Evaluation of kerosene for the control of *Callosobruchus maculatus* (F.) and *Sitophilus zeamais* (L.) on stored cowpea and maize seeds

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ABSTRACT

Kerosene was evaluated in the laboratory as a protectant of stored cowpea and maize seeds against infestation by *Callosobruchus maculatus* (F.) and *Sitophilus zeamais* L., respectively. The kerosene was applied at the rate of 5 and 10 ml kg^{-1} of cowpea and maize seeds. The results showed that it significantly (P<0.05) reduced oviposition and progeny emergence of *C. maculatus* and *S. zeamais*. In addition, kerosene significantly (P<0.05) depressed the development of *S. zeamais* and, consequently, reduced the mean percentage weight loss in maize. Although kerosene reduced oviposition and progeny emergence in both insects, even at the low dosage of 5 ml kg^{-1}, it did not adversely affect the viability of both seeds after 6 months' storage. Kerosene seems to be a good substance for protecting stored cowpea and maize seeds against *C. maculatus* and *S. zeamais*. Therefore, peasant farmers could be encouraged to use it to store seeds of these two crops.

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RÉSUMÉ

OSEKRE, E. A. & OPOKU-AGYEMAN, M.: *Evaluation de kérosène pour le contrôle de* Callosobruchus maculatus *et* Sitophilus zeamais *sur les graine de dolique et de maïs stockés.* Kérosène était évalué au laboratoire comme un phytoprotecteur des graines de dolique et de maïs stockés contre l'infestation respectivement par *Callosobruchus maculatus* (F.) et *Sitophilus zeamais* L. Le kérosène était appliqué à la proportion de 5 et 10 ml par kg de graines de dolique et de maïs. Les résultats montraient qu'il reduisait considérablement l'oviposition et l'apparition de progéniture de *C. maculatus* et *S. zeamais*. Par conséquence kérosène reduisait considérablement (P< 0.05) le pourcentage moyen de perte de pois en maïs et influençait défavorablement le développement de *S. zeamais*. Malgré que kérosène influençait défavorablement l'oviposition et l'apparition de progéniture en deux insectes, même à faible dose de 5 ml kg^{-1}, il n'a pas influencé défavorablement la viabilité des deux graines après six mois de stockage. Le kérosène est, pour cette raison, une bonne substance pour la protection des graines de dolique et de maïs contre *C. maculatus* et *S. zeamais*, et les petits agriculteurs pourraient être encouragé de stocker les graines de ce deux cultures.

Introduction

Cowpea, *Vigna unguiculata* (L.) Walp, and maize, *Zea mays* L., are two very important staple foods in Ghana and Africa as a whole. In Ghana, cowpea is the legume of choice for many homes, considering the high cost of animal protein; whilst Obeng-Antwi *et al.* (2002) noted that maize is the most important cereal in terms of total production and use in Ghana. These grains are usually stored to provide food reserve as well as seeds for planting, especially by peasant farmers who have to store seeds from their own produce, as they cannot afford certified seeds.

In most developing countries, these grains are subject to attack by many insect species, especially at the small-scale farmer level with usually inadequate storage conditions to prevent or reduce insect attack (Niber Tierto, 1994). Singh & Jackai (1985) reported that farm storage of cowpea for 6 months recorded about 30 per cent loss in weight, with up to 70 per cent seeds being infested and virtually unfit for consumption as a result of the attack by several species of *Callosobruchus*. Maize is also attacked by the maize weevil, *S. zeamais*.

The use of synthetic insecticides still remains the main control measure against these insect pests, in spite of the problems of prohibitive cost, erratic supply, and toxic residue associated with their use. These problems have stimulated interest in finding alternate protection for the seeds, especially for the small-scale farmer. The use of vegetable oils has been identified as one of the alternatives (Mital, 1971; Messina & Renwich, 1983; Don-Pedro, 1989; Murdock *et al.*, 1997). Although these materials are locally available, relatively cheaper, and produce no toxic residues, they have not been used extensively. The attention of scientists has, therefore, been focused on identifying other cheap but equally effective materials that can be used to complement the use of synthetic insecticides. Kerosene is one of the commodities used by some farmers to store cowpea and maize seeds for planting. However, information is unavailable on appropriate dosage, duration within which it is effective (treatment period), and effect on storage insect pests. It is against this background that this study was conducted.

The objective of this study was, therefore, to evaluate the efficacy of kerosene as a protectant of stored cowpea and maize seeds meant for planting.

Materials and methods

Test insects

Samples of *C. maculatus* and *S. zeamais* were collected from cultures growing on cowpea and maize, respectively, maintained in the laboratory at the Plant Genetic Resources Centre (PGRC) at 26 ± 2 °C and 65-70 % r.h.

Test grains

Cowpea and maize seeds were also collected from the seed store of the PGRC, and heat-sterilized (at 60 °C for 4 h).

Grain treatment with kerosene

Kerosene was admixed with the seeds at the rate of 5 and 10 ml kg^{-1} seed, using a glass rod to ensure complete and even coating of the seeds. The treated seeds were put in 1-l plastic containers and five replications were maintained for each treatment. Five separate 1-l plastic containers containing 1 kg of either grains, which had not been treated with kerosene, were also maintained as control. Five pairs of up to 1-day-old adults of *C. maculatus* were put into each of the plastic containers containing test cowpea seeds. Ten adults of *S. zeamais* were also placed in each of similar plastic containers with the maize seeds. These were maintained for 6 months in the same laboratory.

For the effect of kerosene on oviposition, five batches of 5-g kerosene-treated cowpea seeds for each dosage level were put in Petri dishes (88 mm diameter × 14 mm high). Three pairs of up to 1-day-old adults of *C. maculatus* were put into each of the jars. For the control, three pairs of up to 1-day-old adults were put into each of five Petri dishes containing 5 g of untreated cowpea seeds. After 8 days, the seeds in each Petri dish were picked individually and the egg cases counted. All the insects in each Petri dish were removed and destroyed.

This experimental set-up was maintained for 35 days after which emerged adults (dead and alive) in each Petri dish were counted.

The viability of the seeds was determined by placing samples of the treated and untreated seeds separately on moist Whatman No. 1 filter paper (9 cm diameter) in glass Petri dishes (10 cm diameter). The number of germinated seeds in each case was recorded 5 days after the treatment. Percentage weight loss of the maize seeds was determined by the Thousand Grain Mass (TGM) method:

$$\% \text{ wt loss} = \frac{(\text{Initial TGM} - \text{Sample TGM})}{(\text{Initial TGM})} \times 100$$

where TGM = mass of a thousand sample seeds
Wt = weight

The data were subjected to analysis of variance, and Fisher's protected Least Significant Difference (LSD) was used to compare means.

Results

Table 1 shows the effect of treatment on oviposition and progeny emergence. The differences between the effects of the two dosage levels of kerosene on oviposition and F1 progeny of *C. maculatus* were not significant. However, significant differences were observed between the two dosage levels and the control. The total number of eggs laid in the untreated control was 308, whilst only six and three were laid in the 5 and 10 ml kg^{-1} kerosene-treated cowpea seeds, respectively. Kerosene caused over 98 per cent reduction in oviposition in the treated seeds. No F1 progeny emergence was recorded in the treated seeds. It was also observed that whilst seeds in the control treatment were mouldy by the 4th month, no mouldiness was observed in the kerosene-treated seeds throughout the experiment.

Fig. 1 shows the mean weight loss of the maize seeds over the period. A marked reduction was observed in the damage caused by *S. zeamais* in the kerosene-treated seeds, as reflected in the reduction in the weight loss of the seeds. By the 5th month, the reduction in weight loss of the untreated seeds was 43.40 per cent, as compared to 1.36 and 0.71 per cent in the 5 and 10 ml kg^{-1} treatments, respectively.

Damage to the untreated seeds was so much that it was difficult to assess the percentage weight

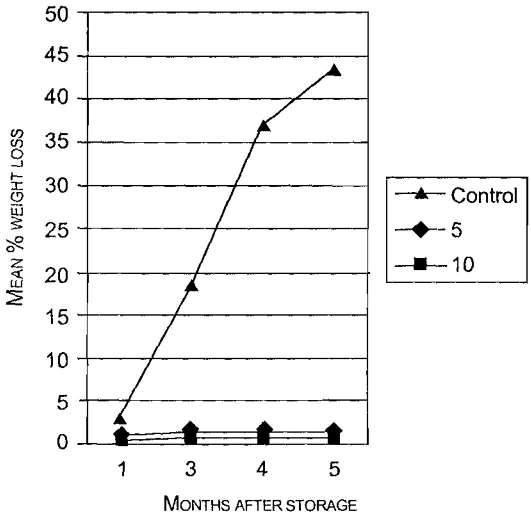

Fig. 1. Mean percent weight loss in kerosene-treated maize seeds stored for 6 months.

TABLE 1

Number of Eggs Laid and Number of Offsprings (F1 Progeny) in C. maculatus *under Different Kerosene Treatments*

Treatment ($ml\ kg^{-1}$)	*Total number of eggs laid*	*% reduction in oviposition*	*Total number of F1 progeny*	*% reduction in F1 progeny*
Control	308 ± 0.53[a]	-	276 ± 0.67[a]	-
5	6 ± 0.12[b]	98.1± 0.17[a]	0 ± 0.00[b]	100 ± 0.00[a]
10	3 ± 0.15[b]	99.3 ± 0.13[a]	0 ± 0.00[b]	100 ± 0.00[a]

Means followed by the same letter in the same column are not significantly different at the 5 % level.

loss in the 6th month. Table 2 also shows the percentage viability of the seeds treated with the two dosage levels and the effect of kerosene on progeny emergence. Kerosene stopped the development of *S. zeamais* such that no new adults were added to the original population introduced. The two kerosene treatments did not reduce the viability of the grains.

TABLE 2

Percent Viability of Kerosene-treated Cowpea and Maize Seeds and the Mean Number of S. zeamais *on Treated Maize Seeds After 6 Months*

Treatment ($ml\ kg^{-1}$)	*% viability 6 months after treatment*		*Mean number of insects after 6 months' storage*
	Maize	*Cowpea*	*Maize*
Control	0 (95)	0 (92)	505 ± 0.97^a
5	87 (95)	89 (92)	10 ± 0.00^b
10	90 (95)	85 (92)	10 ± 0.00^b

Figures in bracket are the percent viability at the beginning of the experiment. Means followed by the same letter are not significantly different at the 5 % level.

Discussion

This study has shown that kerosene is effective in controlling *C. maculatus* and *S. zeamais*, killing the adults and preventing further development and occlusion of their eggs deposited on the treated materials. The action of kerosene in reducing oviposition and progeny emergence of *C. maculatus* and *S. zeamais* may be similar to that of applying oils for similar purposes. One reason why the females laid fewer eggs could be that they found it difficult to stick the eggs to the grains, because the coating of kerosene was an unsuitable surface for sticking eggs to grains. Singh *et al.* (1978) offered a similar reason for the action of oils in reducing oviposition in *C. maculatus*.

The reason for the reduction or prevention of progeny emergence could be that kerosene was toxic or caused osmotic tension and, consequently, coagulation of protoplasm and mortality of eggs. Mital (1971), Su *et al.* (1972), Singh *et al.* (1978), Messina & Renwich (1983), and Don-Pedro (1989) offered a similar explanation for the action of oils as grain protectant.

A mean of 505 insects after 6 months' storage in the control, as compared to the 10 insects in the treated seeds, showed that egg and larval development of both pests were also adversely affected.

Conclusion

The results of the study have shown that the cowpea beetle, *C. maculatus,* and maize weevil, *S. zeamais,* can be effectively controlled by mixing 5 ml of kerosene with 1 kg of each seed type for 6 months. It should, however, be noted that seeds should be thoroughly and evenly coated with kerosene to ensure good protection. The very high percentage viability of both seeds after kerosene treatment and storage for 6 months makes kerosene a very good alternative to conventional insecticides for protecting maize and cowpea seeds. It should, therefore, be promoted for adoption by peasant farmers.

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