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ORIGINAL RESEARCH ARTICLE



Survey and efficacy test of selected botanical pesticides to manage maize weevil at Gauradaha, Jhapa, Nepal

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ABSTRACT

This study was carried out in eastern terai-Gauradaha municipality, Jhapa-of Nepal to evaluate the effectiveness of locally available botanicals for managing the maize weevil (*Sitophilus zeamais*). Lab experiment was set up in Completely Randomized Design (CRD) with 7 treatments and 3 replications. Six botanicals such as *Acorus calamus*, *Azadirachta indica*, *Melia azedarach*, *Artemisia vulgaris*, *Eucalyptus globulus* and *Curcuma longa* were compared with the control. The botanicals were used in dust forms at the rate of 2g/200g of maize grains. Maize grains were infested with *Sitophilus zeamais* at the rate of 20 adults/200g. In preference analysis, 66% farmers preferred the use of botanicals, 12% preferred using chemicals and 22% preferred both. On the 28 days of treatment, the highest mortality of maize weevil recorded was 100% in *A. calamus* and the lowest mortality of maize weevil recorded was 45% in control. Grain damage and weight loss were recorded significantly highest (17.15% and 24.33%, respectively) in control and lowest (0% and 0%) in *A. calamus*. Also, 100% weevil mortality was observed in *A. calamus* within 7 days, making it the most effective. Turmeric followed closely with 85% mortality within 28 days followed by chinaberry (78.33%) and neem (75%) during the study. Therefore, varied concentrations of these botanicals can be used to find out effective dose for the management of weevil and further suggests farmers to use recommended dose of botanical pesticides.

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INTRODUCTION

Approximately 9000 years ago, domestication of maize was founded to be began in southern Mexico/Meso America (Erenstein *et al.*, 2022). Due to its superior genetic yields potentials; considered as the queen of cereals and also the most substantial cereal crops in developing countries used as staple food for more than 900 million of peoples (Gezahegn, 2021). Maize is second most important cereals crop cultivated in Nepal after rice used not only for human consumption but also as animal feed. In Nepal, 13% of the total dietary requirement is satiated by maize as annual per capita demand of maize is 45 kg but only 43 kg is the annual consumption (Poudel, 2024). In hilly region of Nepal maize is grown widely than terai region. Yet, 75 maize pest species has been recognized among which *Sitophilus*

zeamais (maize weevil) is mostly noxious, causing major crop loss globally during field and post-harvest cycle with 20% and 40% loss, respectively (Zuluaga *et al.*, 2026). Gauradaha Municipality, eastern part of Nepal in Jhapa district, here agriculture is the major occupation. Rice is mostly cultivated followed by maize which is grown twice a year as *Kharif* and *Rabi* crop. Due to its high yielding capacity and inaccessible market condition during season, small holder farmers are compelled to store maize after production for more than half a year where infestation of *s. zeamais* is primary problem (Cosmas *et al.*, 2018). Widespread use of synthetic chemical pesticides to control agricultural insect pest, which causes the problem of resistivity in pest after long term use, residual effect in grain and also not the best way to control pest. As maize weevil is of economic importance and it highly infest stored maize; using chemical as first

hand solution is hazardous to be used in stored crops. Because of the harmful repercussions due to use of artificial chemical fertilizers, botanical control is found to be most effective due to its less detrimental effect to human health, easily availability, perishable quality and cost-effective point of view. Plant based pesticides are found to have repulsive and lethal effect as well, destructive changes in growth and development, along with antifeedant also retardant properties, and have not only antibacterial, antifungal but antibacterial effect as well in opposition to pests (Getahun & Wondimu, 2020). Nepal being heterogeneous in flora availability in different topographical regions fifty five plant species-such as *Acorus calamus*, *Azadirachta indica* oil and leaf, *Melia azedarach seed powder*, *Zanthoxylum armatum* and *Artemisia vulgaris* are some commonly used to control maize pest- were found to be used to limit insect pest in crops and grains in Nepal (Neupane et al., 2022).

Besides the field, maize can also be affected by insect pests in storage and more economic loss can occur. Storage insect pest causes severe damage to the stored grains and make them unfavorable for consumption; also seeds become unfit for cultivation. This research is about controlling maize weevils by using locally available plants (in dust form), and knowing about their efficacy so that we can find the most effective botanical control of maize weevil (*Sitophilus zeamais*). Therefore, keeping above in view, this study was conducted to assess farmer's practice and evaluate the efficacy of botanical pesticides for management of maize weevil populations.

MATERIALS AND METHODS

Study area and design

The study was conducted in Gauradaha municipality (Area: 149.83 km²; Latitude: 26°33'42"N; Longitude: 87°43'02"E; Altitude: 78 masl), Jhapa, Nepal divided into two parts; the first one farmer's survey and next one was bio efficacy test of locally available botanicals. Farmer's survey was conducted to know about management practices used by them for management of maize weevil and to reveal locally available botanicals used.

Data collection

Primary source of data were the respondents interviewed by using questionnaire, mainly head of the family such as elder people were selected as key informants. Total of 60 households were surveyed through individual household survey.

Bio-efficacy test

For bio-efficacy test, laboratory of Gauradaha Agriculture Campus was used. Newly harvested local variety of maize grains were collected from farmer of Gauradaha municipality and then these grains were kept for sterilization in dry oven at 55°C for 5 hours. Sterilization was done to kill the pathogens and to destroy the eggs present in grains if any. Weevils required for culture were collected from stored grains of maize of local farmers in that locality. Sufficient amounts of adult weevils were collected from the storage before culture. Botanicals plants of insecticidal properties: *Acorus calamus*, *Azadirachta indica*, *Melia azedarach*, *Eucalyptus globulus*, *Artemisia vulgaris* and *Curcuma longa* were taken and sorted out by removing useless parts only leaving leaves in *A. indica*, *M. azedarach*, *E. globulus* and *A. vulgaris* whereas rhizome in case of *C. longa* and *A. calamus* which were then dried for 4 to 5 days in shade and converted into fine powder in the proportion as shown in Table 1. Treatment and set up was made by using 200gm of maize and in each jar 2gm of each respective botanicals powder was mixed along with 20 adult weevils in each setup; was covered with muslin cloth tightly for air circulation as well to avoid possible contamination. Each jar was recognized as experimental block and left for observation. Treatments were assigned in Complete Randomized Design (CRD) with 3 replications and 7 treatments. The lab research was conducted from last week of May to first week of July of 2024 up to 42 days. Data on different parameters-adult mortality rate respective to treatment, weight of damaged grain and number of damaged grains-were taken from each experimental unit. After the experimental set-up adult mortality was observed on weekly basis up to 4th week. Damaged grain number and weight were recorded at 7th week because significant loss and exit holes can be observed after larval damage when new progeny emerges. It takes 36 days for complete metamorphosis of maize weevil so data for damaged grain number and weight loss were recorded at 7th week to observe damage caused by newly emerged progeny.

Percentage mortality (%) = $\frac{\text{Number of dead maize weevils}}{\text{Number of introduced maize weevils}} \times 100$

Percentage weight loss (%) = $\frac{\text{Initial weight of maize grains} - \text{Final weight of maize grains}}{\text{Initial weight of maize grains}} \times 100$

The recorded data were entered in Microsoft excel and analyzed using R Stat software version 4.4.1.

Table 1. Treatments used in the study.

S. No.	Notation	Treatments	Common Name	Local Name	Formulation	Rate
1	T ₁	<i>Acorus calamus</i>	Sweet flag	Bojho	Powder	10g/Kg
2	T ₂	<i>Azadirachta indica</i>	Neem	Neem	Powder	10g/Kg
3	T ₃	<i>Melia azedarach</i>	Chinaberry	Bakaino	Powder	10g/Kg
4	T ₄	<i>Artemisia vulgaris</i>	Mug-wort	Titepati	Powder	10g/Kg
5	T ₅	<i>Eucalyptus globulus</i>	Eucalyptus	Masala	Powder	10g/Kg
6	T ₆	<i>Curcuma longa</i>	Turmeric	Besar	Powder	10g/Kg
7	T ₇	Control	-	-	-	-

RESULTS AND DISCUSSION

In Figure 1, it is shown that out of total respondents, majority of people were Brahmin (52%) followed by Chhetri (38%), Janajatis (8%) and Dalit (2%). This ensures that most of the people living in Gauradaha municipality and engaged in maize weevil management practices belong to Brahmin community. Likewise, Figure 2 shows preference analysis indicating 66% farmers preferred botanical pesticides whereas only 12% farmers preferred chem-

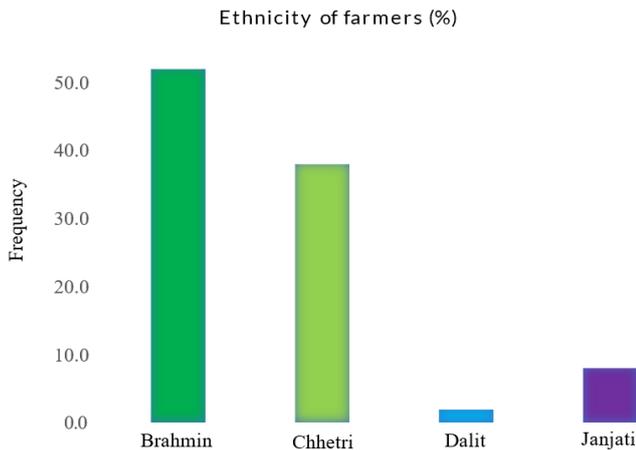


Figure 1. Ethnicity of farmers in survey area, Gauradaha, Nepal.

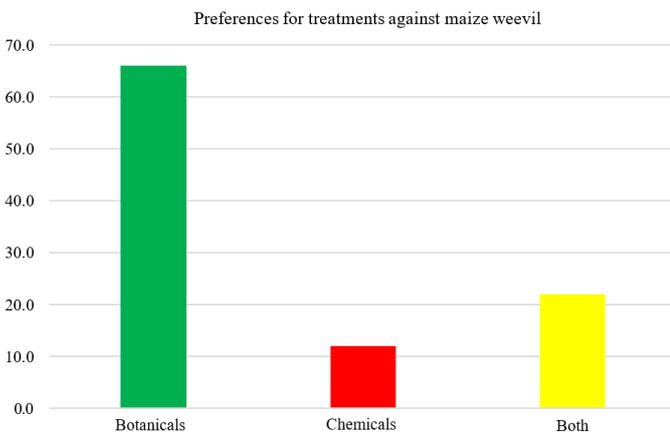


Figure 2. Preferences of farmers about method of treatment for management of maize weevil, Gauradaha, Nepal.

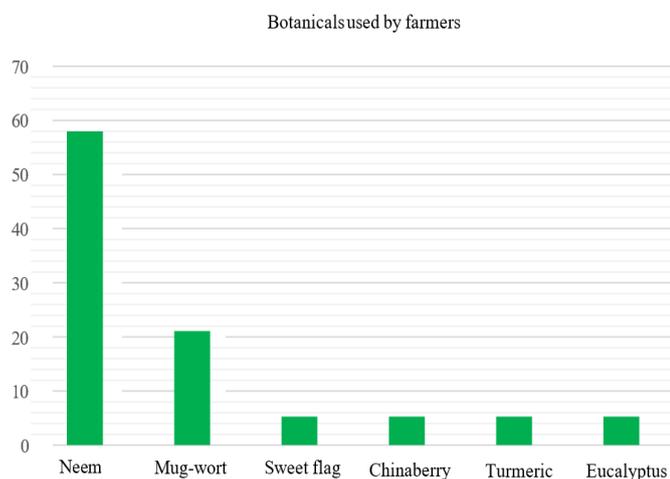


Figure 3. Different botanicals used by farmers for management of maize weevil, Gauradaha, Nepal.

ical pesticides. And, 22% farmers were seen choosing both pesticides for the management of maize weevil. The data also showed that the farmers of Gauradaha municipality were health conscious as they widely used botanicals for the management of pests. In Figure 3, it is shown that, for the management of maize weevil, 58% farmers used neem while only 21% farmers used mug-wort as botanical pesticides. As compared, only around 5-6% each botanical such as sweet-flag, chinaberry, turmeric and eucalyptus was preferred by farmers for the management of maize weevil. In Table 2, it is shown that 100% adult mortality was observed in sweet flag (*Acorus calamus*) within 7 days after treatment followed by Turmeric with 78.33% mortality, China berry 75%, Neem 70%, Eucalyptus 55% and Mug-wort 51.67% at 0.001 level of significance. At 28th DAT, the adult mortality was increased in turmeric up to 85% followed by China berry 78.33%, Neem 75%, Eucalyptus 58.33% and Mug-wort 55% at 0.001 level of significance. 45% of adult mortality was observed in control and this is due to unfavorable conditions and difficulty in adjustments. In Table 3, maximum 17.15% grain damage was observed in control followed by Mug-wort 16.94%, Neem 12.23%, China berry 11.39%, Eucalyptus 3.91%, Turmeric 3.70% and no damage (0%) in sweet flag at 0.05 level of significance. Similarly, maximum weight loss 24.33% observed in control followed by Mug-wort 23%, China berry 8%, Neem 6%, Eucalyptus 6% and Turmeric 5.67% and no weight loss (0%) in sweet flag at 0.001 level of significance.

Though majority of farmers used neem as a botanical pesticide but the bio efficacy test result showed that sweet flag (*Acorus calamus*) has strong insecticidal properties with 100% adult maize weevil mortality rate within 7 days of treatment at the rate of 2 gm dust per 200 grams of maize grains (Table 2) making it the most effective botanical. Corresponding result was found in the study conducted by Basyal in 2022 which elucidated the highest weevil mortality (100%) was recorded in *A. calamus* within 14 days of treatment (Basyal et al., 2022). Most exist holes was seen in 4th day of treatment by neem oil among other treatment in the study carried in Lamjung district of Nepal (Poudel et al., 2023). Turmeric followed closely with 85% mortality within 28 days, followed by China berry (78.33%), Neem (75%), Eucalyptus (58.33%) and Mug-wort (55%). In this study, adult mortality rate in neem was 75% within 28 days. When study was conducted in sorghum, highest mortality rate, 93.8 and 90.6%, of maize weevil was found in treatment with milkweed and mesquite at the dose of 0.2gm respectively (Kadi et al., 2025). *Artemisia vulgaris* as compared to other botanicals has lower adult mortality i.e. 55% at 28 days, which is in line with Basyal experiment where adult mortality was observed 31.26% (Basyal et al., 2022). Grain damage and weight loss were also recorded lowest (i.e. 0% and 0% respectively) in *A. calamus* at 42 days after treatment. In the similar study, concentration of *A. calamus* essential oil with 10% and 5% showed a few grain weight loss as compared to the concentration of 2.5% used against *S. zeamais* (Aryal et al., 2023).

Table 2. Adult weevil mortality in different treatments, Gauradaha, Nepal.

Treatments	Adult weevil mortality			
	7 DAT	14DAT	21DAT	28DAT
Sweet flag	100.00 ^a (2.00)	100.00 ^a (2.00)	100.00 ^a (2.00)	100.00 ^a (2.00)
Neem	70.00 ^{bc} (1.84)	73.33 ^{bc} (1.86)	73.33 ^{bcd} (1.86)	75.00 ^{bc} (1.87)
Chinaberry	75.00 ^b (1.87)	76.66 ^b (1.88)	78.33 ^{bc} (1.89)	78.33 ^b (1.89)
Mug-wort	51.67 ^{cd} (1.71)	51.67 ^{cd} (1.71)	55.00 ^{de} (1.74)	55.00 ^d (1.74)
Eucalyptus	55.00 ^{cd} (1.73)	56.67 ^{cd} (1.74)	58.33 ^{cde} (1.75)	58.33 ^{cd} (1.75)
Turmeric	78.33 ^b (1.88)	81.67 ^b (1.91)	81.67 ^{ab} (1.91)	85.00 ^{ab} (1.93)
Control	45.00 ^d (1.66)	45.00 ^d (1.66)	45.00 ^e (1.66)	45.00 ^d (1.66)
F- test	***	***	**	***
LSD	18.92(0.13)	17.93(0.12)	20.75(0.08)	18.03(0.03)
CV	3.9	3.66	2.61	0.96
SEM (±)	5.19(0.033)	5.10(0.03)	5.25(0.03)	5.19(0.033)

Where, CV= Coefficient of variation, ***=significant at 0.1% level of significance, **=significant at 1% level of significance, *: significant 5% level of significance, LSD: Least Significant Difference and SEM: Standard Error of Mean. Values in brackets used in this parenthesis are log transformation of data.

Table 3. Damaged grains and weight loss in percentage (42nd day).

Treatments	Damaged grain percentage	Weight loss percentage
Sweet flag	0.00 ^c	0.00 ^c
Neem	12.23 ^{ab}	6.00 ^b
China berry	11.39 ^{ab}	8.00 ^b
Mug-wort	16.94 ^a	23.00 ^a
Eucalyptus	3.91 ^{bc}	6.00 ^b
Turmeric	3.70 ^{bc}	5.67 ^b
Control	17.15 ^a	24.33 ^a
F-test	*	***
LSD	10.55	2.68
CV	32.81	20.26
SEM (±)	2.19	1.23

Where, CV= Coefficient of variation, ***=significant at 0.1% level of significance, **=significant at 1% level of significance, *: significant at 5% level of significance; LSD: Least Significant Difference and SEM: Standard Error of Mean.

Conclusion

This study concluded that most of the farmers preferred botanical pesticides over chemicals for maize weevil management, which indicated that they are health conscious. Also, farmers widely used neem as a botanical pesticide to control maize weevil, followed by mug-wort, sweet flag, Malabar nut, etc. For the bio efficacy test of botanical pesticides, neem, sweet flag and mug-wort were selected based on their availability and farmer's use. Other three botanical pesticides were selected as reference from literature review and compared all of them with control. Although neem is widely used by farmers, it was less effective than sweet flag in terms of adult maize weevil mortality. However, neem was more effective as compared to eucalyptus and mug-wort. In conclusion, sweet flag (*Acorus calamus*) performed best during the efficacy test with 100% weevil mortality and almost zero grain damage and weight loss when applied at the rate of 2 gm per 200 g maize (10g/ Kg). In contrast, control recorded the lowest maize weevil mortality i.e. only 45% overall with grain damage of 17.15% and weight loss of 24.33%. The test was carried out at a confined location of Gauradaha municipality, Jhapa.

Further studies should be conducted to explore other botanicals and management of pest in different crops.

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DECLARATIONS

Authorship Contribution statement: Conception and Methodology: H.K.K. and A.C.; Software and Validation: A.C. and L.S.; Investigation: H.K.K. and A.C.; Data Curation: H.K.K. and L.S.; Writing original draft: H.K.K. and L.S.; Writing-review and editing: H.K.K., L.S. and A.C. Supervision: H.K.K., A.C. and L.S. All authors have reviewed and approved the final version of the manuscript before submission.

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