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Short Communication

EFFICACY OF PLANT- POWDERS AGAINST RICE WEEVIL, *Sitophilus oryzae* (Linnaeus) (CURCULIONIDAE: COLEOPTERA) AT LABORATORY CONDITION

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ABSTRACT

An experiment was conducted to evaluate the efficacy of plant-based repellent powders for *S. oryzae* at the National Rice Research Program, Hardinath, Dhanusha, Nepal in 2020 at laboratory condition. Two hundred gram of paddy grains of cv. Sambha Mansuli Sub-1 was kept in each plastic jar in the experiment. Ten pairs of newly emerged adult rice weevil, *S. oryzae* of uniform age obtained from stock culture were released in each plastic jar. Laboratory bioassay contained *Acorus calamus* (rhizome powder) @10 gm/kg, *Piper nigrum* (seed powder) @10 gm/kg, *Curcuma longa* (rhizome powder) @10 gm/kg, *Azadirachta indica* (kernel powder) @ 10gm/kg, *Zingiber officinale* (rhizome powder) @10 gm/kg, and Malathion powder 5% dust @2 gm/kg were used for the rice weevil. *Acorus calamus* was the most effective botanical powder followed by *P. nigrum* to reduce grain damage percent on number basis (1.15%) and on weight basis (1.22%), weight loss percent (0.84%) & weevil population count (1.54). The efficacy ranks of the botanicals were: *A. calamus>P. nigrum>A. indica>Z. officinale>C. longa.* Thus, use of *A. calamus* powder is recommended to manage rice weevil in the storehouse condition.

Keywords: Botanicals, Paddy grains, Rice, Storage, Weevil

INTRODUCTION

Rice is solely responsible for 20% AGDP & 7% GDP in Nepal (CBS, 2017). In 2018-19 AD, the area under rice cultivation was 14,91,744ha, with total production was 56,10,011 MT and productivity of 3.96 mt/ha in Nepal (MoALD, 2019). In spite

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of increasing productivity of rice in Nepal, demand is yet not fulfilled. This is due to many reasons and among them; post-harvest loss of harvested rice during storage is also a critical problem. Rice weevil is one of the severe damaging pests of cereal grains during storage (Neupane, 1995). In general, the losses (pre and post-harvest) due to pests have been estimated to be 15-20% (Neupane, 1995). Even 1% loss of rice grain during storage accounts for 56000MT annual loss which can feed 3,36,000 persons per year in Nepal (MoALD, 2019).

Nowadays, the main method of pest control of stored rice grain has been chemical, using phosphine (Hossain et al., 2014). These synthetic insecticides possess inherent toxicities that endanger the health of the farmers, consumers, and the environment (Prasannath, 2016). Similarly, Aluminium Phosphide and EDCT (Ethylene Dichloride & Carbon Tetrachloride) mixture is also widely using in Nepal (Neupane, 2018) but consumers do not realize their chemical residues in the stored grains.

Considering the negative effects of synthetic pesticides, botanical powders are quite promising as they are less poisonous to humans, biodegradable, and eco-friendly (Guzzoet al., 2006). Use botanical powders were found to be more effective to control insect pest (Pal et al., 2018). Out of 41 highly effective plant species for insect control, 23 species are in Nepal (Neupane, 2005). With the abundance of such plant species in Nepal, researchers have opportunities to find out plant-derived pesticides. Therefore, the present study was undertaken to explore the efficacy of some botanical powders to manage rice weevil in storage condition.

MATERIALS AND METHODS

Research location

The research was conducted at the Entomology Laboratory in the National Rice Research Program (NRRP), Hardinath, Dhanusha, Nepal from January to June 2020. The research station was located at a latitude $26^0$47'46.5"N and longitude $85^0$57'49.35"E and an altitude of 93.0 meters from the sea level.

Experimental details

The experiment was laid out in a Completely Randomized Design (CRD) with three replications. Total seven plant based repellent powders were used as treatments and are listed in Table 1. Newly emerged 10 pairs of fresh adult weevils (10males and 10females) were kept in each plastic jar at the time of beginning of experiment.

Table 1. Experimental plant powders and application doses

Powder	Dose	
	(g/kg grains)	(g/200gm grain)
Acorus calamus (rhizome powder)	10	2
Piper nigrum (seed powder)	10	2
Curcuma longa (rhizome powder)	10	2
Azadirachta indica (kernel powder)	10	2
Zingiber officinale (rhizome powder)	10	2
Malathion powder 5% dust	2	0.4
Untreated Control	-	-

As there were 7 treatments with 3 replications, a total of 21 plastic jars with screened holes on their lids were taken for the experiment. At first, 200gm of sterilized rough rice grains cv. Sambha Mansuli Sub-1 were kept in each jar with 2gm of prepared plant powders and were replicated thrice. As there were five botanicals with their three replications, altogether of 15 jars were maintained. In addition to this, 0.4gm Malathion powder (5% dust) was added to 3 jars as a standard check and also 3 jars were maintained having no powders as a control treatment. Then, 10 pairs (10 male & 10 female) of newly emerged adult weevils from the stock culture were released in each jar and their lids were covered tightly to prevent the escape of weevils. Females are identified based on their larger body size and shiny with an elongated rostrum. All the jars were placed in the laboratory at the room temperature.

Sampling and data observation

The data were observed from the start of experiment and repeated at every 15 days interval up to 90 days. The population build up was recorded by counting the number of adults from whole 200 gm grain and damaged & undamaged grain number by taking 10 gm grain as sample from each treatment.

Thousand-grain weight

At every 15 days interval thousand grain weights was recorded with the help of a digital weighing balance (SF-400A).

Moisture content

Moisture content of rice grains was recorded with the WILE-moisture meter device.

Number of damaged and undamaged grains

The number of damaged and undamaged grains was examined by taking a 10 gm random sample from each treatment.

Weight of damaged and undamaged grains

The weight of damaged and undamaged grains was taken with the help of a digital weighing balance (SF-400A).

Percentage of damaged and undamaged grain

The percentage of damaged and undamaged grain was taken (Enbakhare and Lawogbomo, 2002) by the following formulae.

$$Damage(\,\%) = \left(\frac{Nd}{Tn}\right) \times 100$$

$$Undamage(\,\%) = \left(\frac{Nu)}{Tn}\right) \times 100$$

Where,

Nd: No. of damaged grains

Nu: No. of undamaged seeds

Tn: Total number of seeds

Weight loss percentage

The weight loss percentage of seeds was calculated (Lal, 1998) by using the count and weight method and the formula is,

$$Weightloss(\%) = [\frac{UNd - DNu}{\{U(Nd + Nu)\}}] \times 100$$

Where,

D: Weight of damaged seeds

U: Weight of undamaged seeds

Nd: No of damaged seeds

Nu: Number of undamaged seeds

Weevil population count

The number of both live and dead weevil was counted from total 200 gm rice grains.

Room temperature and relative humidity

The temperature and relative humidity of the laboratory were recorded every day with a Thermo-Hygrometer device.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) to evaluate the significance of treatment effect. R-STUDIO software was used for analysis of data, and mean comparisons was done by using Duncan's Multiple Range Test (DMRT) at 5% level of significance.

RESULTS AND DISCUSSION

Effect on mean grain damage (number basis)

The mean grain damage percent (number basis) with plant powders was significantly different ($p<0.05$) among the treatments over 90 days after treatment. The highest grain damage percent was in untreated control (1.75%) followed by *C. longa* (1.42%) and the lowest in Malathion (0.94%) followed by *A. calamus* (1.15%). The damage of *A. calamus* was statistically at par with *P. nigrum* (1.20%) and *A. indica* (1.24%) while damage of *C. longa* was at par with *Z. officinale* (1.34%). However, damage effects of *P. nigrum, A. indica* and *Z. officinale* were not statically different (Table 2).

Effect on mean grain damage percentage (weight basis)

The mean grain damage percent (weight basis) with plant powders was significantly different ($p<0.05$) among the treatments over 90 days after treatment. The highest grain damage percent was in untreated control (1.92%) followed by *C. longa* (1.57%) and the lowest in Malathion (1.00%), followed by *A. calamus* (1.22%). The damage of *A. calamus* was statically at par with *P. nigrum* (1.30%) and *A. indica* (1.35%) while damage of *C. longa* was at par with *Z. officinale* (1.46%). However, damage effects of *P. nigrum, A. indica* and *Z. officinale* were not statically different (Table 2).

Effect on mean weight loss percentage

The mean weight loss percent with repellent powders was significantly different ($p<0.05$) between various treatments over 90 days after treatment. The highest weight loss percent was in untreated control (1.19%) followed by *C. longa* (1.01%) and the lowest in Malathion (0.74%), followed by *A. calamus* (0.84%). The weight loss of *A. calamus* was statically at par with *P. nigrum* (0.91%), *A. indica* (0.92%) and also with Malathion while weight loss of *C. longa* was at par with *Z. officinale* (0.97%). However, weight loss percent of *P. nigrum, A. indica* and *Z. officinale* were not statically different (Table 2).

Effect on the mean number of live weevils

The mean number of live weevils population with plant powders was significantly different ($p<0.05$) among the treatments over 90 days after treatment. The highest number of live weevils was in untreated control (7.68) followed by *C. longa* (4.92) and *Z. officinale* (4.46) while the lowest in Malathion (0.67%) followed by *A. calamus* (1.54), *P. nigrum* (2.71) and *A. indica* (3.35). However, weight loss of *P. nigrum* was statically at par with *A. indica* and similarly *C. longa* with *Z. officinale* (Table 2).

Table 2. Effect of rice weevil on grain damage, weight loss and live weevil population (Mean Over 90 days) with plant based repellent powders in 2020

Treatments	Mean grain damage % (number basis)	Mean grain damage % (weight basis)	Mean weight loss %	Mean number of live weevils
A. calamus (10gm/kg)	1.15^{d}	1.22^{d}	0.84^{de}	1.54^{d}
P. nigrum (10gm/kg)	1.20^{cd}	1.30^{cd}	0.91^{cd}	2.71^{c}
C. longa (10gm/kg)	1.42^{b}	1.57^{b}	1.01^{b}	4.92^{b}
A. indica (10gm/kg)	1.24^{cd}	1.35^{cd}	0.92^{cd}	3.35^{c}
Z. officinale (10gm/kg)	1.34^{bc}	1.46^{bc}	0.97^{bc}	4.46^{b}
Malathion 5% (2gm/kg)	0.94^{e}	1.00^{e}	0.74^{e}	0.67^{e}
Untreated control	1.75^{a}	1.92^{a}	1.19^{a}	7.68^{a}
SEm (±)	0.062	0.062	0.031	0.491
CV (%)	7.98	8.53	6.41	10.9
p- value	<0.001	<0.001	<0.001	<0.001
Significance	s	s	s	s

Among all the tested repellent powders, *A. Calamus* caused the minimum damage with less weevil population buildup which is in line with Tiwari et al. (2018) who found that use of *A. calamus* (rhizome powder) against weevil on stored grains was the best which resulted in the least grain damage percent and weight loss percent than other botanical powders. These powders can cause suffocation which leads to the death of storage insect pests (Asawalam et al., 2012) and is also supported by Yao et al. (2008) who found that *A. calamus* contains a bioactive compound (β-asarone) which shown insecticidal properties and responsible for weevil mortality. Similarly, Gyawali and Kim (2009) observed that *A. calamus* rhizome contains 7493.59 ml/kg of volatile compounds and among which 46.78% was β-asarone compounds.

The pungent substance found in the black pepper extract "Piperine" and the principal component of cinnamon flavor "cinnamaldehyde" are reported to possess insecticidal activities (Huang & Ho, 1998). The main components of the turmeric plant which act as insect repellent are turmerone and ar-turmerone (Tripathi et al., 2002). Similarly, *Azadirachtin* is a natural antifeedant, sterilant, and insect growth regulator that is found in the kernel of neem and has a negative influence on feeding, mating, molting, and fecundity of insects (Hummel et al., 2012). *Z. officinale* contains geranial, α-zingiberene, α-farnesene, and neral as the main bioactive compounds (Franz et al., 2011) and was less effective because of thicker exoskeleton of weevil which afforded them to tolerate the active compounds in *Z. officinale* (Olajire et al., 2015).

In the present context, the main method of pest control of stored rice grain has been chemical, using phosphine (Hossain et al., 2014). The chemical Aluminium Phosphide can be used only in airtight containers to make it effective (Neupane, 2018) which may not be available in traditional handmade storage structures in the rural areas of Nepal. Besides this, the use of recommended chemical fumigants is either expensive, not available to everywhere and can cause toxicity to users as well as leads to residual pollution to the environment (Benhalima et al., 2004). Due to this, Nepalese government has been banned several chemical pesticides that used either in the field or during storage. Therefore, resource-poor farmers can use *A. calamus* as botanical powders to control rice weevil during the storage period.

CONCLUSION

The rice weevil is one of the severe damaging pests of rice that causes grain losses in the storage condition. Losses of agricultural commodities during the post-harvest period have been considered a major problem in Nepal. *A. calamus* (rhizome powder) was found to be the most effective, next to chemical followed by *P. nigrum* (seed powder), *A. indica* (kernel powder) and *Z. officinale* (rhizome powder) in the reduction of grain damage percent, weight loss percent and live adult weevil population during storage. It can be recommended to use with the stored grain products.

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