing of of the weevil*:* Freshly infested fallen leaves of mango were collected under the mango trees of HSTU campus. The infested leaves were then placed on Petri dish (150 ml) containing moist soil and kept them in the laboratory (25 - 32ºC and 85 - 90 % RH). After emerging the adults, they were released in big plastic pot / chamber (40 cm) and newly flushed twigs of mango were supplied as food for *D. marginatus* during that period. This process was continued until the experimental requirements.

Collection and preparation of weed extracts: The leaves of tested weeds namely, Black nightshade (Tit begun)–*Solanum nigrum*, Wild tobacco (Bon tamak)–*Nicotiana plumbaginifolia,* Leucas (Shethdrun)–*Leucus aspera*, Lantana–(*Lantana camara*), Goat weed (Saglagacha)–*Ageratum conyzoides* and Raan tulas (Ban marich)–*Croton sparsiflorus* were collected from campus and the surrounding area of HSTU, Dinajpur. After collection, they were kept in laboratory for air-drying and after dried they were made powder separately by electric grinder and passed through the sieve (60 mm meshes) to get fine powder. For extracts preparation, 100 g of each category of powder was separately mixed with 300 ml of solvents (methanol). The mixture stirred for 30 minutes and left stand for next 72 hours with shaking several intervals in mechanical shakers. After that, the mixture was filtered through Whatman no.1 filter paper. The filtrates were taken into round bottom 100 mm flasks and condensed by evaporator at 70°c temperature to make it crude extract. Then the extracts were preserved in refrigerator for further experimental use.

Experimental protocol and bioassay of test insect: Newly flushed 5 twigs of each mango variety were selected and tagged for observing the seasonal infestation and damage incidence of mango leaf cutting weevil. The injured with cut leaves were counted from each selected twigs. The infestation was observed on only newly flushed twigs emerged in every month of study period. Before bioassay test, 3 concentrations (1.25, 2.5 and 5.0%) along with control were prepared from the crude extracts with methanol solvent. Pilot experiment was done to obtain the appropriate dose prior to conducting study. Newly flushed leaf twigs of Amrapali mango variety were collected and the base of the leaf twigs was kept in the water containing bottle to retain it fresh. The bottles with leaf twigs were

kept in different plastic containers (30 cm ×26 cm). Each weed extract was diluted with respective solvent to make the desired doses. The leaf twigs were sprayed with the weed extracts using hand sprayers. After spraying, the leaf twigs were dried by electric fan or air at shading condition for 20 minutes to avoid wet condition. Spray with only solvent was maintained for the control treatment. Each weed extract with each concentration was considered as one treatment and three replications were maintained for each treatment. Three days old, 10 adult weevils were randomly selected from the mass culture and released inside the plastic container for each replication.

Data collection: The number of cut leaves and uncut leaves were counted in each month. The percent infestation was calculated with the following formula:

% Leaf infestation= Number of cut leaf / Total number of leaf (number of cut leaf + number of uncut leaf) x 100.

Adult mortality was recorded at 24, 48, and 72 and 96 hours after treatments (HAT) and mortality percent was calculated by Abbott's formula (Abbott 1987).

$$P = \frac{p' - C}{100 - C} \times 100$$

Where,

P= Percentage of corrected mortality
P'= Observed mortality (%)
C= Mortality (%) at contro*l*.

Statistical analysis: The collected data for insect mortality rates were statistically analyzed by analysis of variance followed by Duncan's New Multiple Range Test (DMRT). The observed mortality data were also subjected to probit analysis.

Results and discussion

The monthly infestation of leaf caused by *D. marginatus* in tested mango varieties is shown in figure 1. The percentage of leaf infestation differed significantly from variety to variety. It was observed that all the varieties were infested by mango leaf cutting weevil (figure 1). Our results are in general agreement with reported by Rafiquzzaman *et al.* 1999 and Uddin *et al*. 2003. Rafiquzzaman *et al.* (1999) carried out an experiment with 10 mango varieties and reported that all of them are susceptible to mango leaf cutting weevil, with Amropali as the most prone variety having 53.9% leaf infestation. Uddin *et al*. (2003) also conducted an experiment with 12 mango cultivars and observed that all cultivars are susceptible to *D. marginatus*. This infestation difference could be related to cultivar specific traits.

Significant difference were observed among different mango varieties from month to month ($df = 9$, $F = 291.8$, $P<0.01$). The highest infestation of leaf was found in the month of August (63.9%) and the lowest was observed in February (11.1%) in Amropali. The infestation caused by *D. marginatus* in the variety of Harivanga were 38.48%, 27.85%, 9.2%, 45.4%, 54.3%, 56.4%, 62.3%, 72.3%, 72.8%, 57.0% for the month of October, November, February, March, April, May, June, July, August, September, respectively. Maximum infestation of leaf of Mallika variety was recorded in the month of August (75.6 %) and minimum was in February (7.9 %). In Surjapuri variety, the percentage of leaf infestation in the months of March, April, May, June, July, September and October were 45.8%, 58.9%, 65.5%, 66.9%, 72.2%, 51.4%, 41.7%, respectively and the highest was recorded in August (77.4%) as well as the lowest in February (28.2%). The Gopalvog variety showed the highest leaf infestation in the month of July (62.8%) and the lowest in the month of February (22.3 %). The mango leaf cutting weevil infested the highest percentage of leaf in July (59.4%) and the lowest in the month of February (15.3%) in Langra variety. Maximum percentage of leaf infested by *D. marginatus* was recorded in the month of August (54.3 and 49.8%) whereas minimum was perceived in February (12.5 and 9.7%) in Fazli and Ashwina variety, respectively. In Guti variety, the highest infestation was observed in the month of June (53.6%) and the lowest was in February (18.8%).

From the results of current study, it is clear that the leaves of all tested mango varieties were infested by mango leaf-cutting weevil. The weevil attacked newly flushed of pink leaves of mango from the month of February to November. The data also indicated that there were variations of leaf damage in different months. The infestation gradually increased from the initial attack in February and reached peak in August, which was statistically identical to June and July. It indicate that from April to August month mango leaf cutting weevil was more active and maximum infestation to mango plants ranging from

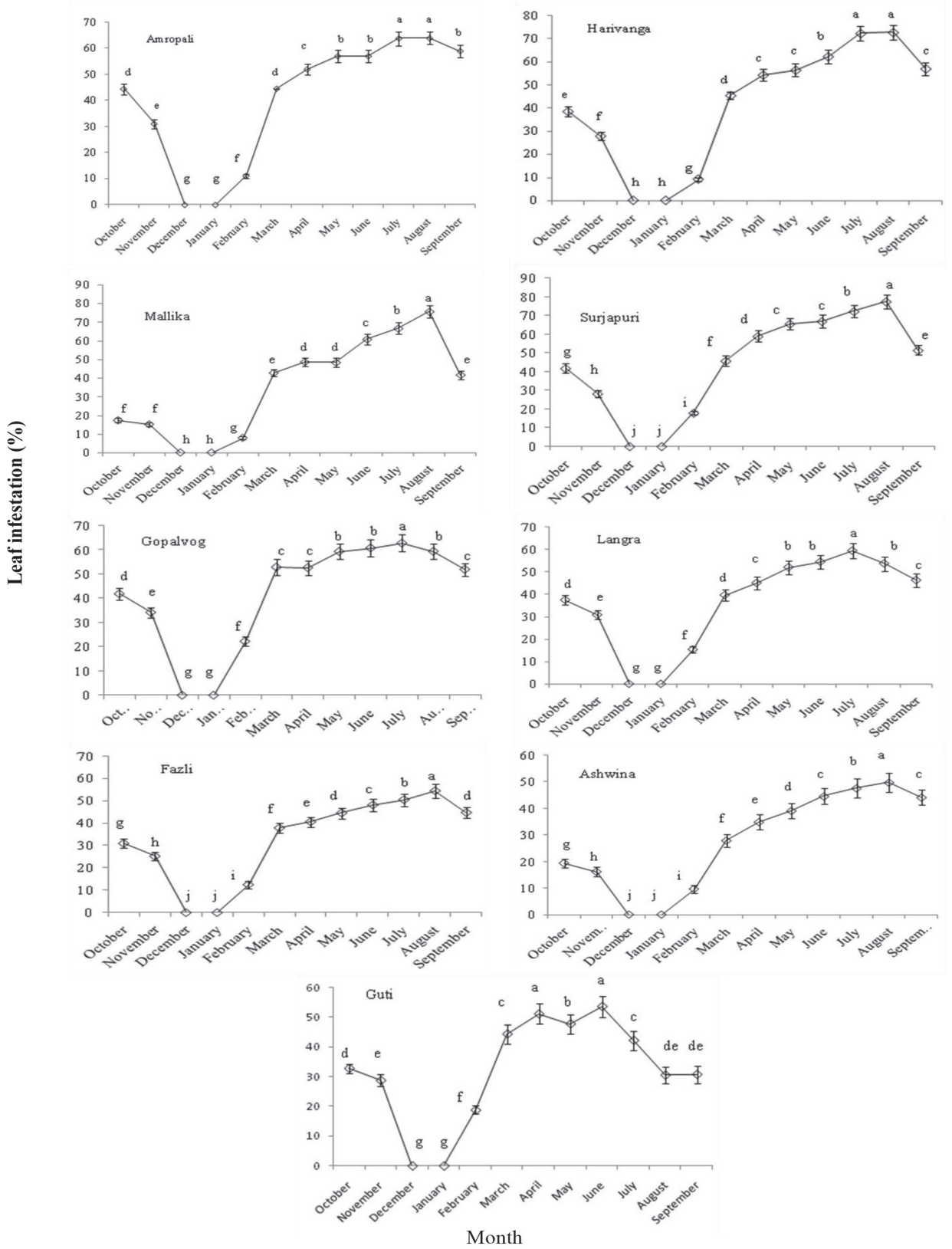


Figure 1. Monthly infestation of leaf (%) by *D. marginatus* in different mango varieties.

34.9 to 77.5 percent. It was gradually decrease from the month of September to November and no infestation was observed on the leaves of all tested mango varieties during December and January. Uddin *et al.* (2012) reported that there was no leaf damage occurred by *D. marginatus* in the months of December, January and February. The persistence of incidence of the pest species reported by Bhole *et al.* (1987) under field condition was up to October and peak incidence in July to October. Rafiquzzaman and Maiti (1999) reported that the leaf damage on mangoes was peak during July-August and least during the second fortnight of November followed by no activity during winter period of December –January. If the new flush is not available then there is no chance to damage in these months because *D. marginatus* only damage to new young leaves. The infestation percentage was extreme during the months of July and August in all tested mango varieties. It was observed that new leaves of mango trees gradually started to flush from February and it was excessive in the months of July and August. The weather data also showed the maximum temperature and rainfall occurred in this two months. So, there was a relationship in between the new leaves and rainfall with temperature. Probably this is the important reason to infest heavily by mango leaf cutting weevil during the month of July and August. The incidence of the insect might be related to the prevailing temperature, relative humidity and rainfall, which was recorded lowest in the winter month as recorded 4.4-36.6°C; 58-99%; 0-647 mm, respectively.

Toxicity effects of six weed extracts and their doses at different time intervals against the adult of *D. marginatus* are presented in Table 1. The mortality of the adult insects were not differed significantly among all the weed extracts applied but differed significantly ($df = 5, F = 20.2, P<0.05$) from the control treatment at 24 hours after treatments (HAT). However, adult mortality was dissimilar among the treatment at 48, 72 and 96 HAT and percentage of mortality was increased with the increased of time. The mortality percentage of *D. marginatus* at different HAT revealed that Rann tulas weed extract showed the highest (average mortality, 39.2%) and Black nightshade weed extract indicated the lowest (average mortality, 30.6%) toxic effect (Table 1). It was also found that mortality percentages were increased proportionally with the time intervals. On the basis of insect mortality, the order of the toxic effect of six weed extracts against mango leaf cutting weevil were Rann tulas > Wild tobacco > Lantana > Goat weed > Leucas > Black nightshade. Mortality of mango leaf cutting weevil was differed significantly ($P<0.05$)

Table 1. Toxicity effect of different indigenous weed extracts and doses against the adults of mango leaf cutting weevil at different hours after treatment

Weed extracts used	Insect mortality (%) in different time interval				Average mortality
	24 HAT	48 HAT	72 HAT	96 HAT	(%)
Wild tobacco	20.0 a	30.8 b	45.8 ab	53.3 a	37.5 ab
Rann tulas	20.8 a	39.2 a	6.7 a	50.0 ab	39.2 a
Black nightshade	19.2 a	30.8 b	35.0 c	37.5 c	30.6 c
Leucas	19.2 a	28.3 b	37.5 bc	47.5 b	33.1 bc
Goat weed	19.2 a	31.7 b	40.0 abc	46.7 b	34.4 abc
Lantana	21.7 a	33.3 ab	35.8 c	48.3 ab	34.8 abc
Control	0.0 b	0.0 c	0.0 d	0.0 d	0.0 d
LSD	4.8	6.5	8.4	5.3	4.8
CV %	34.3	28.9	29.7	15.9	19.8
Doses used (%)					
5.00	39.5 a	54.8 a	66.2 a	78.6 a	59.8 a
2.50	22.4 b	43.3 b	52.4 b	58.6 b	44.2 b
1.25	6.7 c	12.9 c	19.1 c	24.8 c	15.8 c
Control	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d
LSD	3.6	4.9	6.3	3.9	3.6
CV %	34.3	28.9	29.7	15.9	19.7

Within column, values followed by different letter(s) are significantly different at 5% level probability by DMRT.

among all the concentration levels at different time interval of different weed extracts. The highest mortality (59.8%) was found at the maximum concentration (5.0mg/L) of weed extract. On the other hand, the lowest mortality (15.8%) was found at the minimum concentration (1.25mg/L) of weed extract. No mortality was observed in control treatment up to 96 HAT. The combined effect of weed extracts, their doses and different time intervals are shown in Table 2. The average percentage of adult mortality at 24, 48, 72 and 96 HAT indicated that the highest toxic effect observed on the extract of Rann tulas (78.3%) followed by Goat weed (74.2%), Wild tobacco (72.5%) and Lantana (69.2 %) at highest dose (5 mg/l) which was statistically identical whereas Black nightshade possessed the lowest toxic effect (10.8 %) at the minimum dose (1.25 mg/L) followed by Leucas (15.0%) whose are statistically identical.

From the above findings it was observed that all weed extract showed toxic effect against the adult mango leaf cutting weevil but Rann tulas was the most toxic. Ramar *et al*. (2015) reported that Rann tulas with hexane extract caused 100 and 89 % mortality of larvae and pupae of *Culex quinquefasciatus* respectively, after 24 hours exposure under laboratory conditions.

The probit analysis was performed for the estimation of LD_{50} values, chi-square values and their 95% fiducially limits at 24, 48, 72 and 96 HAT using six weed with methanol solvent for the mortality of mango leaf cutting weevil are presented in Table 3. The LD_{50} values of wild tobacco (5.9 mg/ml), rann tulas (3.3 mg/ml), black nightshade (6.7 mg/ml), leucas (4.9 mg/ml), goat weed (5.4 mg/ml) and lantana (4.8 mg/ml) at 24 HAT revealed that rann tulas extract showed the highest toxic effect followed by the lantana weed extract. On the other hand, the highest LD_{50} values of black nightshade indicated the lowest toxic effect among all the weed extracts applied. The LD_{50} values of wild tobacco, rann tulas, black nightshade, leucas, goat weed and lantana weed extracts were 3.4, 2.3, 3.3, 3.6, 3.0 and 3.1 mg / ml, respectively at 48 HAT also indicated that rann tulas showed the highest

Table 2. Interaction effect of different indigenous weed extracts and doses against the adults of mango leaf cutting weevil at different hours after treatment

Weed extracts used	Doses used (%)	Insect mortality (%) in different time interval				Average mortality (%)
		24 HAT	48 HAT	72 HAT	96 HAT	
Wild tobacco	5.00	43.3 a	56.7 bc	90.0 a	100.0 a	72.5 a
	2.50	26.7 b	50.0 c	70.0 bcd	80.0 bc	56.7 b
	1.25	10.0 c	16.7 de	23.3 ef	33.3 f	20.8 cd
Rann tulas	5.00	46.7 a	73.3 a	93.3 a	100.0 a	78.3 a
	2.50	30.0 b	56.7 bc	66.7 cd	73.3 cd	56.7 b
	1.25	10.0 c	23.3 d	33.3 e	36.7 f	25.8 c
Black nightshade	5.00	43.3 a	53.3 bc	60.0 cd	66.7 de	55.8 b
	2.50	23.3 b	53.3 bc	56.7 d	56.7 e	47.5 b
	1.25	6.7 c	6.6 ef	10.0 fg	20.0 g	10.8 d
Leucas	5.00	46.7 a	56.7 bc	76.7 abc	93.3 a	68.3 a
	2.50	30.0 b	46.7 c	53.3 d	66.7 de	49.2 b
	1.25	0.0 c	10.0 def	20.0 ef	30.0 fg	15.0 d
Goat weed	5.00	43.3a	76.7 a	86.7 ab	90.0 ab	74.2 a
	2.50	23.3 b	46.7 c	56.7 d	66.7 de	48.3 b
	1.25	10.0 c	16.7 de	23.3 ef	26.7 fg	19.2 cd
Lantana	5.00	53.3 a	66.7 ab	56.7 d	100.0 a	69.2 a
	2.50	23.3 b	50.0 c	63.3 cd	66.7 de	50.8 b
	1.25	10.0 c	16.7 de	23.3 ef	26.7 fg	19.2 cd
Control		0.0 c	0.0 f	0.0 g	0.0 h	0.0 e
LSD		9.6	13.1	16.7	10.6	9.7
CV %		34.3	28.9	29.7	15.9	19.7

Within column, values followed by different letter(s) are significantly different at 5% level of probability by DMRT.

Table 3. Relative toxicity (Probit analysis) of different weed extracts treated against the adult of mango leaf cutting weevil after 24, 48, 72 and 96 hours after treatment

Weed extracts used	No. of insect used	LD_{50} (mg/ml)	95% fiducial limits		values with 1 df
			Lower	Upper	
		24HAT			
Wild tobacco	30	5.9	3.2	11.0	0.1
Rann Tulas	30	3.3	2.2	4.8	1.1
Black Nightshade	30	6.7	3.0	14.8	0.1
Leucas	30	4.9	3.4	7.0	1.7
Goat weed	30	5.4	3.4	8.5	1.1
Lantana	30	4.8	3.2	7.2	0.2
		48HAT			
Wild tobacco	30	3.4	2.3	5.1	1.8
Rann Tulas	30	2.3	1.8	3.0	0.4
Black Nightshade	30	3.3	2.3	4.9	2.6
Leucas	30	3.6	2.6	5.1	2.6
Goat weed	30	3.0	2.4	3.7	1.3
Lantana	30	3.1	2.3	3.9	1.4
		72HAT			
Wild tobacco	30	1.9	1.6	2.4	0.6
Rann Tulas	30	1.8	1.4	2.4	0.1
Black Nightshade	30	2.8	1.9	4.2	2.4
Leucas	30	2.5	1.9	3.2	0.2
Goat weed	30	2.3	1.9	2.7	0.0
Lantana	30	2.1	1.6	2.7	0.4
		96HAT			
Wild tobacco	30	1.6	1.3	1.9	0.1
Rann Tulas	30	-	-	-	-
Black Nightshade	30	2.4	1.7	3.5	1.5
Leucas	30	1.8	1.4	2.3	0.0
Goat weed	30	-	-	-	-
Lantana	30	1.8	1.4	2.2	0.5

Values were based on three concentrations, three replications of 10 insects each. χ^2 = Goodness of fit. The tabulated value of χ^2 is 3.84 (d.f = 1 at 5% level).

and wild tobacco exhibited the lowest toxic effect against mango leaf cutting weevil. Among the six weed extracts applied rann tulas also performed the highest toxicity as compared the LD_{50} values at 72 and 96 HAT. The chi-square values were insignificant at 5 % level of probability of different weed extracts at different HAT and mortality data did not show any heterogeneity.

From the above probit results, it was observed that all the tested weed extracts would more or less effective for controlling mango leaf cutting weevil but rann tulas leaves extract had the most effective.

Conclusion

The present study indicates the year round infestation and damage incidence of mango leaf-cutting weevil in field conditions. Surjapuri (leaf infestation 52.6%) mango variety showed the highest susceptibility to mango leaf-cutting weevil but Ashwina (leaf infestation 33.4%) showed the lowest susceptibility. Mango leaf cutting weevil damaged the new pinkish flushes of mango leaves almost round the year except the month of December and January. The percentage of leaf infestation was higher during the month of July and August. Applied all weed

extracts showed different efficacies against the adult of mango leaf cutting weevil but extract of rann tulas was the most promising to control this pest.

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