ISSN: 2467-9283

INTERNATIONAL JOURNAL OF GRADUATE RESEARCH AND REVIEW

OPEN ACCESS

Indexing & Abstracting

Open Academic Journals Index (OAJI), InfoBase Index, Cosmos, ResearchGate, CiteFactor, Scholar Stear, JourInfo, ISRA: Journal-Impact-Factor (JIF), Root Indexing etc.

Impact Factors*

IBI factor: 3

Impact factor (OAJI): 0.101

*Kindly note that this is not the IF of Journal Citation Report (JCR)

Vol-5, Issue-1

February 2019

Research Article

Evaluation of Repellent Plant Materials for Management of the Maize Weevil (*Sitophilus zeamais*) in Storage Condition

Sundar Tiwari[1]*

Department of Entomology, Agriculture and Forestry University of Nepal, Chitwan, Nepal

Abstract

Maize weevil**,** *Sitophilus zeamais* Mots. (Coleoptera: Curculionidae) is an important storage pest of maize and other cereal crops such as wheat, rice and barley in humid tropical regions. The infestation of pest has been recorded up to 80 % in worse conditions. However, damages on maize in storehouse can be influenced by moisture and storage conditions. Regarding its management, farmers of south Asian regions have been used a chemical pesticide called Celphos (Aluminum phosphide), a toxic poison releasing chemical. This chemical is extremely poisonous to human health and the environment. Hence, an alternative benign approach of pest management has been realized for the sustainable control of this pest. A laboratory study was conducted by using various potential repelling plant materials in Chitwan Nepal from March to November 2017. These treatments materials were: *Acoros calamus* L. rhizome dust (Sweet flag), *Azadirachta indica* A. Juss. seed powder (Neem), *Artemisia vulgaris* L. leaf dust (Common mugwort), *Zanthoxylum armatum* DC fruit powder (Prickly ash), *Melia azedarach* L. seed powder (Chinaberry tree), *Justicia adhatoda* L. leaf dust (Malabar nut). All of these materials were compared with the susceptible control (no-treatments). Experiment design was a complete randomized block design with three replication for each replicate. The average temperature and humidity of the storehouse were 27.5ºc and 75% RH respectively. At the end of the data observation, less than one percent grain damage was recorded in *A. calamus* treated maize grains followed by *J. adhatoda*, and maximum damage was recorded in control maize. The number of holes per 100g was lowest in *A. calamus* treated maize and more numbers of holes were recorded in control. *Acorus calamus* and *A. indica* treated maize have lowest weevil population but control maize had highest weevil population. The highest weight loss was recorded in control and the lowest weight loss was in *A. calamus* treated maize grains. This information's suggested that *A. calamus* is the most potential plant material to repel the maize weevil from the storehouse

Keywords: *Sitophilus zeamais; Acorus calamus;* maize weevil; storage; weight loss; grain loss

Introduction

Maize **(***Zea mays* L.) is an important cereal crop grown worldwide and mostly used for livestock and poultry feed in North America and Europe but is used as a staple food in the Asian countries (Pingali and Pandey, 2001; Ranam et al. 2014). In Nepal, this is the second most important cereal crop after rice which occupies about 29% of the total cultivated land and produces about 24% of the total cereal production (MoAD, 2014). The production of maize in Nepal is 22,83,222 Metric tons and yield 2458 mt/ha (AICC, 2014; MOAD, 2015/2016). These crops have been damaged by a wide range of insect pests both in the field and in storage (Neupane *et al.*, 1991) conditions. Maize stem borer, *Chilo partellus* Swinhoe (Lepidoptera: Pyralidae), white grub, *Phyllophaga rugosa* Melsheimer (Coleoptera, Scarabaeidae), maize cob worm, *Helicoverpa armigera* Hubner (Lepidoptera, Noctuidae), rice ear-cutting caterpillar, *Mythimna separate* Wal (Lepidoptera, Noctuidae), rice grasshopper, *Hieroglyphus banian* Fab. (Orthoptera, Acrididae) etc. are the major pest of maize in fields (Neupane, 2009). In storage conditions, about 30

Cite this Article as:

S. Tiwari (2019) Int. J. Grad. Res. Rev. Vol 5(1): 12-16.

[1*]**Corresponding author**
Sundar Tiwari,
Department of Entomology, Agriculture and Forestry University of Nepal, Chitwan, Nepal
Email: tiwarisundar1979@gmail.com

Peer reviewed under authority of IJGRR

species of insects commonly infect food grains and other grain products. Among them, maize weevil (*Sitophilus zeamais* L.) and rice weevil (*Sitophilus oryzae*a L.) is the most important storage pest in the storehouse in Nepal (Paneru and Thapa, 2018). Normally the storage pest damage the maize seeds by making holes and feed endosperms which ultimately reduce the maize quality exacerbate loss in germination (Trematerra et al. 2013). These losses in the world has recorded more than 20% (Oerke, 2006). However, in Nepal, the study conducted by Pradhan and Manandhar (1992) reported that the loss can vary based on location and altitude of the locality and suggested that the loss in storage conditions are estimated 8%, 7.4% and 13% respectively in Mountain, Hills and Terai regions of Nepal.

In Nepal, farmers have been used the broad spectrum chemical pesticides such as Aluminum Phosphide for the control of a broad range of storage pests (Paneru and Thapa, 2018). During pesticide handling and application in a storehouse, they do not follow the health precautionary measurements. Basically, children and old members of the household are severely affected by these poisonous gases and cause many human health-related issues. Sometimes, they feed the pesticides treated seeds to the livestock animals and poultry as a result many livestock and poultry animals have been killed (Sharma and Tiwari, 2016). Hence, these practices are extremely harmful to human beings, livestock and wildlife animals. An alternative measure of storehouse insect pest management has been realized for the sustainable pest management and protection of human health and protecting the house environment (Sharma et al. 2016).

Nepal is rich in plant biodiversity and plant constitutes many alkaloids and plant volatiles which can be used to repel the insect. These practices are traditionally adopted in many rural parts of Nepal to avoid the damage from the maize weevil, rice moth and many other insect pests in a storehouse. These common plant materials are *A. indica*, *Z. aratum*, *A. vulgaris* (sharma and Tiwari, 2016, Anonymous, 1988). Hence, this study was hypothesized to evaluate their properties to repel weevil from the storehouse and reduce their damage on the maize grains.

Materials and Methods

The study was conducted in farmers storehouse at Fulbari Chitwan (27°38′N 84°22′E), Nepal. A popular maize cultivar Manakamana-3 was used for the experiment. About 3.0 kg of maize seeds were taken for each treatment. Six plant materials such as *Acoros calamus* L. rhizome dust @ 10gm kg-1, *Azadirachta indica* A. Juss. seed powder @ 10gm kg-1, *Artemisia vulgaris* L. leaf dust @ 10gm kg-1, *Zanthoxylum armatum* DC fruit powder @ 4gm kg-1, *Melia azedarach* L. seed powder @ 10gm kg-1, *Justicia adhatoda* L. leaf dust @ 10gm kg-1 were used and each of these treatments was compared with the control. Three kilograms maize seed with plastic pot was taken and each plastic pot was considered as a treatment (see above) and kept on a table (block). Each treatment was replicated in three times and experiment design was laid out in completely randomized design (CRD).

Data Recording and Analysis

Room temperature and humidity were taken daily. Data was observed in every two-month interval form the date of the experiment set up. The parameters recorded were % grain damage, number of exit holes, weevil population and weight loss. For measurement of grain damage percentage, a number of exit holes, and weevil populations, 100 g of maize seed samples were taken for each and data was recorded accordingly in each sampling date. Weight loss was measured by subtracting from the original weight (3.0 kg) and converted into a percentage. Data was analyzed by using GenStat statistical software for the mean comparisons and treatment means were compared by using unprotected LSD at < 0.05 (Saville, 2015)

Result and Discussion

Grain Damage Percentage

Treatments were significantly different ($P < 0.005$) on the grain damage by the maize weevil. After 2-month of an experiment set up highest damage was recorded on control and lowest was recorded on *A. indica* treated maize. However, the highest grain damage percentage was recorded in control (4.88% and 5.88%) at 4-month and at 6-month, respectively and lowest was on *A. calamus* i.e., 0.99% and 0.77%, at 4-month and at 6- month, respectively (Table 1). The study also confirmed by G.C. (2006) and Paneru and Thapa (2018) and suggested that *A.calamus* can reduce grain damage during storage condition.

Number of Exit Holes Per 100 Gram of Maize

The effect of different botanical treatment had a significant effect on the number of exit holes made by the weevil ($P < 0.05$). The lowest number of exit holes was found in *A. calamus* treated seeds in 2, 4 and 6-months of an experiment set up. The highest exit holes were also recorded in control pot in all sampling periods (Table 2). Similar results were also observed by Shrestha (2016) and reported that good control of maize weevil was found in *A. calamus* treated storehouse in farmers' condition with negligible exit holes in maize grains.

Weevil Population

The effect of *A. calamus* rhizome dust and *A. indica* seed powder were found significant on the weevil population as compared to other treatments ($P < 0.05$). At 6- months, the lowest number of weevil was recorded in *A. calamus* treated seeds whereas the highest weevil population was recorded in control (Table 3). Β-arsanone found in *A. calamus* dust could cause the mortality of weevils thus can reduce population in a subsequent generation (Paneru et. al., 1997. A similar result was also proposed by Panthee (1997) and suggested that *A. calamus* treated maize seed produce lower weevil population compared with other treatments such as neem, Malabar nut tree, mugwort treated seeds.

Table 1: Grain damage percentage by the maize weevil (*Sitophilus zeamais*)

Treatments	**Grain damage (%)**		
	2 months	4 months	6 months
Acorus calamus	1.39a	0.90a	0.77a
Azadirachta indica	1.21a	1.91b	3.64b
Justicia adhatoda	2.83b	2.59b	1.75b
Zanthoxylum armatum	2.66b	2.98b	2.11b
Artemisia vulgaris	1.88a	2.84b	2.60b
Melia azadirach	2.07b	2.04b	2.27b
Control	3.67b	4.53c	5.88c
P-value	0.007	0.002	<.001
$LSD_{0.05}$	1.150	1.266	1.104

Means within a column with no letters in common are significantly different (Unprotected LSD; P < 0.05).

Table 2: Exit whole numbers of maize weevil (*Sitophilus zeamais*)

Treatments	No. of exit holes per 100-gram maize seeds after indicated days of treatment		
	2 month	4 month	6 month
Acorus calamus	1.60a	1.344a	1.17a
Azadirachta indica	1.77a	1.581a	2.29a
Justicia adhatoda	1.90a	2.112a	1.95a
Zanthoxylum armatum	1.93a	2.529b	2.32a
Artemisia vulgaris	1.52a	1.739a	1.71a
Melia azadirach	1.56a	1.774a	2.23a
Control	1.97a	3.130b	3.85b
P-value	0.880	<.001	0.001
$LSD_{0.05}$	0.947	0.3473	0.881

Means within a column with no letters in common are significantly different (Unprotected LSD; P < 0.05).

Table 3: Weevil population in various treatments

Treatments	**Weevil population**		
	2 months	**4 months**	**6 months**
Acorus calamus	0.707a	0.707a	0.71a
Azadirachta indica	0.707a	0.998a	0.71a
Justicia adhatoda	0.707a	1.052b	1.56a
Zanthoxylum armatum	0.880a	0.998a	1.18a
Artemisia vulgaris	0.707a	0.880a	1.00a
Melia azadirach	0.707a	0.707a	1.56a
Control	0.707a	1.774b	3.28c
P-value	0.468	0.015	0.002
$LSD_{0.05}$	0.2010	0.5348	1.050

Means within a column with no letters in common are significantly different (Unprotected LSD; P < 0.05).

Table 4: Percentage weight loss by maize weevil (*Sitophilus zeamais*)

Treatments	**% weight loss**		
	Initial weight (kg)	**Final weight (kg)**	**% weight loss**
Acorus calamus	3.00	2.975a	0.84a
Azadirachta indica	3.00	2.844a	5.20b
Justicia adhatoda	3.00	2.904a	3.19b
Zanthoxylum armatum	3.00	2.937a	2.09b
Artemisia vulgaris	3.00	2.860a	4.67b
Melia azadirach	3.00	2.854a	4.87b
Control	3.00	2.538a	15.40c
P-value	-	<.001	<.001
$LSD_{0.05}$	-	0.0997	3.325

Means within a column with no letters in common are significantly different (Unprotected LSD; P < 0.05).

Percentage Weight Loss After Six Months of Treatment

A significant difference was observed in the final weight of treated maize grains as compared to control ($P < 0.05$). The lowest weight loss was recorded in *A. calamus* treated maize grains (0.84%) at 6-month of an experiment set up and the highest loss was evident in control (15.40%) (Table 4). Sah (1999) in his study reported that *A calamus* (30 gm/kg) in maize grains caused the least damage in both low and mid hills of Nepal and significantly reduced the weight loss. A similar study conducted by Regmi et al. (2012) concluded that a significant reduction of damage on maize by *A. calamus* was observed followed by significant weight loss compared to the control pot.

Conclusions

Maize is an important cereal crop in South Asia including in Nepal. This crop commonly used for livestock and poultry food as well as for human consumption. It has been grown in the mid-hills and inner-terai regions of Nepal during summer season after rainy period. Insect and diseases are the major production constraints that limit the production and productivity of maize. Field loss is comparatively higher than in the store loss Nepal. Pesticide use to control the field pest and storage pests are the common pest management practice. However, the use of highly hazardous pesticide such as Aluminium Phosphide (Celphos) and Malathion powder are the common weevil management practices in the storehouse. The current use of pesticides can impact on human health and the environment. Hence, a locally available repelling plant materials were tested for the eco-friendly management of weevil. Out of the several tested plant materials, *A. calamus* (rhizome powder) has significantly reduced the weevil population and protect the grain form weevil damage in storage conditions. The weight loss, number of grains damage, number of exit holes and weevil population were significantly lower in *A. calamus* treated sample than control and other tested treatments. *Melia azadirach* (seed powder), *A.indica* (seed powder) are the second most important treatments materials. This information is important to develop integrated weevil management protocol in the storehouse.

Acknowledgements

We are grateful to Basu Dev Sapkota for helping to collect the potential plant materials to use for weevil management We also thank National Maize Research Programme and Sahayougi Agro-Vet for providing maize seeds for the experiments.

References

AICC (2016/017) Agriculture Diary 2017. Agriculture information and communication Centre. Ministry of Agriculture Development. Hariharbhawan, Pulchowk, Lalitpur, Nepal.

Anonymous (1988) Use of local materials to control storage pests. Publication serial no 35, rural save grain program, Kathmandu.

GC YD (2006) Efficacy of indigenous plant materials and modified storage structures to insect pests of maize seed during on-farm storage. *Journal of Institute of Agriculture and Animal Sciences* **27**: 69-76.

MOAD (2014) Statistical information on Nepalese agriculture 2012/2013. Agri-Business Promotion and Statistics Division. Ministry of Agriculture and Development. Singhadurbar, Kathmandu, Nepal.

MOAD (2015/016). Statistical information on Nepalese agriculture 2015/016. The government of Nepal, Ministry of Agricultural Development, Monitoring, Evaluation and Statistics Division, Agri Statistics Section, Singha Durbar, Kathmandu, Nepal. June 2017.

Neupane FP (2009) Insect pest of crop pest and their integrated management. Sajha Prakashan, Pulchok, Lalitpur, 243P.

Oerke EC (2006) Crop losses to pests. *The Journal of Agricultural Science* **144**(1): 31-43.

Paneru RB and Thapa RB (2018) Efficacy of plant materials and storage containers against maize weevil, *Sitophilus zeamais* (Mots.) in maize storage. *International Journal of Agriculture, Environment and Bioresearch* **3**(1): 119-128.

Paneru RB, Duwadi VR, Khanal R and Bhattarai MR (1997) Testing of the efficacy of some local materials against weevil in stored maize. PAC Working Paper 139. PAC, Dhankuta c/o BAPSO PO Box 106, Kathmandu, Nepal

Panthee DR (1997) Efficacy of different indigenous pesticides for wheat seed storage. *Journal of Agriculture and Animal Science*, Rampur, Chitwan. **17/18**: 71-76.

Pingali PL and Pandey S (2001) Meeting world maize needs: Technology opportunities and priorities for the public sector. In P.L Pingali (ed.) CIMMYT 1999-2000. World maize facts and trends. Meeting world maize needs: Technological opportunities and priorities for the public sector. CIMMYT. Mexico City.

Ranum P Peña-Rosas JP and Garcia-Casal MN (2014) Global maize production, utilization, and consumption. *Annals of the New York Academy of Sciences* **1312**(1): 105-112. doi:10.1111/nyas.12396

Regmi H, GC YD and Shih CJ (2012) Efficacy of natural products against *Callosobruchus chinensis* (Coleoptera: Bruchidae) in Nepal. *Journal of Economic Entomology* **105**(3): 1095-1099.

Sah YP (1999) Minimizing the losses in stored maize under farmer's storage condition in the eastern hills of Nepal. ARSP Technical Paper No. 188. Agricultural Research Station, Pakhribas, Dhankuta, Nepal.

Saville DJ (2015) Multiple comparison procedures-cutting the Gordian knot. *Agronomy Journal*. 107(2): 730–735. doi:10.2134/agronj2012.0394.

Sharma S and Tiwari S. (2016) Maize variety screening against maize weevil Sitophilus zeamais under Storage in Chitwan Condition of Nepal. *Advances in Zoology and Botany* **4**(3): 31-36.

Sharma SD Thapa RB KC GB Bhandari G and Tiwari S (2016) Studies on food preferences of maize weevil, Sitophilus zeamais Mots. to different crops in Chitwan, Nepal. *Journal of Maize Research and Development* **2**(1): 58-65.

Shrestha BK (2006) Use of botanicals in organic agriculture. Proceedings of a First National Workshop on Organic Farming (12-14 June), Pp 147.

Trematerra P Ianiro R Athanassiou CG and Kavallieratos NG (2013) Behavioural responses of *Sitophilus zeamais* Motschulsky adults to conditioned grain kernels. *Journal of Stored Products Research* **53**: 77-81. doi: 10.1016/j.jspr.2013.02.005