

## Efficacy of Some Indigenous Plant Powders against *Sitophilus* Spp. through Quantitative Test of Maize Grains and Their Impact on Seed Germination

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### ABSTRACT

Maize (*Zea mays* L.) is a vital cereal crop worldwide, yet its post-harvest storage is threatened by the maize weevil (*Sitophilus* spp.), a pest responsible for significant quantitative and qualitative losses. Conventional reliance on synthetic insecticides raises environmental, health, and resistance concerns, necessitating eco-friendly alternatives. This study evaluated the efficacy of selected indigenous plant powders *Acorus calamus* (sweet flag), *Vitex trifolia* (Chinese chaste tree), *Cymbopogon citratus* (lemongrass), *Azadirachta indica* (neem seed kernel extract, NSKE), *Zanthoxylum acanthopodium* (wing leaf prickly ash), and *Ageratum conyzoides* (floss flower) in protecting maize seeds during storage and their impact on seed germination. The powders were applied at 10g/kg of maize seeds and compared with

a chemical standard (Fenvalerate 0.4% DP) and an untreated control. Results revealed that untreated seeds suffered the highest seed loss (23.92%) and weight loss (9.39%). Fenvalerate 0.4% proved most effective, with minimal seed (7.88%) and weight loss (2.46%). Among botanicals, *A. calamus*, NSKE, and lemongrass powders significantly reduced seed loss (10.46–13.58%) and weight loss (4.07–4.69%), showing parity with the chemical check. In terms of germination, NSKE, treated seeds recorded the highest viability (80%), followed by lemongrass (57%) and *V. trifolia* (55.33%), while chemical treatment (16%) and some botanicals like sweet flag (18.66%) and floss flower (12%) reduced germination drastically. These findings suggest that NSKE, lemongrass, and sweet flag are promising eco-friendly protectants for reducing maize weevil damage without severely compromising seed viability, offering farmers sustainable alternatives to synthetic insecticides.

**Keywords** NSKE, Indigenous plant powders, *Sitophilus* spp, Seed protection, Seed germination, Post harvested losses.

### INTRODUCTION

Maize (*Zea mays* L.), often referred to as the “queen of cereals” due to its high yield potential, is among the most widely cultivated grains globally (Nand 2015). However, its storage is severely threatened by the maize weevil (*Sitophilus zeamais*: Coleoptera: Curculionidae), a major pest causing extensive

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postharvest losses (Nwosu 2018, Ileke *et al.* 2020). While infestation begins in the field, most damage occurs during storage (Demissie *et al.* 2008). Globally, insect-related postharvest losses range from 1–5% in developed countries to 20–50% in developing nations (Nukenine 2010). The maize weevil can inflict qualitative and quantitative damage, with grain weight losses reported between 20–90% in untreated maize (Muzemu *et al.* 2013). Infested grain often becomes unsuitable for human consumption and loses market value (Garcia-Lara *et al.* 2004). Minimizing pest damage is thus critical for food safety and storage preservation. Traditionally, synthetic insecticides have been widely used (Rajashekar *et al.* 2012), but concerns over environmental impact, food contamination, pesticide resistance, and cost persist (Cherry *et al.* 2004). As a safer alternative, botanical pesticides derived from medicinal plants are gaining attention due to their lower mammalian toxicity and potential effectiveness against storage pests (Longe 2010). These plant-based protectants offer promising advantages and are increasingly considered essential for sustainable grain preservation, food security, and safety (Khakata *et al.* 2018).

## MATERIALS AND METHODS

### Preparation of plant powders

Plant parts from six indigenous species were collected and processed into powder (Table 1). After shade drying, the plant materials were ground to a fine powder using a 30-mesh sieve. Each 50-gram of plant powder were mixed with 250ml of acetone and stirred for 30 minutes, then left to stand for a week. Following

**Table 1.** List of plant species used as powder against *Sitophilus* spp.

Sl. No.	Common name	Scientific name	Part used
1	Sweet flag	<i>Acorus calamus</i>	Rhizome
2	Chinese chaste tree	<i>Vitex trifolia</i>	Leaf
3	Lemon grass powder	<i>Cymbopogon citratus</i>	Leaf
4	NSKE powder	<i>Azadirachta indica</i>	Seed
5	Wing leaf prickly ash	<i>Zanthoxylum acanthopodium</i>	Leaf
6	Floss flower	<i>Ageratum conyzoides</i>	Leaf
7	Fenvelerate 0.4% DP (chemical check)	-	-
8	Untreated control check	-	-

**Table 2.** Details of different treatments against *Sitophilus* spp.

Treatments	Treatment details
T1	<i>Acorus calamus</i> (sweet flag) @10g/ kg seeds
T2	<i>Vitex trifolia</i> (Chinese chaste tree) @10g/kg seeds
T3	<i>Cymbopogon citratus</i> (lemon grass powder) @10g/kg seeds
T4	<i>Azadirachta indica</i> (NSKE powder) @10g/kg seeds
T5	<i>Zanthoxylum acanthopodium</i> (Wing leaf prickly ash) @10g/kg seeds
T6	<i>Ageratum conyzoides</i> (Floss flower @10g/kg seeds
T7	Fenvelerate 0.4% DP (chemical check)
T8	Untreated control check

this, the mixture was filtered through whatman grade 1 filter paper. The resulting filtrates were evaporated to dryness, and the final crude extracts were weighed and stored in sealed bottles in a refrigerator for future study.

### Details of the experiments

The powders of indigenous plants at a dose of @ 10g/ kg maize seed would be tested on the seeds of most susceptible maize variety, Chakhao Chujak (local) that were evaluated (Table 2). In each jar, 5 pairs of *Sitophilus* spp. moth adults of same age were released into each jar containing 100g of seeds of different treatment and kept under room condition. The mouth of jar was covered with muslin cloth and tied with rubber band to prevent entry and exit of any insect. Each treatment was replicated thrice. After 40–45 days, open the jar and weight seeds of each jar by removing all dust, insect and their stages.

### Observation to be recorded

Per cent seeds loss were calculated from number of damaged seed and total number of seeds after 45 days of release. Per cent seed loss is calculated by using following formula suggested by (Giga *et al.* (1993).

$$\% \text{ percent seed loss} = \frac{\text{Number of damaged seed}}{\text{Total number of seed}} \times 100$$

Percentage weight loss was calculated based on formula suggested by Boxall (1986).

$$\% \text{ Weight loss} = \frac{\text{Initial weight} - \text{final weight}}{\text{Initial Weight}} \times 100$$

### Effect of indigenous plant powders on seed germination of maize

After quantitatively evaluating the effect of various indigenous plant powders and, 25 number of seed of each treatment including untreated control treatment were placed in sterilized petridish with filter papers and to be moistened daily. The number of seeds germinated in each treatment after 5 days were counted and germination success were expressed in percentage.

$$\text{Germination \%} = \frac{\text{Number of germinated seeds}}{\text{Number of seeds used}} \times 100$$

## RESULTS

### Effect of plant powders on seed loss by *Sitophilus* spp. in maize

The mean data of percentage of seed loss after one and half month of treatment shows in reveal the effectiveness of various botanical and chemical treatments in minimizing seed loss caused by *Sitophilus* spp. during storage. The untreated check recorded the highest seed loss at 23.92%, indicating severe damage in the absence of any protective measures. In contrast, the standard check insecticide, Fenvelerate @ 0.4%, exhibited the lowest seed loss at 7.88%, which was significantly lower than the untreated check and serves as a comparison for treatment effectiveness.

Among the botanicals, sweet flag @10g/kg of seed recorded a seed loss of 10.46%, which was statistically at par with NSKE powder @10g/kg of seed

at 11.56% and Lemon grass powder @10g/kg of seed at 13.58%. These treatments were also found to be statistically similar to the chemical check, suggesting their potential as effective alternatives to synthetic insecticides. Chinese chaste tree @10g/kg of seed, with 15.54% seed loss, was slightly less effective but still significantly better than the untreated control.

However, treatments such as Wing leaf prickly ash @10g/kg of seed and Floss flower @10g/kg of seed recorded higher seed losses at 18.24% and 17.45% respectively, which were not significantly different from the untreated check, indicating lower effectiveness in protecting the seeds.

Overall, Fenvelerate @ 0.4% was the most effective, while botanicals like sweet flag, NSKE powder, and Lemon grass powder showed comparable efficacy and could serve as eco-friendly alternatives for seed protection in storage.

### Effect of plant powder on weight loss by *Sitophilus* spp. in maize

The data on percent weight loss presented in the demonstrate the comparative effectiveness of different botanical treatments and a chemical check against *Sitophilus* spp. infestation in stored maize. The untreated check recorded the highest weight loss at 9.39%, indicating significant seed weight loss in the absence of any protective treatment. In contrast, the chemical insecticide Fenvelerate @ 0.4%, used as the standard check, resulted in the lowest weight

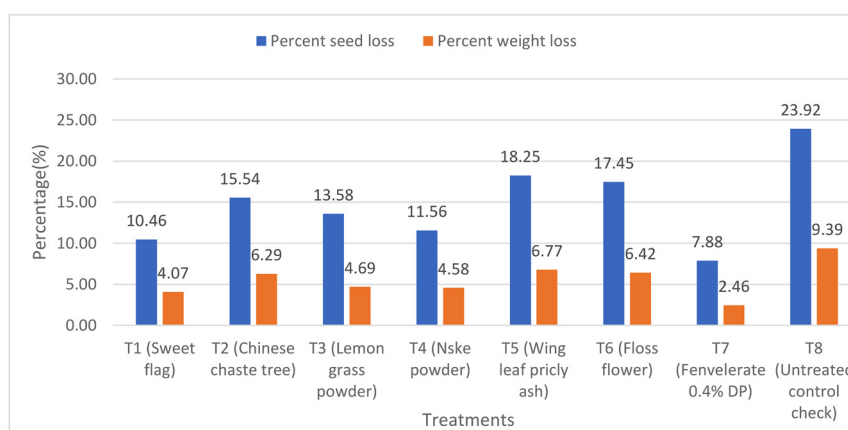


Fig. 1. Graphical representation of effect of plant powders against *Sitophilus* spp. through quantitative test of maize grains.

**Table 3.** Effect of some plant powders against *Sitophilus* spp. through quantitative test of maize grains.

Treatments	Percent seed loss %	Percent weight loss %
T1- Sweet flag	10.46 (3.23)	4.07 (2.02)
T2- Chinese chaste tree	15.54 (3.94)	6.29 (2.51)
T3- Lemon grass powder	13.58 (3.69)	4.69 (2.17)
T4- NSKE powder	11.56 (3.40)	4.58 (2.14)
T5- Wing leaf prickly ash	18.24 (4.27)	6.77 (2.60)
T6- Floss flower	17.45 (4.18)	6.42 (2.53)
T7- Fenvelerate (standard check insecticide)	7.88 (2.81)	2.46 (1.57)
T8- Untreated check	23.92 (4.89)	9.39 (3.06)
SEm	1.05	0.58
CD 5%	3.15	1.74

Figure in table are square root transformed values.

loss of 2.46%, which was significantly lower than most treatments.

Among the botanical treatments, sweet flag @10g/kg of seed, Lemon grass powder @10g/kg of seed, and NSKE powder @10g/kg of seed recorded weight losses of 4.07%, 4.69%, and 4.58% respectively.(Fig. 1). These values were statistically at par with each other and not significantly different from the chemical check, indicating their potential as effective alternatives for reducing weight loss due to weevil damage.

Chinese chaste tree, Floss flower, and Wing leaf prickly ash, showed relatively higher weight losses of 6.29%, 6.42%, and 6.77% respectively.(Table 3). These losses were significantly higher compared to Fenvelerate @ 0.4% and the more effective botanicals, but still significantly lower than the untreated check, suggesting moderate levels of protection.

Overall, Sweet flag, NSKE powder, and Lemon grass powder performed similarly to Fenvelerate @ 0.4% (chemical check) but due to its hazardous nature to the environment an eco-friendly alternative may be used for reducing post-harvest losses in maize due to *Sitophilus* spp.

### Effect of plant powders on seed germination of maize var. Chakhao chujak

In the maize seed quality in terms of germination percentage was evaluated after 45 days of treatment. It is evident from the result presented that the maize seeds of var. chakhao chujak treated with plant powders in the response of germination after 5 days of germination test.

Among the botanical treatments, the highest germination percentage was recorded in seeds treated with NSKE powder, showing 80.00% germination, indicating its potential as a safe botanical for seed treatment. This was followed by lemongrass powder and Chinese chaste tree, which resulted in 57.00% and 55.33% germination, respectively, and were also higher than the untreated control.

The untreated control showed a germination rate of 42.00%, which was moderate compared to the other treatments. Lower germination rates were observed in treatments with wing leaf prickly ash (27.00%), sweet flag (18.66%), and floss flower (12.00%), showing that these plant powders may reduce seed germination (Table 4).

Notably, the standard chemical insecticide, Fenvelerate @ 0.4%, used as a check, resulted in a

**Table 4.** Effect of plant powders on seed germination of maize var. Chakhao chujak.

Treatments	% germination after 5 days of germination test
T1- Sweet flag	18.66 (25.60)
T2- Chinese chaste tree	55.33 (48.06)
T3- Lemon grass powder	57.00 (49.02)
T4- NSKE powder	80.00 (63.43)
T5- Wing leaf prickly ash	27.00 (31.31)
T6- Floss flower	12.00 (20.27)
T7- Fenvelerate (standard check insecticide)	16.00 (23.58)
T8- Untreated check	42.00 (40.40)
SEm	3.95
CD 5%	11.84

Figure in tables are angular transformed values.

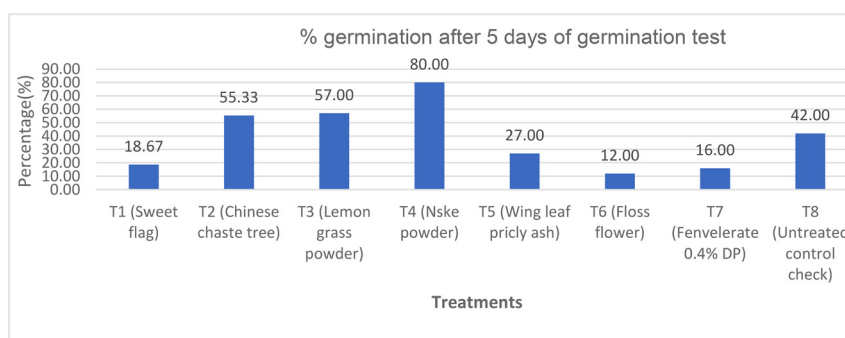


Fig. 2. Graphical representation on effect of plant powders on seed germination.

low germination rate of 16.00%, even lower than the untreated control, indicating potential negative effects of chemical residues on seed viability.(Fig. 2).

These results indicate that some plant-based treatments botanicals especially NSKE, may be safer alternatives to chemical insecticides for managing storage pests without compromising seed germination which can be easily assesible to farmers regardless of the price and availability.

## DISCUSSION

### Effect of plant powders on seed loss and weight loss against *Sitophilus* spp. in maize

The result on laboratory study of plant powders against *Sitophilus* spp. in maize var. Chakhao chujak indicated that all the tested seed protectants viz., plant powders were found to be effective and significantly superior over untreated control. The minimum seed damage of 7.88% was observed with Fenvalerate 0.4%DP which is a standard check insecticide but the harmful effects of its use are enormous. Among the botanicals, sweet flag @10g/kg of seed recorded a seed loss of 10.46%, which was statistically at par with NSKE powder @10g/kg of seed at 11.56% and Lemon grass powder @10g/kg of seed at 13.58%. The results are in accordance with Padmasri *et al.* (2017) who reported that *Acorus calamus* rhizome powder @10g/kg seed gave complete protection to seed by preventing adult emergence and also completely protect the seeds up to three months of treatment. The results were also in agreement the

findings of Spandana *et al.* (2025) who reported that treatment of stored mung bean with botanical protectants including *Acorus calamus* oil and powder effectively inhibited oviposition and adult emergence of pulse beetle, resulting in no seed damage and better seed quality during storage. Similar work was done by Chandrabhanu *et al.* (2025) who reported that extracts derived from *Acorus calamus* rhizome showed strong insecticidal activity against storage pests and significantly reduced pest survival and damage in treated commodities. Aryal *et al.* (2023) envisaged that seeds treated with *Acorus calamus* rhizome oil showed strong insecticidal activity against stored-grain beetles and significantly reduced adult emergence and seed damage, indicating long-term protection during storage.

The data on the effect of plant powders on weight loss of seeds by *Sitophilus* spp. after 45 days of treatment indicated lowest percent weight loss was observed with maize seeds treated with sweet flag @ 10g/kg seed recording 4.07% which is statistically at par with NSKE powder @10g/kg seed and Lemon grass powder @ 10g /kg seed giving weight loss of 4.58% and 4.69 %, respectively. The chemical check Fenvalerate 0.4%DP @2g/kg seed was the best treatment managing the infestation of *Sitophilus* spp. giving only 2.46% weight loss of seeds after 45 days of treatment but considering its harmful effects and human safety, a safer alternative like sweet flag @ 10g/kg seed, NSKE powder @10g/kg seed and Lemon grass powder @ 10g /kg seed can be taken into consideration which were statistically on par with each other. Padmasri *et al.* (2017) reported that *Acorus*

calamus rhizome powder@10g/kg seed recorded the lowest weight loss per cent after Emamectin benzoate of 0.02 per cent. Mallah *et al.* (2018) reported that Bhojo (sweet flag) powder was significantly more effective having a least weight loss percent than neem, titepatati, which is in accordance with our present findings. Similarly, Paneru *et al.* (1993), Jilani and Saxena, (1984), Biradar, (2000) and Spandana *et al.* (2025) found that *Acorus calamus* was a good preservative with a long-lasting effect on mung beans. Kalasagond (1998) who reported that no weight loss was observed in wheat grains at 0.8 per cent concentration of sweet flag rhizome powder.

#### **Effect of plant powders on seed germination of maize var. Chakhao chujak**

The data on the seed germination of treated maize seeds var. Chakhao chujak after 5 days of germination test showed that all the treatments hampered complete seed germination up to varying extent through significantly higher than untreated control recording only 42% germination of seeds. After 45 days of treatment with various powders, the percent germination ranged from 12% to 80% within the treatments. The highest germination percentage was recorded in seeds treated with NSKE powder, showing 80.00% germination, indicating its potential as a safe botanical for seed treatment. This was followed by lemongrass powder and Chinese chaste tree which resulted in 57.00% and 55.33% germination, respectively. Present findings are in partial agreement with the reports given by Tripathy *et al.* (2001) and Singh and Yadav (2003) which stated that seeds treated with botanicals have negligible effect on seed germination. The present findings were in support by the findings made by, Barre and Jenber (2022) where Neem seed, neem leaves, ginger, garlic, lantana and pepper treatments have shown 100 % seed germination. (Danga *et al.* 2015) reported the rate of seed germination was not affected by NeemPro as observed in Malagrain. Nukenine *et al.* (2011) also reported similar findings where NeemAzal did not have negative effects on maize seed germination (germination rates of 92.23 % at 3 g/kg to 97.77 % at 12 g/kg were recorded).

Despite plant powders being superior in controlling the damage by *Sitophilus* spp. treatment of

seeds with any plant powders would affect the milling quality of maize seeds for consumption. Traces of powder on seed coat may leave unwanted odour and taste to the milled grains. Hence, all the plant powders effective in these present findings may be opted for storing meant for upcoming season and not for human consumption.

#### **CONCLUSION**

The study demonstrated that indigenous plant powders possess considerable potential as eco-friendly protectants against *Sitophilus* spp. in stored maize. Among the treatments, neem seed kernel extract (NSKE), sweet flag, and lemongrass powders significantly reduced seed and weight loss, performing on par with the chemical standard Fenvalerate 0.4%. Notably, NSKE-treated seeds maintained the highest germination rate, underscoring its safety for preserving both grain quality and seed viability. In contrast, chemical insecticide residues negatively impacted germination, highlighting a major drawback of synthetic protectants. While some botanicals such as wing leaf prickly ash and floss flower provided moderate protection, their effectiveness was inferior to NSKE, sweet flag, and lemongrass. Overall, the findings confirm that indigenous botanicals, particularly NSKE, offer a sustainable, accessible, and environmentally safe alternative to chemical insecticides for reducing post-harvest losses in maize. However, since some powders negatively influenced germination or left residues that may affect grain palatability, their use should be prioritized for seeds intended for planting rather than direct consumption. Future research should focus on optimizing dosage, evaluating combinations of plant powders, and testing long-term storage performance under farmer-managed conditions to enhance the practical adoption of these eco-friendly technologies.

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