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Evaluation of Some Paddy Rice Products as Anti-Ovipositant against *Callosobruchus maculatus* Fabricius. (Coleoptera: Chrysomelidae)

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ABSTRACT

Under laboratory conditions (28 ± 3ºC and 65 ± 5% RH) in Akure, Nigeria, rice husk powder, Rice husk ash and rice grain powders were tested separately as anti-ovipositant against freshly emerged adults of Callosobruchus maculatus. The powders and ash were applied at the rates of 0.4, 0.6, 0.8 and 1.0g per 20g of cowpea seeds in small plastic containers with tight fitted lids. Each container was shaken such that each powder made contact with the seeds and 2 pairs of insects. The eggs of C. maculatus were counted at once after 14 days of insect infestation. Experimental findings indicated that paddy product treatment significantly inhibited oviposition against C. maculatus as compared to untreated seeds. Number of eggs laid by C. maculatus on the seeds dereased with increasing rates of rice husk ash, rice husk powder and rice grain powder respectively. At the highest rate of application of 1.0g of paddy products per 20g of cowpea seed, oviposition by C. maculatus was reduced by more than 50% in comparison with the control. Rice husk ash recorded the lowest oviposition by C. maculatus, followed closely by rice husk powder and rice grain powder

Key words: *Callosobruchus maculatus*, oviposition, paddy rice product and anti-ovipositant

INTRODUCTION

The cosmopolitan pest of cowpea seeds in storage, *Callosobruchus maculatus* (F.) is of economic importance, as bruchids infestation often results in dry weight loss, reduction in nutritional value or physical quality and poor seed germinability (Ofuya, 2001). Uncontrolled infestation of legume seeds in storage by *C. maculatus* often results in very serious depredation, making infested seeds unfit for human consumption and farmers and traders incur great financial losses (Ogunkoya and Ofuya, 2001). In order to reduce the huge losses that can result from uncontrolled infestation and damage to stored cowpea by *C. maculatus*, synthetic insecticides such as pirimiphos-methyl and aluminium phosphide have been effectively deployed by farmers and traders in developing countries (Lale, 2010; Idoko and Adebayo, 2011; Idoko and Adesina 2012, Magaji *et al*., 2012). However, use of chemical pesticides for stored products protection worldwide have become fraught with problems including genetic resistance of pest species, toxic residues on treated stored products, increasing cost of application and hazards from handling (Isman, 2006). Many insecticidal active plants have been investigated as alternative source of safer and more available and affordable stored products protection materials against *C. maculatus* but with varying degrees of success (Boeke *et al*., 2001). Botanical insecticides, therefore, continue to receive increased attention for use as safe and effective protectant of stored grains against insect pest infestation and damage (Ofuya and salami, 2002; Ngamo *et al*., 2007). A prominent mechanism by which plant materials reduce damage to stored cowpea seeds by *C. maculatus* is inhibition of oviposition (Boeke *et al*., 2001; Lale, 2010). This study was undertaken to compare the anti-oviposition effect of products from paddy rice including husk powder, husk ash and grain powder against *C. maculatus* on cowpea seeds and the effective rate at which rice paddy products will deter oviposition by *C. maculatus*.

MATERIALS AND METHODS

Insect Culture

C. maculatus was cultured in Kilner jars with meshed lids throughout the period of the study in the Crop, Soil and Pest Management Research Laboratory of the Federal University of Technology, Akure, Nigeria. Seed beetles were cultured using standard methods (Ofuya and Credland 1995). Oloyin Type 1, a susceptible cowpea cultivar, was used for culturing of *C. maculatus*, which also served as the substrate for all the treatments throughout the duration of the experiment. Cowpea seeds to be used for the experiment were disinfested by deep-freezing them for 2 weeks and were later acclimatized in the laboratory conditions (temperature, 28 ± 3ºC and 65 ± 5% RH).

Preparation of Paddy Rice Product

Paddy husk of Igbemo local rice variety was obtained from a rice processing mill in Emure-Ekiti in Ekiti State, Nigeria. Igbemo local rice grain was also purchased from local market in Emure-Ekiti, Nigeria. Paddy husk and rice grain were each pulverized separately in an electric blender into a fine powder. Part of the paddy husk was ashed (converted to ash) in electric furnace. The ash and each of the powder type (approximately 50g) was kept in a separate plastic container with tight fitted lids prior to the period of the experiment

Effects of Paddy Rice Products on Oviposition of C. maculatus

Rice husk powder, rice husk ash and rice grain powder were tested separately as anti-ovipositants against *C. maculatus* at different application rates of 0.4, 0.6, 0.8 and 1.0g per 20g of cowpea seeds in a small plastic container with tight fitted lids. With each paddy product and rate of application, two males and two females of freshly emerged adults of *C. maculatus* were used to infest cowpea seeds in the container. Each container was shaken such that the powder made contact with the seeds and insects. There was also a control treatment in which the cowpea seeds and insects were not exposed to the paddy products. Each treatment, including the control was replicated four times. Fourteen days after the application of treatments, the number of *C. maculatus* eggs on the cowpea seed in each replicate was counted once and recorded

Data Analysis

The treatments were laid in completely randomized experimental design. To correct for the violation of the assumptions of Analysis of Variance (ANOVA) due to count data, eggs count data were square root transformed. Data were subjected to analysis of variance (ANOVA) to test for significant difference due to treatment as well as due to rate of application. Where the ANOVA test indicated significant differences between treatments, Tukey's Honestly Significant Difference Test was used to separate treatment means.

RESULTS

The results of the anti-oviposition effects of products from paddy rice against *C. maculatus* are shown in Figures 1 – 5. Using rice husk powder as anti-ovipositant, the number of eggs laid by *C. maculatus* on cowpea seeds decreased significantly with increase in the rate of application (Fig. 1). The highest mean number of eggs (111.3) was laid by *C. maculatus* on cowpea seeds that were untreated i.e. control treatment. The lowest mean number of eggs (46.0) was laid on cowpea seeds treated with rice husk powder at the application rate of 1.0g. With the rice grain powder as an anti-ovipositant, the number of eggs laid by *C. maculatus* on cowpea seeds also decreased significantly with increase in the rate of application (Fig. 2).

The highest number of eggs (120.8) was laid by *C. maculatus* on cowpea seeds that were untreated. The lowest mean number of eggs laid (51.8) was laid on cowpea seeds subjected to 1.0g of rice grain powder. The number of eggs laid by *C. maculatus* on cowpea seeds similarly decreased significantly with increase in the rate of application of rice husk ash (Fig. 3). The highest mean number of eggs (103.0) was laid by *C. maculatus* on cowpea seeds that were not treated. The lowest men number of eggs (45.5) was laid on cowpea seeds that were treated with 1.0g of paddy husk ash. Irrespective of the rate of application, the lowest mean number of eggs (73.1) was laid by *C. maculatus* on cowpea seeds treated with rice husk ash, which was significantly lower than the number of eggs (84.5) laid by the beetle on

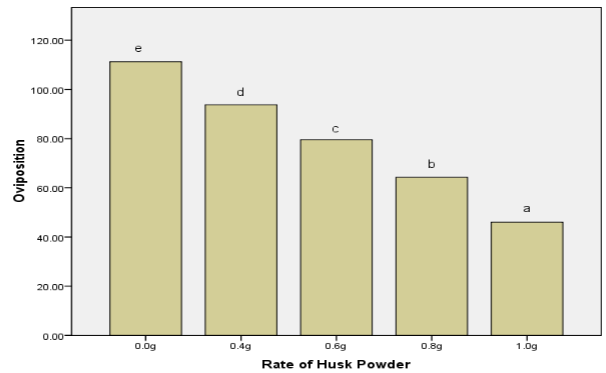

Figure 1: Mean oviposition by *C. maculatus* on cowpea seed treated with rice husk powder at different rates of application. (values bearing different letters are significantly different, P<0.05).

seeds treated with rice grain powder (Fig. 4). Also, irrespective of the kind of paddy rice product, the number of eggs laid by *C. maculatus* on cowpea seeds decreased significantly with increase in the rate of application of product (Fig. 5). The highest mean number of eggs (111.7) was laid by *C. maculatus* on cowpea seeds that were untreated (i.e. control). The lowest mean number of eggs (47.8) was laid on cowpea seeds that were treated with 1.0g of paddy rice product.

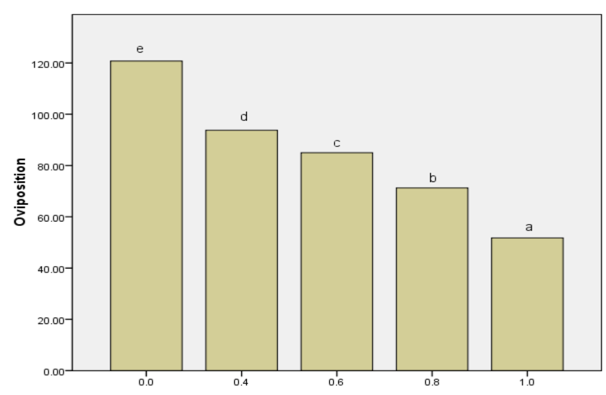

Figure 2: Mean Oviposition by *C. maculatus* on cowpea seeds treated with rice grain powder at different rates of application. (values bearing different letters are significantly different, P<0.05).

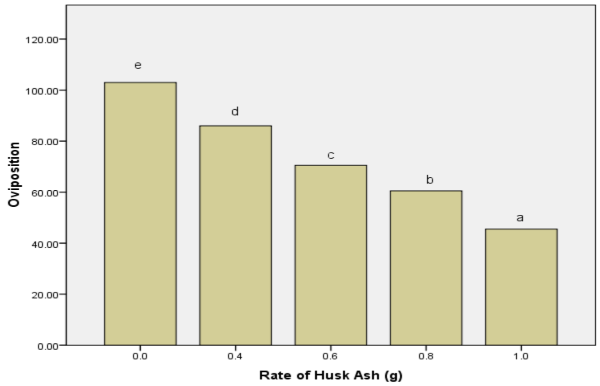

Figure 3: Mean oviposition by *C. maculatus* on cowpea seeds treated with rice husk ash at different rates of application. (values bearing different letters are significantly different, P<0.05).

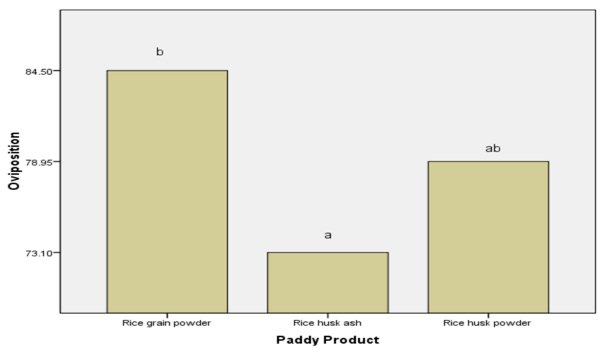

Figure 4: Mean oviposition by *C. maculatus* on cowpea seed treated with different paddy products irrespective of rate of application. (values bearing different letters are significantly different, P<0.05).

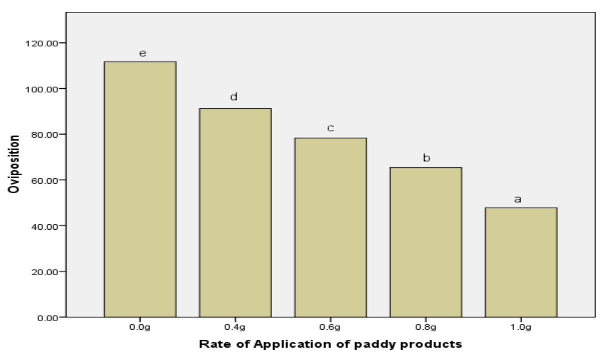

Figure 5: Mean oviposition by *C. maculatus* on cowpea seeds treated with different application rates irrespective of the paddy product. (values bearing different letters are significantly different, P<0.05).

DISCUSSION

Several scientists, who have studied the use of botanical materials in preventing or reducing depredation of cowpea seeds in storage by *C. maculatus* have indicated that efficacious materials adversely affect the beetle thereby preventing the full expression of its oviposition potential (Boeke *et al*., 2001; Ofuya, 2001; Lale, 2010). The results of this study showed that rice husk powder, rice husk ash and rice grain powder significantly prevented oviposition of *C. maculatus*. Significantly lower number of eggs were laid, at all rates of applications tested, by the beetle on cowpea seeds protected using any of the three paddy products compared with that laid on the control treatment. However, Rice husk ash was observed to be the most effective anti-ovipositant. Reduced oviposition caused by the paddy husk ash will result in fewer adult emergence and consequently lower seed damage when used for protecting cowpea seeds in storage. Using paddy husk powder, paddy husk ash or rice grain powder as anti-ovipositant, the number of eggs laid by *C. maculatus* on cowpea seeds decreased significantly with increased rate of application. At the highest rate of application of 1.0g of paddy product per 20g of cowpea seed, oviposition by *C. maculatus* was reduced by more than 50% in comparison with the control treatment. Umar (2008) obtained results which showed that at the rate of 2.0 g per 20g of seeds, the leaf power of *Jatrohpa curcas* reduced oviposition by 30% compared to the control treatment while studying the potential of leaf, bark and wood powder of *J. curcas* as protectants of stored cowpea against *C. maculatus*. Maina *et al*. (2012) also reported significantly reduced bruchids oviposition and number of F_1 adult emergence from pulses treated, especially at higher dosage (i.e. 0.06g or 0.08g per10g of seed) of bio-nimbecidine botanical powders in comparison with the control. Similar reports has been given by many other research workers on the insecticidal activity of some other pulverized plant products against *C. maculatus* (Boeke *et al*., 2001; Ofuya and Salami, 2002; Opareke and Dike, 2005; Ofuya *et al*., 2007). This is usually ascribed to increasing amount of the insecticidal active materials or active ingredients with increasing rate of application thereby producing great insecticidal effect (Pedigo and Rice, 2009; Gullan and Cranston, 2010). The paddy products investigated as anti-ovipositant in this study did not completely prevent oviposition by *C. maculatus* on cowpea seeds. However, the results indicate that paddy husk powder, paddy husk ash and rice grain powder manifested anti-oviposition activity against the beetle. It is probable that a much higher rate of application of paddy products for the protection of cowpea in storage may render the seeds immune to *C. maculatus* attack. This requires further empirical verification.

Oviposition deterrence activity of insecticidal botanical powders against *C. maculatus* has been partly attributed to their chemical constituents (Boeke *et al*., 2001; Lale 2010) as well as specific physical or mechanical mechanisms (Ofuya, 2003). Silica and Silicon are often found to be the bioactive constituents of Rice husk powder and rice husk ash (Kalapathy *et al*., 2000; Ajayi *et al*., 2012), it may therefore be postulated that that the silica and silicon may just have weakened the exposed adults through dehydraton and the abbreviated life span made it impossible for expression of the oviposition potential. Pulverized botanicals may also physically impede insect movement and hinder mating and thus, oviposition (Wolfson *et al*., 1991). This may be an unlikely mechanism of action in this study because at the highest rate of application of the paddy product (1.0 g/20g of seeds) there was plenty of room between seeds for beetle movement and activities.

The results from this study show that rice husk powder and rice husk ash may have direct potential use in the control of storage insect pests. This study has also shown that oviposition by *C. maculatus* differ significantly with paddy products. Rice husk ash recorded the lowest oviposition by *C. maculatus*, followed closely by rice husk powder and lastly by rice grain powder. Significantly higher mean number of bruchids eggs laid on untreated seeds compared to treated cowpea grains indicated that rice husk can effectively deter oviposition by *C. maculatus*. This effect is however dependent on the dosage used, as it has already been pointed out in this study that increase in the dosage of paddy products progressively reduced oviposition. Mean oviposition of 111.67, 91.17, 78.33, 65.33, and 47.75 was recorded for 0.0g, 0.4g, 0.6g 0.8g and 1.0g of rice husk ash, rice, husk powder and grain powder espectively. Maina *et al*., (2012) opined that reduced bruchids oviposition and the number of F1 adults emerged from pulses treated, especially with higher dosages (0.06g or 0.08g per 10 g of seeds) of Bio-nimbecidine botanical powder, than from untreated ones, must have contributed to the lowering of mean severity of damage to these pulses. Also, Umar (2008) obtained results which showed that at the rate of 2.0g per 20g of seeds, the leaf powder of *J. curcas* reduced oviposition by 30% compared to the control treatment. In majority of rice producing countries like Nigeria, much of the husk produced from processing of rice is either burnt or dumped as waste, posing a great environmental threat (Ajayi *et al*., 2012). Commercial use of rice husk and its ash as anti-ovipositant against *C. maculatus* is undoubtedly an alternative solution to the disposal problem.

CONCLUSION

Results obtained from this study have shown that number of eggs laid by *C. maculatus* on the cowpea seeds decreased with increasing rates of paddy rice products. The rice husk powder, rice husk and rice grain powder are active as natural products from plant which serve as an alternative to conventional insecticides effective for the control of *C. maculatus*. Observation from the study also shows that rice husk ash at 1.0g can be used for effective control of oviposition, which is a major determinant of adult emergence by *C. maculatus.*

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