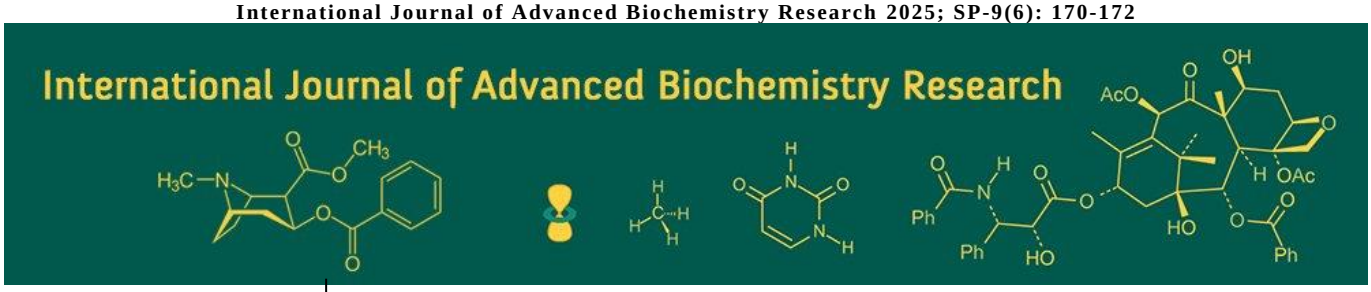

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Vishaka Dhakad
Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

MK Mahala
Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

S Ramesh Babu
Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Virendra Singh
Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

HK Sharma
Department of Nematology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Kishore Kumawat
Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Corresponding Author:
Vishaka Dhakad
Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Bio-efficacy of different botanicals and newer insecticides against red pumpkin beetle (*Aulacophora foveicollis* LUCAS) infesting pumpkin

Vishaka Dhakad, MK Mahala, S Ramesh Babu, Virendra Singh, HK Sharma and Kishore Kumawat

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Abstract
The field trials conducted to evaluates the efficacy of various insecticides and botanicals for managing the red pumpkin beetle (*Aulacophora foveicollis*) on pumpkin. Out of six insecticides/botanicals tested, beta-cyfluthrin 5% + Imidacloprid 10% found most effective followed by Novaluron 10 EC and Azadirachtin 1%, while *Parthenium* leaf extract and *Lantana* leaf extract were proved least effective against red pumpkin beetle on pumpkin. Newer insecticides like Beta-cyfluthrin + Imidacloprid and Novaluron demonstrated superior efficacy in controlling the red pumpkin beetle. Botanical extracts, while offering some control, were less effective. *Lantana* leaf extract was the least effective among all treatments.

Keywords: *Aulacophora foveicollis*, botanical extract, *Parthenium* leaf extract, *Lanatana* leaf extract

Introduction
India ranks as the second-largest producer of vegetables globally, following China. Vegetable crop accounts for approximately 5.43% of the nation's gross cropped area and 39.52% of the area designated for horticulture crops (Govind *et al.* 2023) [6]. Cucurbits represent a vast category of vegetable crops cultivated globally, with significant production also occurring in India. The *Cucurbitaceae* family includes approximately 115 genera and 960 species, and it mainly consists of annual herbaceous vines typically characterized by their tendrilled structures (Rolim *et al.* 2023). Pumpkin, scientifically known as *Cucurbita pepo* Linnaeus, is part of the *Cucurbitaceae* family and is cultivated widely during both the *Kharif* and summer seasons across India. The fruits of pumpkins have been found to contain a variety of antioxidant components, including vitamins A, E, C, K, B2, along with carotenes, xanthophylls, and phenolic compounds (Chanwitheesuk *et al.*, 2005) [3].
Cucurbits faces attacks from various insect pests, resulting in decreased yield and hindered crop development. The fruit fly (*Bractocera cucurbitae* Coquillett), the red pumpkin beetle (*Aulacophora foveicollis* Lucas), leaf miners (*Liriomyza trifolii* Burgess), aphids (*Aphis gossypii* Glover), pumpkin leaf caterpillars (*Diaphania indica* Saunders), Stem gall fly (*Neolasioptera falcata*), stink bug (*Aspongopus janus*), the bottle gourd moth (*Sphenarches caffer* Zeller), and spotted beetle (*Epilachna vigintioctopunctata*) are common pests that contribute to annual losses in both quantity and quality (Sahu *et al.*, 2020) [11]. The red pumpkin beetle is a highly destructive and polyphagous pest that poses significant threats to cucurbitaceous vegetables particularly cucumber, white gourd, watermelon, pumpkin, muskmelon, and sweet gourd in India (Doharey, 1983) [4]. The adult beetles feed on both sides of the leaves. When they consume the tissue in the center of the leaf, they create a distinctive circular injury pattern. The beetles also damage fruits, creating distinct circular patterns on them that contribute to decay and facilitate the onset of diseases in the fruits (Atwal and Dhaliwal, 2002) [1].
The management of the red pumpkin beetle has predominantly relied on chemical pesticides. Their frequent application has led to the insects developing resistance, along with causing disturbances to ecosystems. Consequently, this study incorporated the effectiveness of new insecticides and botanicals to address the issue of red pumpkin beetle infestations on pumpkin.

Materials and Methods

Experimental details

The field experiment was carried out at instructional horticulture farm, Rajasthan college of Agriculture, Udaipur (Rajasthan) during *Kharif*, 2024. The experiment was laid out in randomized block design with 7 treatments, including control with 3 replications in table 1. All the recommended horticultural practices applied to all the treatments.

- Location: Instructional Horticulture farm, RCA, Udaipur
- Season: *Kharif, 2024*
- Design: Randomized block design
- Plot size: 3 X 2.4 m each
- Variety: SVHP-077
- Spacing: 120 X 60 cm
- Replication: 3
- Treatment: 7

Table 1.1: Details of botanicals and newer insecticides used

Sr. No.	Treatments	Dosages (ml/liter)
T1	*Azadirachtin* 1% (10000 ppm)	2.5 ml
T2	*Lantana* Leaf Extract 10%	100 ml
T3	*Parthenium* Leaf Extract 5%	100 ml
T4	*Azadirachtin* 1% (10000 ppm)	5 ml
T5	Beta-cyfluthrin 5% + Imidacloprid 10%	2 ml
T6	Novaluron 10 EC	2 ml
T7	Untreated check (water spray)	-

The pumpkin crop was raised following standard horticultural practices. The first spray was done with the appearance of red pumpkin beetle reaching ETL and the second spray was done at 15 days intervals.

2.2 Observation to be recorded

The population of the red pumpkin beetle affected by botanicals and insecticidal application were observed. The observation were recorded by selecting five randomly tagged plants taking pre-treatment observation one day before spray and post treatment after 1, 3, and 7 days of each spray application.

2.3 Statistical analysis

Bioefficacy of different treatment against red pumpkin beetle was analyzed by analysis of variance. The data were subjected to the population reduction percentage values as given by Henderson and Tilton (1995) described below:

$$\text{Population reduction\%} = 100 \times \left[1 - \frac{Ta \times Cb}{Tb \times Ca}\right]$$

Where,
Ta = Number of insect after treatment
Tb = Number of insect before treatment
Ca = Number of insect in untreated check after treatment
Cb = Number of insect in untreated check before treatment.

Results

First spray

The data presented in table 1.2 indicates that all the treatments significantly outperformed the untreated control in terms of reducing the beetle population. One day after application, the Beta-cyfluthrin 5% + Imidacloprid 10% (2 ml/lit) proved to be the most effective, achieving the highest reduction (60.00%), closely followed by Novaluron 10 EC (2 ml/lit), which resulted in the mean reduction of 57.87 percent. The application of *Azadirachtin* 1% (5 ml/lit) resulted in the mean reduction of 52.24 percent, while *Azadirachtin* 1% (2.5 ml/lit) and *Parthenium* leaf extract demonstrated moderate effectiveness with the mean reduction of 39.15 percent and 31.94 percent, respectively. The lowest efficacy was observed with *Lantana* leaf extract (100 ml/lit), which recorded a reduction of 19.83 percent.

After third day of application, the Beta-cyfluthrin 5% + Imidacloprid 10% (2ml/lit) proved to be the most effective, achieving the mean reduction of 75.90 percent, followed closely by Novaluron 10 EC (2 ml/lit), which had a mean reduction of 71.53 percent. Following these, *Azadirachtin* 1% at both 5 ml/lit and 2.5 ml/lit, along with *Parthenium* leaf extract (100 ml/lit), showed efficacy with mean reductions of 55.17 percent, 43.84 percent and 35.27 percent, respectively. Among all the treatments assessed, *Lantana* leaf extract 10% (100 ml/lit) was the least effective, with mean reduction of only 12.75 percent.

The after seven days of application, the Beta-cyfluthrin 5% + Imidacloprid 10% (2 ml/lit) resulted in the mean population reduction of 72.67 percent followed by Novaluron 10 EC (2 ml/lit), with the mean population reduction of 67.74 percent, making them significantly more effective compared to the other treatments. *Azadirachtin* 1% at both 5 ml/lit and 2.5 ml/lit, along with *Parthenium* leaf extract 5% (100 ml/lit), demonstrated mean population reductions of 51.34 percent, 41.98 percent, and 29.06 percent, respectively. *Lantana* leaf extract 10% was observed to be the least effective, showing a mean population reduction of 9.69 percent.

Second spray

The data shown in table 1.2 indicated that, after one day of spray, the Beta-cyfluthrin 5% + Imidacloprid 10% (2 ml/lit) achieved the highest reduction (62.16%) in beetle population, which was followed by Novaluron 10 EC (2 ml/lit), which resulted in the mean population reduction of 57.30 percent. Among the tested botanical treatments, *Azadirachtin* 1% (5 ml/lit) led to the mean population reduction of 50.08 percent, while *Azadirachtin* 1% (2.5 ml/lit) with mean reduction of 37.34 percent, and *Parthenium* leaf extract 5% (100 ml/lit) with mean reduction of 27.43 percent, making them moderately effective. The lowest population reduction was observed with *Lantana* leaf extract 10% (100 ml/lit), which recorded a reduction of 14.08 percent.

On the third day after spray, the maximum (74.66%) reduction in beetle population was observed in plot treated with Beta-cyfluthrin 5% + Imidacloprid 10% (2 ml/lit), significantly surpassing Novaluron 10 EC (2 ml/lit) (69.87%), *Azadirachtin* 1% (5 ml/lit) (53.25%), *Azadirachtin* 1% (2.5 ml/lit) (36.30%), and *Parthenium* leaf extract 5% (100 ml/lit) (28.78%). *Lantana* leaf extract 10% (100 ml/lit) exhibited the least mean population reduction of 11.17 percent.

After seven days of application, the highest (64.66%) reduction in beetle population was noted with Beta-cyfluthrin 5% and Imidacloprid 10% (2 ml/lit). The efficacy of the remaining treatments was observed in the following order: Novaluron 10 EC (2 ml/lit) with mean reduction of 57.72 percent, *Azadirachtin* 1% (5 ml/lit) with mean reduction of 40.08 percent, *Azadirachtin* 1% (2.5ml/lit) with

mean reduction of 28.27 percent, and *Parthenium* leaf extract 5% (100 ml/lit) with mean reduction of 16.45 percent. *Lantana* leaf extract 10% (100 ml/lit) resulted in the lowest population reduction of 7.63 percent.

Discussion

In the present investigation, insecticides and botanicals were evaluated for their effectiveness against the red pumpkin beetle on pumpkin. The treatment Beta-cyfluthrin 5% + Imidacloprid 10% caused maximum reduction of 75.28 percent in the population of red pumpkin beetle, which was significantly superior over other treatments, followed by Novaluron 10 EC (70.2%). *Azadirachtin* 1% and *Parthenium* leaf extract 5% were moderately effective. *Lantana* leaf extract 10% exhibited the least effectiveness. Based on results, the present findings align with previous studies conducted by Gathala and Bajpai (2010) [5], who reported that the maximum reduction of red pumpkin beetle population was observed on the seventh day after treatments. The Beta-cyfluthrin gave maximum reduction (99.41%) of beetle population. Rathod and Borad (2009) [9] observed that neem based synthetic products are significantly effective against the red pumpkin beetle. Furthermore, Hussain and Ahmad (2011) [8] observed that among the treatments Methomyl and *Parthenium hysterophorus* extract showed significant results against *A. foveicollis*, where minimum adult population was observed as compared to check plot. Chandra (2023) [2] reported that the least effective treatment was recorded [Fipronil (soil application) + *Lantana* leaf extract (foliar spray) 30 g a.i. + 10%/ha] with minimum reduction in beetle population and lowest yield recorded (192.34 q/ha).

Table 1.2: Bioefficacy of different botanicals and insecticides against red pumpkin beetle on pumpkin during *kharif*, 2024

Treatments	Mean population reduction% 1st spray					Mean population reduction% 2nd spray			
	Dose (ml/lit)	PTP	1 DAS	3 DAS	7 DAS	PTP	1 DAS	3 DAS	7 DAS
Azadirachtin 1% (10000 ppm)	2.5	4.94 [2.33]	39.15 (38.73)	43.84 (41.46)	41.98 (40.39)	5.98 [2.54]	37.34 (37.67)	36.60 (37.22)	28.27 (32.12)
Lantana Leaf Exract 10%	100	5.16 [2.38]	19.83 (26.45)	12.75 (20.92)	9.69 (18.13)	5.71 [2.49]	14.08 (22.04)	11.17 (19.53)	7.63 (16.04)
Parthenium Leaf Extract 5%	100	4.43 [2.31]	31.94 (34.41)	35.27 (36.44)	29.06 (32.62)	5.90 [2.53]	27.43 (31.58)	28.78 (32.44)	16.45 (23.93)
Azadirachtin 1% (10000 ppm)	5	5.16 [2.38]	52.24 (46.28)	55.17 (47.97)	51.34 (45.77)	5.93 [2.54]	50.08 (45.04)	53.25 (46.86)	40.08 (39.28)
Beta-cyfluthrin 5% + Imidacloprid 10%	2	5.08 [2.36]	60.00 (50.77)	75.90 (60.60)	72.67 (58.48)	6.01 [2.55]	62.16 (52.04)	74.66 (59.78)	64.66 (53.52)
Novaluron 10 EC	2	5.23 [2.39]	57.87 (49.53)	71.53 (57.75)	67.74 (55.39)	6.14 [2.58]	57.30 (49.20)	69.87 (56.71)	57.72 (49.44)
Untreated check	-	5.15 [2.38]	0	0	0	6.14 [2.58]	0	0	0
SEm±	-	0.150	0.098	0.087	0.109	0.167	0.101	0.088	0.111
CD (p=0.05)		0.461	0.301	0.268	0.337	0.514	0.310	0.271	0.343

PTP-Pre-treatment population

DAS-Day after spray

Figures in parenthesis are angular transformed values; Figures in square bracts are square root transformed value

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