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Effect of Plant Materials on Damage and Germination of Cowpea Seeds Stored on small Farms

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ABSTRACT

On-farm experiments were carried out in Ibadan on stored cowpea *Vigna unguiculata* (L) Walp) to evaluate the effectiveness of post-harvest treatments designed for the control of *Callosobruchus maculatus* F. and adoptability by small farmers. Two treatments effectively reduced *C. maculatus* damage. *Dennettia tripetala* Baker f. and *Piper guineense* Schum and Thonn. essential oil extracts at 5ml/5kg seeds effectively reduced seed damage to 10% and 12.5% compared to 43% and 90% seed damage on cowpea treated with Permethrin dust (2.5ppm) and untreated control respectively, 6 months after treatment. Treatments, which successfully controlled bruchids in on-farm experiments, were evaluated to determine effects on germination. Germination was determined by trials planted in sand. Germination was not significantly ($P > 0.05$) changed by storage treatments. Analysis of bruchid damage on seed quality showed a decrease in germination related to the number of emergence holes. The promise for small-farmer adoption of these successful treatments is evaluated.

INTRODUCTION

Explosive *Callosobruchus maculatus* F. populations usually limit cowpea storage in the tropics to about two months. Schoonhoven (1976) reported that damage caused results in cowpea grains becoming unattractive, unpalatable to humans, and have reduced viability. Evaluation of small-scale, on-farm post-harvest storage treatments designed to control *C. maculatus* infestation with plant materials will no doubt benefit the farmer by preserving cowpea seeds in good condition for planting, postponement of sales to achieve a better pricing and domestic consumption.

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The application of oils extracted from various spices, herbs and plants on cowpea for protection against attack by *C. maculatus* has been confirmed effective by many workers with *D. tripetala, P. guineense, Azadirachta indica* Juss, *Cymbopogon nardus* Linn. and *Citrus aurantifolia* Swingle for a period of months (Osisiogu and Agbakwuru, 1978; Olaifa and Erhun, 1988; Ivbijaro, 199 Lale, 1991; Don-Pedro, 1996 a,b,c; Okonkwo and Okoye, 1996; Okonkwo, 200 Adebayo and Gbolade, 1994).

According to Baier and Webster (1992b) the criteria that served a guideline in the search for a successful and appropriate on-farm cowpea see storage treatment include: farmers' opinion of the treatment which reflect potential for adoption; easy and safe application at the small farm leve availability of treatment materials, non-toxicity of treatment to the applicato consumer, and the environment; treatment that effectively controls bruchids retention of seed germination potential; maintained seed flavour and appearance and economical or cost-effective treatment.

In the present study, the first six criteria were used as guidelines to selec appropriate treatments for these experiments. Experiments were designed tc evaluate promising bruchid control treatments with regard to seed damage and germination.

MATERIALS AND METHODS

Preparation of seed powders

D. tripetala and *P. guineense* fruits were purchased from a market in Nnewi in Anambra state. The seeds of *D. tripetala* were removed with a scalpel from the soft pericarp, washed thoroughly in running tap water, rinsed in distilled water and dried at 60°C for 96h, while *P. guineense* fruits were washed thoroughly in running tap water, rinsed in distilled water and dried at 60°C for 96h. The dried seeds were ground using a hammer mill and sieved through a 40 holes/mm^2 mesh sieve to obtain fine powders. The powders were kept in air-tight jars prior to use (Okonkwo and Okoye, 1996).

Essential Oils Extraction

Oil from each seed powder (25g) was extracted for 16h with 250ml of *n*-hexane (b. p. 40-60°C) in a Soxhlet extractor according to the AOAC (Anon,1984) method. After the extraction of each essential oil, the solvent was recovered by heating the flasks in a ventilated oven for 45mins at 103 ± 2°C. The oils were stored in glass vials at 5°C. The yields of oil extracted from 25g of the seed powder with 250ml *n* -hexane were *D. tripetala* 0.7ml and *P. guineense* 3.5ml.

Damage: Experiment 1

Three post-harvest treatments were selected for their success in control of *C. maculatus* in laboratory experiments. These were applied to Ife brown variety of cowpea seeds purchased from IAR & T Ibadan after harvest in July 1996, and were evaluated throughout the subsequent 6 month storage period on 3 collaborating farms in Ibadan, Nigeria. The cowpea seeds were sieved using a Donald sieve, I mm diameter, to remove any dead insects and dirt. Cowpea seed lots were divided into 5kg batches. *D. tripetala* and *P. guineense* essential oil extracts were applied with a micro syringe and thoroughly mixed with cowpea seeds by hand at dosage of 5ml / 5 kg cowpea inside a Donald pan and were placed in jute bag of (55 x 35 cm) size. Permethrin (0.5%) dust was mixed at 2.5g per 5kg grain to give the recommended dosage of 2.5ppm. Another 5kg batch was set up as the untreated control. No insects were introduced into the bags and each treatment bag was arranged on each farm platform in a completely randomized design (CRD). All treatments were replicated four times.

After the treatments, the samples of cowpea were examined at 2,4 and 6 months. One thousand seeds were sampled and sieved inside a bag to separate and retain treatment materials and insects. All bruchid-damaged seeds were counted and the number of emergence holes in each seed was recorded. Each sample was remixed with treatment material removed and returned to the storage bag. All the data in percentage were subjected to angular transformation before ANOVA tests were carried out on the treatments (SAS, 1993) and comparison means separated using Fisher's LSD at P = 0.05.

Damage caused by the emergence of adult bruchids was expressed as percent damage of average number of emergence holes per cowpea, calculated by dividing the total number of holes in a sample by the total number of seeds sampled. This is biologically precise since (with few exceptions) each hole is created by one emerging adult.

Germination: Experiment 2

Germination experiments were carried out bimonthly for the 6 months storage. Seed without visible bruchid damage was selected for planting from cowpea stored on 3 collaborating farms in Ibadan after having been treated with *D. tripetala, P. guineense* essential oil extracts 5ml/5kg seeds and permethrin (0.5%) dust at 2.5ppm respectively. Seed was placed on sterilized moistened sand at a depth of 2.5 cm in Donald trays with four replicates per farm of 100 seeds. Emerged seedlings were counted 8 days after planting, and percentage germination was calculated as: No. of seeds germinated/Total no. of seeds planted x 100.

A second germination experiment was designed to determine the extent of bruchid damage, which constitutes a problem, in terms of loss of germination for the farmer planting, infested cowpea seeds. Six months later seed from untreated (control) cowpeas stored at each farm with the heavy infestation was separated according to number of bruchid emergence holes (0-5) per seed. Four replication of 50 seeds each were planted and evaluated as above to quantify the effect of bruchid damage on seed germination. All the data in percentage were subjected to angular transformation before ANOVA tests were carried out on the treatments (SAS, 1993) and comparison means were separated using Fischer's LSD at P = 0.05.

RESULTS

Damage : Experiment 1

Seed damage on cowpea increased progressively from an initial 5.5% to 7.3% for *D. tripetala* and *P. guineense* oil-treated seeds, 20% for permethrin treated seeds and to 60.5% for untreated control 4 months after treatment for farms 1,2 and 3 (Fig. 1).

Dennettia tripetala essential oil extract reduced damage in cowpea to 10% compared to 12.5%, 43% and 90.1% seed damage recorded in cowpea treated with *P. guineense* essential oil extract, permerthrin dust and untreated control respectively, 6 months after treatment for farms 1, 2, and 3 (Fig. 1).

The final evaluation, 6 months after treatment showed minor differences in *C. maculatus* activity in *D. tripetala* and *P. guineense* oil treated cowpea seed: the damage level of *P. guineense* oil-treated cowpea rose slightly, though insignificantly ($P > 0.05$) above that of *D. tripetala* oil treated seed. Therefore little, bruchid damage was visible and differences among treatments were observable, *D. tripetala* oil being more insecticidally active. Bruchid damage in permethrin treated cowpea remained low for 2 months after treatment but rose with emergence of the third generation of bruchids and increased rapidly with emergence of subsequent generations 4 and 6 months after treatment in farms 1,2 and 3 and was significantly different ($P < 0.05$) from the untreated control which had severe cowpea seed damage 6 months after storage in all the three farms (Fig. 1). There was no significant ($P > 0.05$) location effect on damage.

In evaluating the effectiveness of *D. tripetala., P. guineense* essential oil extracts and permethrin, it was observed that there was need for repeated treatment after 6 months of storage with permethrin, if the treated grains were to be stored longer than period of six months.

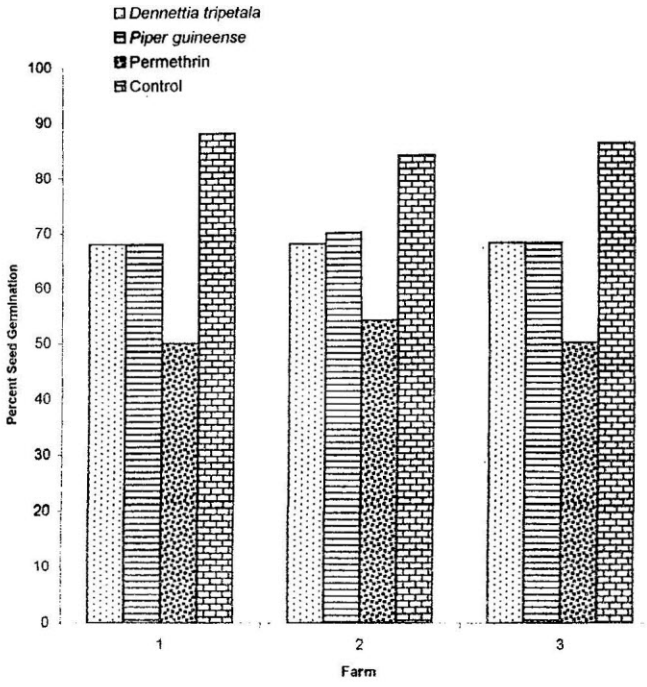

Fig. 1: Percentage seed germination on cowpea treated with *Dennettia tripetala* and *Piper guineense* oils and Permethrin for each farm 6 months after storage

The two essential oil extracts saved a considerable portion of the grain that would have been destroyed if the cowpea had been left untreated and were significantly ($P < 0.05$) more effective than stored cowpea treated with permethrin dust (Fig. 1).

Germination : Experiment 2

Figure 2 illustrates the percentage seed germination on cowpea seeds treated with oils of *D. tripetala., P. guineense* and permethrin dust 6 months after storage for farms 1, 2 and 3. There were no significant differences ($P > 0.05$) among treatments in germination experiments. No treatment changed the quality of cowpea for seed. There was no significant ($P > 0.05$) location effect on germination. Percent germination was high in the three farms. Germination was lowest in cowpea seeds treated with permethrin at the three farms. Germination was highest in untreated control (Fig. 2).

Increasing numbers of bruchid emergence holes per seed resulted in highly significant ($P < 0.05$) reductions in germination. With each additional emergence hole there was a loss of germination (Fig. 3). Reduction in germination of bruchid-damaged seeds was attributed to damage to the embryo. Bruchid-damaged seed may be weakened to such extent that germination fails.

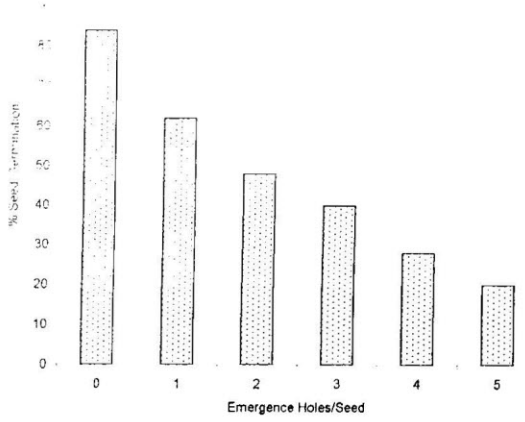

Fig. 2: Germination of untreated cowpea seeds 6 months after storage in relation to number of burchid holes (Farm 1)

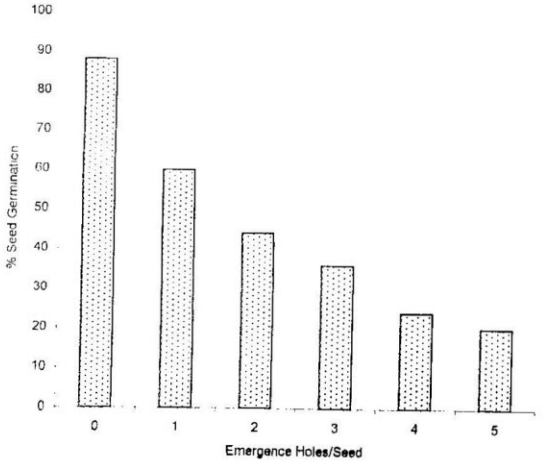

Fig. 3: Germination of untreated cowpea seeds 6 months after storage in relation to number of burchid holes (Farm 2)

DISCUSSION

Dennettia tripetala and *P. guineense* essential oil extracts significantly reduced damage of *C. maculatus*, an effect that has also been observed by Okonkwo and Okoye (1996) who stated that *D. tripetala* and P. *guineense* oils treated with cowpea or maize at 0.3ml / 100g suppressed emergence of F_1 offspring and gave protection for 4 months of storage. The oils afforded protection to stored cowpea against *C. maculatus* infestation. This is also consistent with the observation of Osisiogu and Agbakwuru (1978) where 0.1ml *D. tripetala* 100g cowpea stored for 14 weeks gave complete protection of the grain against damage by *C. maculatus*.

This is also in agreement with Olaifa and Erhun (1988), and Ivbijaro (1990) in their separate experiments who reported that 0.02% oil applied to cowpea completely prevented oviposition by adult *C. maculatus* and that 2ml/kg cowpea seed caused 100% mortality in adult *C. maculatus* within 24h and prevented the emergence of F_1 adults respectively.

Quality of cowpea seeds for consumption or planting was not adversely affected by storage treatments in control of bruchids. Regardless of insect damage, germination decreased with storage time. This study shows that *D. tripetala* or *P. guineense* essential oil extracts may be used to protect stored cowpea against bruchid damage without risk to seed quality, an effect that has also been observed by Osisiogu and Agbakwuru (1978) and Agbakwuru *et al.* (1978) who reported in their experiments that cowpea seeds treated with *Dennettia* oil or β-phenylnitroethane respectively did not affect the viability of the seeds. This is in agreement with Baier and Webster (1992b) who reported in their experiments that there was no significant differences ($P > 0.01$) among the germination of *Phaseolus vulgaris* L. treated with vegetable oil, threshing residue, kitchen ash, Malathion and black pepper 4 months after treatment. They also noted that regardless of insect damage, germination decreased with storage time.

Ivbijaro and Agbaje (1986) reported that cowpea seeds treated with ground, or whole fruits of either *P. guineense* or any of the two *Capsicum* varieties had no effect on the germination potential compared to untreated control. This is also consistent with observation of Schoonhoven (1978) who reported in his experiment that germination of beans treated with African palm and cotton seed oils at 10ml/kg were unaffected and remained equal to Malathion treated beans 6 months after storage. Bruchid-damaged cowpea seed suffered a decline in germination related to each emergence hole. Farmers may plant seeds damaged by up to 2 bruchid emergence holes with only a small reduction in germination. Seed with more than 4 - 5 emergence holes per seed is not recommended for planting. This is in agreement with Baier and Webster (1992b) who observed in their experiments that bruchid damaged bean seed suffered a decline in germination related to each emergence holes, and suggested that farmers may plant seeds damaged by up to 2 bruchid emergence holes with only a small reduction in germination.

All treatments were selected for their potential adoptability, safety, availability and non-toxicity. Cowpea seeds treated with *D. tripetala* and *P. guineense* essential oil extracts remained free of *C. maculatus* damage and in good condition for home consumption, planting, and sale. *D. tripetala* and *P. guineense* oils are recommended for treatment of cowpea intended for all purpose, *P. guineense* being more expensive. Olaifa and Erhun (1988) suggested that the use of volatile oils for control of cowpea seeds is preferred if the production of the

seeds of *P. guineense* can be backed up with industry to produce the volatile oil. They also suggested that the use of essential oil extracts that are volatile oils calls for the establishment of small-scale industry for the extraction of these oils at the village level. As *D. tripetala* and *P. guineense* are produced in Nigeria, the production of their volatile oils is likely to be cheaper than imported essential oils e.g. Jasmine oil.

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