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RESEARCH ARTICLE

EFFICACY OF *PLUMERIARUBRA* POWDERS FOR THE CONTROL OF BRUCHID BEETLES DURING STORAGE

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ABSTRACT

The present research was conducted to evaluate the efficacy of *Plumeriarubra* products on bruchid beetles (*Callosobruchusmaculatus* (F)) during storage. A synthetic insecticide, Pirimiphos methyl and four *Plumeriarubra*products (leaf, stem bark, root bark and flower) powders were tested on cowpea (*Vignaunguiculata*) seeds infested with teneral adults of *Callosobruchusmaculatus* in a completely randomized design. Data were collected on mean number of eggs laid, mean eclosion, mean number of emerged adults, and mortality of insects at different treatments. The results obtained revealed significant ($P \leq 0.05$) differences in the mean oviposition rate, mean eclosion and total developmental period of the insects treated with different products of *Plumeriarubra*. The highest number of eggs oviposited and ecloded were 85.4 and 81. 6 respectively, which were significantly different when compared with the values of 43.2 and 40.2 obtained when the root bark powder was applied. The total developmental period obtained for the cowpea weevils ranged from 16 – 23 days. No plant product matched the efficacy of Pirimiphos-methyl; however, the powder of *Plumeriarubra* flower showed good potential as insecticide for the control of cowpea weevil (*Callosobruchusmaculatus*) on cowpea (*Vignaunguiculata*) during storage.

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INTRODUCTION

Cowpea (*Vignaunguiculata* (L) Walp) is regarded as a popular and important indigenous African legume crop by many rural communities living in less developed countries of the tropical and subtropical Africa. It is grown as pulse, vegetable, fodder and cover crop (Ushamalini *et al*., 1998). Cowpea is a warm weather crop and grows best in areas where the minimum and maximum temperatures are about 24 and 37 ^{0}C respectively in any growing season. It is mainly consumed as a favourite foodstuff in the form of dried seeds either as flour or slit (Johnson and Raymond, 1964; Whyic and Gericke, 2000). It is a good source of carbohydrate, vitamins and protein, providing more than half of plant protein in human diets in some areas of the semiarid tropics (Singh *et al*., 1997). Ogunwolu (1991) reported that cowpea grains could be stored in silos, cribs, rhombus, steel drums, earthenware, pots, plastic or gourds. The several practices followed in cowpea storage exploits three factors namely; temperature, oxygen and mobility to reduce insect infestation. Mobility of insect is restricted by packing grains tightly in storage container and by admixing wood ash or sand with grains. Hermetic scaling of storage container prevents replenishment of oxygen to insects, thereby increasing mortality rate (Anda and Anda, 2002). The cowpea weevil (*Callosobruchusmaculatus* (Fabricius)) is the most important storage pest of cowpea throughout the tropics (El-Sawaf, 1954; Oliveira and Santos, 1983; Oliveira *et al*., 1984; Caswell, 1981). In Nigeria alone, yield losses caused by this pest in storage are estimated at US$ 30 million each year (Caswell, 1973). Infestation often occurs in the field when pods are near maturity (Adenekan, 2002). Eggs are laid on the pods, but weevils prefer to enter inside of pods through holes made by other pests and lay eggs directly on the seed (Wasserman, 1985). Damaged seeds have reduced weight, low viability and poor marketability. A female bruchid beetle deposits about 120 eggs over a period of 7 days. Wasserman (1985) stated that about 40 % of the total numbers of eggs are laid in the first day of life. The eggs are glossy, ovoid in shape, firmly glued to the testa of seeds and hatch in about 3 – 5 days. The colour is pinkish when freshly laid, but turns milky white after eclosion (Adenekan *et al*., 2013). Several reports on the biology and damages of *C. maculatus* have been made on cowpea seeds, its supposedly principal host (Ofuya, 1987;

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Giga and Smith, 1983; Dick and Credland, 1984). It was reported that the beetle completes its holometabolous developmental period (from egg – adult) in 21 days and there are four larval instars in the development of the insects when reared on cowpea seeds (Adenekan, 2006; Owusu-Akyaw, 1987).

Plumeriarubra, otherwise known as temple or pagoda tree belongs to the family Apocynaceae, which comprises of several genera and species. Many members of this family have alkaloids which have insecticidal properties that could be used as seed protectant against infestation of storage pests. Plant derivatives have recently become of great interest owing to their versatile application (Bariset *et al*., 2006). Natural plant products are biodegradable and may provide structure which lead for pesticidal discovery (Duke *et al*., 2000). There has been growing interest in the use of natural plant products, bio-insecticides for the protection of agricultural commodities due to their low mammalian and vertebrate's toxicity and low persistence in the environment, no undesirable effects on animals and human beings (Raja *et al*., 2001); however, the use of synthetic chemicals in pest control is eliciting much concern owing to the undesirable side effects emanating from their usage (Tovignan *et al*., 2001). Emphasis in recent times has been laid on non-chemical strategies to protecting stored produce and human environment. Plant materials were reported to be effective, cheap and easily available for the control of stored product pests (Onifade and Alabi, 1998). Akinwumi *et al*. (2007) have reported the efficacy of several plant products against the control of insect pests of agricultural importance; therefore, efforts are hereby made to evaluate the insecticidal properties of *Plumeriarubra* powders for the control of cowpea weevils during storage.

MATERIALS AND METHODS

The plant products tested for insecticidal activities were collected from growing stands of *Plumeriarubra* in Ibadan, Oyo State a month before the commencement of the study. The leaves, stem bark, root bark and flowers of the plant were separately collected. They were rinsed and dried at laboratory temperature of 25 – 27 ^{0}C under shed, then ground separately to fine powders using an electric blender and kept in dry bottles in the laboratory until needed for the experiment. The source of cowpea weevils used in this investigation was laboratory-cultures established and maintained in 2016 as described by Adenekan (2002). The study was carried out in the Entomology Laboratory of the Federal College of Agriculture, Ibadan under ambient temperature conditions (23 – 30 ^{0}C) and relative humidity (50 – 85 %). Untreated Ife Brown variety of cowpea seeds used in this study was obtained from the International Institute for Tropical Agriculture, Ibadan. After sorting and cleaning, seeds of similar sizes were selected and kept in the refrigerator until they were needed for the experiment so as to prevent weevil infestation. The untreated cowpea seeds kept in the refrigerator were taken out and allowed to acclimatize for twenty four hours under ambient laboratory condition before being used. Thirty (30) grams of seeds were placed in each petri dish arranged in four groups. There were six treatments replicated four times each. The treatments were powders of leaf, stem bark, root bark and flower of *Plumeriarubra*, Pirimiphos-methyl and untreated cowpea seeds which served as the control experiment. The plant product powders were applied at the rate of 25 g per kilogram of cowpea seeds. Pirimiphos-methyl was applied according to the manufacturer's recommendation (0.2 g kg^{-1}) to serve as a standard check.

Five (5) virgin males and females (teneral adults) stage of *C. maculates* were introduced and confined in each petri dish for ten days. The petri dishes were arranged in completely randomized design each group containing six treatments with the control experiment was set aside in the laboratory for ten days before data collection commenced. The weevils were left to mate and oviposit on the seeds. Total number of eggs oviposited, ecloded and numbers of adults that emerged from each treatment were recorded and analyzed using analysis of variance (ANOVA), while treatment means were separated with the least significant difference (LSD) at 5 % level of significance. The percentage of seed perforations and the total developmental period as well as mortality of insects under each treatment were observed and recorded.

RESULTS AND DISCUSSION

The results of the efficacy of *Plumeriarubra* powders and Pirimiphos-methyl on the oviposition, eclosion, mortality and mean number of adult emergence of weevils on cowpea seeds at storage were presented in Table 1. There were significant differences among cowpea weevils treated with different powders of *Plumeriarubra* ($P \leq 0.05$). All the weevils treated with Pirimiphos-methyl died within two hours when the insects were introduced. The beetles exposed to seeds treated with *Plumeriarubra* powder products survived at various levels to periods of adult emergence (Table 1). The mean number of eggs of 12.1 ± 2.4 laid on cowpea seeds obtained when the flower powder was applied was significantly ($P \leq 0.05$) different from the mean number of eggs of 43.2 ± 2.8, 69.3 ± 3.6 and 63.4 ± 2.1 obtained when the root bark, stem bark and leaf powder products were applied respectively (Table 1). However, there was no oviposition on seeds treated with Pirimiphos-methyl while the leaf and stem bark powders of *Plumeriarubra* treatments were able to significantly reduce oviposition of the beetles in comparison with the control. The highest mean number of eggs ecloded and percentage of adult emergence at the control experiment were 81.6 and 84.3 respectively, which significantly reduced when compared with values obtained in other treatments where *Plumeriarubra* powder products were applied (Table 1). The damage to seeds protected with leaf and flower powders of *Plumeriarubra* were minimal as compared with the damage done which was high when no treatment was applied (Table 2).

Table 1. Effect of *P. rubra* products and Pirimiphos-methyl on the oviposition, eclosion and mortality of weevils (*C. maculatus*) on cowpea seeds

Treatment	Mean no. of eggs laid (± SE)	Mean no. of eggs ecloded (± SE)	Mean no. of dead weevils (mortality) (± SE)	Mean % of emerged adult)
P. rubra powder				
products	63.4 ± 2.1	41.6 ± 3.1	3.4 ± 1.1	56.6
Leaf	69.8 ± 3.6	60.4 ± 2.5	1.7 ± 0.4	54.3
Stem bark	43.2 ± 2.8	40.2 ± 4.3	4.5 ± 1.7	50.8
Root bark	12.1 ± 2.4	4.3 ± 1.3	8.6 ± 1.9	22.4
Flower	0.0	0.0	10.0	0.0
*Pirimiphos-	85.4 ± 4.2	81.6 ± 2.7	2.9	84.3
methyl	10.8	7.4	2.5	-
Control				
$LSD_{(0.05)}$				

n = 10 (teneral adults of the bruchid beetle) *Standard Check

Table 2. Efficacy of *P. rubra* products and Pirimiphos-methyl on seed perforation and developmental periods of cowpea weevils

Treatment	Seed perforation (%)	Mean no. of holes/seed	Total developmental period (day)
P. rubra powder products			
Leaf	20.2	0.5	20
Stem bark	32.6	0.6	18
Root bark	10.4	1.4	21
Flower	4.3	0.1	16
*Pirimiphos-methyl	0.0	0.0	-
Control	42.3	2.6	23
$LSD_{(0.05)}$	11.4	0.4	-

Standard Check

Pirimiphos-methyl, a synthetic insecticide is used for prevention of storage wastages in Nigeria and its performance in this experiment confirms the assertion of Singh (1989) who reported that for long term grain storage, synthetic insecticides should be sensibly and judiciously applied so as to prevent insect infestation. The results presented in Table 2 revealed that percentage seed perforation and mean number of holes per seed caused by cowpea weevils were significant at 0.05 level of significance. The lowest seed perforation of 4.3 % and mean number of holes (0.1) was obtained when flower powder of *P. rubra* was applied, indicating that *P. rubra* could be used as a perfect substitute to synthetic insecticides. Total developmental period of 16 days was recorded at the treatment where the flower powder of *P. rubra* was applied, while the highest developmental period of 23 days was observed in the control experiment where no plant product was applied. This result agrees with Adenekan (2001) who reported that the developmental period obtained for *C. maculatus* was 23 days when reared on cowpea seeds at ambient temperature conditions. There was no significant difference in the mean number of holes of 0.5 and 0.6 obtained when the powders of leaf and stem bark powders were applied respectively, but was significantly different with 2.6 obtained at the control experiment where no plant product powder was applied.

There is increasing emphasis on mammalian toxicity and environmental pollution carried by the abuse of using synthetic insecticides for storing grains, most especially legumes. The results of this trial unequivocally showed that the powder from the flowers of *P. rubra* has higher potential for controlling cowpea weevils during storage. It is therefore recommended that in order to reduce the adverse effect of synthetic insecticides in human being and the environment, *P. rubra* flower powder product should be adopted by indigenous farmers in storing cowpea grains.

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