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EXTENDED ABSTRACT
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Efficacy of Different Botanicals against Red Pumpkin Beetle *(Aulacophora foveicollis Lucas)* Infesting Cucumber in Lamjung, Nepal

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Cucumber *(Cucumis sativus L.),* a cucurbitaceous crop grown globally, is renowned for its versatile use in salads, pickling, and cooked dishes. Cucumber has over 90% water content and thus provides a low-calorie option with potassium, folic acid, and other essential nutrients like vitamins A and C. In Nepal, *C. sativus* is primarily a summer crop grown in hills and flatland regions. However, the cultivation of cucurbits, including cucumber, faces a formidable challenge due to many insect pests. One of the most important insect pests is the red pumpkin beetle (RBP) *(Aulacophora foveicollis)* (Coleoptera: Chrysomelidae), which can cause significant yield loss of up to 100% if not controlled on time. Adults and larvae cause damage to the plant differently. Adults feed on the above-vine parts, including the leaves, which often results in complete defoliation. They also attack the seedlings and consume them completely. In contrast, larvae feed on the root system, weakening the plant and making it vulnerable to other physiological stresses. The adult female lays 150-300 eggs in the soil at the stem base. Larvae hatch from the eggs and burrow into the soil to find roots and feed on them. Farmers often use synthetic pesticides to control this pest, but the negative effects of these insecticides on the environment and human health have been proven significant. Also, repeated use of the same class and broad-spectrum insecticides can impact the ecosystem and increase the risk of pesticide resistance. Despite using chemical insecticides, farmers in the Lamjung district have reported an average of 14% damage to cucumbers due to this pest. The growing concern over chemical pesticides has sparked interest in exploring alternative botanical pesticides, such as azadirachtin, derived from the neem plant, which is less toxic to humans and the environment. The objective of this study was to evaluate the efficacy of various experimental plant-based extracts in controlling red pumpkin beetle in cucumber.

A field experiment was conducted at a university-owned farm at the Institute of Agriculture and Animal Science (IAAS), located in the Lamjung district of Nepal, from February to September. Field preparation involved plowing, harrowing, and leveling the land. Robust cucumber seedlings were raised in a 2:1:1 mixture of garden soil, farmyard manure (FYM), and sand in poly bags and transplanted after 27 days. Fertilizers were applied according to recommended rates, and weeds were controlled by manual hoeing. Irrigation was provided based on plant needs, and staking was done using bamboo splits, jute ropes, and metallic wire for support. The experiment used a randomized complete block design with seven treatments: Neem leaf extract (*Azadirachta indica*), Azadirachtin 0.03% (Multiplex Multineem), ginger-rhizome extract (*Zingiber officinale*), turmeric-rhizome extract (*Curcuma longa*), Jhol Mol, Bojo oil (*Acorus calamus*), and untreated control (water). Each treatment was replicated thrice. One commonly grown cucumber, 'Bhaktapur local,' was planted at the 1-meter spacing between and within rows. Plant extracts like *Azadirachta indica*, *Zingiber officinale*, and *Curcuma longa* were prepared by drying, grinding, and diluting to 5% concentrations. Jhol Mol, a mixture of locally available plant leaves such as neem (*Azadirachta indica*), bakaino (*Melia azedarach*), timur (*Zanthoxylum armatum*), bojo (*Acorus calamus*), Titepati (*Artemisia vulgaris*), Asuro (*Justicia adhatoda*), Red Chilies (*Capsicum annuum*), turmeric (*Curcuma longa*), garlic (*Allium sativum*), and animal urine and water with a ratio of 1:5:5 were mixed. *Acorus calamus* (Bojo Mint Natural Liquid Balm) was purchased from a nearby agrovet market for the solution (3ml/liter). The data on beetle counts and population reduction percentages were recorded. A total of 3 sprays were applied at an interval of 10 days after 15 days of transplanting (DAT), i.e., 15 DAT, 25 DAT, and 35 DAT. The number of beetle populations was recorded a day before the spray as the pre-treatment count and the 3rd, 6th, and 9th day of each spray as the post-treatment count. Five cucumber plants were randomly selected, tagged, and labeled, and the beetle populations on the plants were then recorded. All data were analyzed using ANOVA, and means were compared for significance level using Duncan's multiple range test. Microsoft Excel 2021 was used to make tables and graphs. The data analysis was done using R software.

Among different treatments, Azadirachtin 0.03% extract consistently exhibited the lowest beetle counts across all sprays, followed by Jhol Mol and neem leaf extract (Table 1). Conversely, bojo oil and ginger-rhizome extract were less effective in controlling beetle populations. The minimum beetle population at three successive sprays (1.82, 1.66, 0.89) was found in the plot treated with Azadirachtin 0.03%, followed by Jhol Mol (2.13, 1.91, 1.14), with bojo oil being the least effective (4.76, 3.34, 2.54).

This study highlighted the efficacy of experimental and commercial botanical pesticides in controlling red pumpkin beetle infestations and improving cucumber yields. Azadirachtin and Jhol Mol were found to be the most effective among the studied botanical extracts for controlling red pumpkin beetles in cucumber crops. Extracts of neem leaf and turmeric rhizome also showed better efficacy compared to the control. Extracts of

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bojo and ginger rhizome were better than the control, but least effective among the botanicals used in the study. These findings highlight that botanical products and homemade botanical extracts may be an effective option for controlling the red pumpkin beetle in cucumber. Future studies should focus on assessing the impacts of these botanicals in cucumber root damage and natural enemy populations. Use of these botanical extracts can enhance integrated pest management (IPM) and help farmers produce economical and healthy crops.

Table 1. Effect of various plant extracts on red pumpkin beetle population during the first, second, and third spray, 2023, Institute of Agriculture and Animal Science (IAAS), Lamjung, Nepal.

Treatments	After 1st Spray	After 2nd Spray	After 3rd Spray
Red beetle population (number/plant)			
Neem-leaf extract 5%	3.04^{e+}	2.36^{d}	1.55^{e}
Azadirachtin 0.03% EC	1.82^{g}	1.66^{f}	0.89^{g}
Ginger-rhizome extract 5%	4.41^{c}	3.23^{bc}	2.25^{c}
Turmeric-rhizome extract 5%	3.84^{d}	3.04^{c}	2.12^{d}
Jhol Mol	2.13^{f}	1.91^{e}	1.14^{f}
Bojo oil	4.76^{b}	3.34^{b}	2.54^{b}
Control	5.74^{a}	4.24^{a}	3.52^{a}
F- test	***	***	***
LSD (0.05)	0.29	0.23	0.09
SEM (±)	0.026	0.017	0.002
CV%	4.39	4.63	2.50
Grand Mean	3.68	2.82	1.99

Note: $^{+}$Values within the same column with different superscript differ ($p<0.05$).

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