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Bioecological studied and control of pulse beetle *Callasobruchus chinensis* (Coleoptera : Bruchidae) on cowpea seeds

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ABSTRACT

A laboratory experiment was conducted to investigate the insecticidal activities of seven plant materials namely: citrus leaf powder (CLP), Acacia leaf powder (ALP), Occimum leaf powder (OLP), mahogany bark powder (MBP), hot pepper powder (HPP), ginger powder (GP) and mahogany wood ash (MWA); and a synthetic insecticide, pirimiphos-methyl dust (PMD) as check. The objective of the study was to investigate the comparative efficacy of the plant materials and PMD in the suppression of Callosobruchus chinensis. developmental durations and damage in cowpea seeds. Plant materials were evaluated at 1 g/20 g cowpea seeds (0.1 g PMD/20 g cowpea seeds). The experiment was laid out in a completely randomized design replicated four times. The results showed that MWA was more effective in causing adult C. chinensis s mortality, but CLP was significantly (P<0.05) more effective in reducing adult emergence, percentage hatching inhibition rate and per cent holed cowpea seeds. There were no significant differences among treatments on number of eggs lai d and developmental durations of C. chinensis s. Application of CLP at the rate of 50 g/kg of cowpea seeds is therefore be recommended for the control of C. chinensis development and damage to cowpea seeds while in storage.

Key words: *Callobruchus chinensis*, Bruchid, Storage pest.

INTRODUCTION

The growth of agriculture based economies of world depend on the sustained supply of quality seed. Thus, it becomes essential to protect the seed from insect pests during storage. Synthetic organic insecticides have played a major role in pest control. However, their increasing use in recent years has created a range of ecological problems such as bio-magnification, resurgence and the development of insecticide tolerant strains of pest species.Insect pests have been reported to be the single most important constraint to cowpea production in most parts of India (Booker, 1965; Jackai and Daoust, 1986; Singh *et al*., 1990; Karungi *et al*., 1999) accounting for the low annual harvest of the crop. Two bruchid, *Bruchidius atrolineatus* and *Callosobruchus chinensis* have been reported to be the most economically important insect pest species attacking stored cowpea in the sahelian zone of West Africa (Huignard *et al*.,1985). *C. maculatus* alone accounts for over 90% of the damage done to store cowpea seeds by insects (Caswell, 1981). Infestation of stored cowpea by *C. chinensis* usually starts in the field before harvest, with the pest being carried into the stores. In Rajasthan, it has been estimated that as much as 10% of the cowpea crop may be damaged before it goes into storage and the infestation builds up rapidly. After about 8–9 months, losses may be as high as 87% in shelled and 32% in unshelled cowpea. Singh (1977) reported 100% loss of cowpea by *C. chinensis* within 3–5 months of storage. Farmers have been reported using banned and highly toxic chemical insecticides in their quest to protect their agricultural products, including stored cowpea seeds against insect pests. Some of the known side effects of using chemical insecticides include increased costs, handling hazards, residue problems and development of tolerance by treated insects (Banks *et al*., 1990). Therefore, control of storage insect pests using fumigants or residual insecticides should be discouraged (van Huis, 1991), and this necessitated the search for alternative sources for the containment of storage insect pests (Dike and Mshelia, 1997; Yusuf *et al*., 1998). In other words, an option that can produce satisfactory result in an acceptable and feasible manner to the farmers is necessary to achieve the desired goal. For now, the use of plant products appears to hold the greatest hope for increased cowpea production. There is a lot of traditional local knowledge on the use of plant materials in storage protection. Some of this knowledge has been neglected over past decades. However, there is an increasing interest and necessity to re-visit such knowledge (Stoll, 2000). This research was therefore, designed to study the effect of seven plant products and a synthetic pesticide on the control of *C. maculatus* and suppression of its developmental durations in stores cowpea seeds.

MATERIALS AND METHODS

Preparation of cowpea seeds

Cowpea seed (*Vigna unguiculata*) was fumigated for 24 hours with phostoxin before the commencement of the experiment in order to kill any insect pest present. The seeds were then exposed for 48 hours to get rid of the gas and then sieved with a 2mm sieve to remove dead insects, exuviae and frass. These seeds were then packed into polythene bags and later used for the experiment.

Source and culturing of test bruchids

The test bruchid (*Callosobruchus chinensis),*were collected from previously infested cowpea seed purchased from Muda–Lawal market in Bauchi. They were brought to the laboratory and cultured on a white cowpea variety, *Kananado* at ambient temperature and relative humidity. Twenty pairs of male and female *C. chinensis* adults were introduced into earthenware pots each containing 1 kg of the cowpea seed. The technique described by Bandara and Saxena (1995) for sexing and handling of bruchids was used in the experiment. The pots were then covered with fine mesh cloth fastened with rubber bands to prevent the contamination and escape of insects. Seven days were allowed for mating and oviposition. The parent stocks were sieved out and the cowpea seeds containing eggs were left undisturbed until the new adults emerge and the subsequent F1 progenies from the cultures were used for the experiment.

Table 1: List of experimental plants and parts used against *C. chinensis*

Scientific name of plants	Common Name	Family	Parts use
Citrus sinensis Osbeck	Sweet orange	Rutaceae	Fruit Peel
Occimum basilicum L.	Sweet Basil	Labiataceae	Leaves
Acacia nilotica (Linn.)	Babul	Fabaceae	Leaves
Capsicum frutescens L.	Chilli pepper	Solanaceae	Fruits
Zingiber officinale Rosc.	Ginger	Zingiberaceae	Rhizome
Khaya senegalensis	Mahogany	Meliaceae	Bark
Khaya senegalensis	Acajou	Mahogany	Wood ash

Preparation of test plant materials

The plant materials evaluated for insecticidal activity against *C. chinensis*, the parts used and other pertinent information are provided in Table 1. The fresh leaves of basil and *Acacia* were obtained from plants growing in different locations at Sikar. They were shade-dried and ground into powder using a laboratory mill. Each plant material was kept in separate plastic bag until needed. Fruits of chilli, rhizomes of ginger and orange fruits were purchased from Sikar markit The fruits of chilli and rhizomes of ginger were dried and milled as previously described, while the orange fruits were peeled using a sharp knife. The peel was also dried and milled into fine powder. Wood of Mahogany was obtained and the bark was stripped off. Both bark and wood were shed-dried. The dried bark was pounded into smaller particles using laboratory pestle and mortar, before milling into fine powder. The dried mahogany wood was burnt to ashes. After cooling, the ash was placed in sealed glass jar to prevent the absorption of air moisture. Each plant product was labelled and kept. The pirimiphos–methyl dust (Actellic 2%) used in the experiment was purchased from the Jakhar Agricultural Supply Company (JASAC).

Experimental layout and design

Each powdered plant product was admixed at the rate of 1g test material per 20 g cowpea seed (5 per cent w/w) in a 9 cm–wide Petri dish. Pirimiphos–methyl dust (PMD) was applied at the rate of 0.1g per 20 g cowpea seed (0.5% w/w). There was a control treatment which did not contain any insecticidal material. A total of thirty six Petri dishes were used in the experiment. Two pairs of *C. chinensis* were introduced into each of the Petri dishes. Treatments were laid out in completely randomized design replicated four times. Oviposition was monitored daily, by counting the number of eggs deposited on the seeds under a dissecting microscope. In the first six days of confinement, dead adults were replaced daily and on the seventh day, all adults (alive or dead) were removed. Developmental period was counted in days from the date when 50% of all eggs were laid to the date when 50% adult emerged (Mueke, 1985). Emergence of adults was monitored and recorded daily; the total number of emerged adults was expressed as a percentage of the total number of eggs laid and was calculated using the formula:

Percentage eggs hatched = Total egg hatched / Total eggs in each Petri dish x 100

Percentage inhibition rate (IR%) was calculated using the formula after Rahman and Talukder (2006):

$$IR\% = Cn - Tn / Cn \times 100$$

Where: Cn = number of insects in control dish; Tn = number of insects in treated dish.

Extent of seed perforation was quantified by counting the number of cowpea seeds with exit holes in each Petri dish. The percentage seed damage was based on 100 seeds counted out from the 20g of test samples in each Petri dish. Any seed with typical “emergence hole” was counted as damaged. Percentage seed damage was determined using the formula:

No. of seeds with insect holes / 100x 100 / 1

Data analysis

Frequency of replacement data, oviposition, adult *C. chinensis* and exit hole counts and the developmental durations having low counts and zero values were transformed to (x + 0.5) before analysis of variance (ANOVA) while treatment efficacy criteria expressed as percentages were arcsine–transformed prior to the analysis. Significantly ($P \leq 0.05$) different treatment means were separated by Student– Newman-Keuls test using the statistical analysis system (SAS) software (SAS, 2000). 47.

RESULTS AND DISCUSSION

Effect of powder and ash of plant materials and pirimiphos-methyl dust on the survival and reproduction of *C. chinensis* Mortality of adult *C. chinensis*:

The result as presented in Table 2 shows that pirimiphosmethyl dust (PMD) was more effective in causing mortality of adult *C. chinensis* with 26.75 dead adults replaced and was significantly different from mahogany wood ash (MWA, 14.75). The least effective treatment was ginger powder (GP, 7.25), although, it was not significantly different from the rest of the treatments, including the control.

Fecundity: Data recorded on mean number of eggs/20g cowpea seeds is shown in Table 2. The result showed that treatment means were not significantly different from each other, although control treatment had the highest (166.75) while PMD recorded the lowest (143.25) number of eggs per 20 g cowpea seeds.

Emergence of adult *C. chinensis:* Treatments containing plant materials or PMD recorded significantly lower number of emerged adults compared to the untreated control (Table 2).PMD recorded the least mean emerged adult (22.25) and was the most effective treatment in terms of reduction in mean emerged adult, although that was not significantly different from citrus peel powder (CLP). These two were followed in effectiveness by *Acacia* leaf powder (ALP), which was found to be statistically same with MWA. The least effective plant material was GP (67.00), but differed significantly from what was observed in the control.

Hatching inhibition rate: The highest percentage hatching inhibition rate (81.67%) was recorded in PMD (Table 2), but was not significantly different from CLP. These two were followed by MWA (63.58%), which was statistically same with ALP. The lowest percentage hatching inhibition rate was recorded in GP (44.85%).

Development period of *C. chinensis*: The result as shown in Table 2 indicates that all reatment means were not significantly different from one another, even though the highest development eriod was recorded by GP (35.00 days) and the lowest (31.75 days) by mahogany bark powder (MBP).

Percentage cowpea seeds with holes:
Treatments with plant materials and PMD recorded significantly (P<0.05) lower per cent holed cowpea seeds compared with the control (Table 2). However, PMD was the most effective with 11.0% holed cowpea seeds, followed by CLP(15.8%), which was not significantly different from MWA. Hot pepper powder (HPP) was the least effective in protecting cowpea seeds against damage by *C. chinensis* with 39% holed cowpea seeds.

Effects of treating cowpea seeds with plant materials and PMD on adult mortality, oviposition and adult emergence
The present study showed that PMD and MWA had the highest insecticidal properties against *C. chinensis*. This showed that MWA could be successfully used for the control of *C. chinensis* and may even replace the synthetic insecticide. The effectiveness of MWA against *Sitophilus zeamais* infesting stored maize had earlier been reported by Yusuf *et al* (1998). Golob and Webley (1980), Golob *et al.* (1982) and Cobbinah and Kwarteng (1989) also reported the effectiveness of ashes of several plants used as grain protectants against various stored products pests, including *C. chinensis*. The synthetic insecticide, PMD was superior to other treatments in reducing the number of eggs laid by *C. maculatus* followed by CLP. Hence, CLP proved more effective compared to other plant materials. Earlier, Lale and Mustapha (2000) reported the superiority of PMD in reducing oviposition of *C. chinensis* in treated cowpea seeds. The effectiveness of CLP in reducing oviposition could be attributed to the presence of volatile/essential oils such as citral, limonene, a-pinene and fenchon; and aromatic compounds such as terpineol and bisabolene, which have ovicidal, toxic and deterrent effects on stored products Coleoptera and other insects (Dushland, 1939; Iwuala *et al*., 1981). Similarly, Oparaeke and Daria (2005) reported that *Syzygium aromaticum* powder significantly prevented oviposition of *C. maculatus*. Elhag (2000) reported that pulse treated with *Rhazya stricta* leaves, neem seeds, *Heliotropium bacciferum* aerial parts and citrus peels acted as highest ovipositional deterrents out of nine plant materials tested. Similar results were obtained using other spices such as African nutmeg, clove, garlic, chilli pepper and West African black pepper powders (Su, 1977; Onu and Aliyu, 1995; Oparaeke, 1997). The fewer number of eggs laid on cowpea seeds treated with the plant materials could be as a result of higher mortality of *C. chinensis*, thereby disrupting the mating and sexual communications as well as deterring females from laying eggs. The present study showed that the effectiveness of PMD was similar to CLP in reducing the number of *C. maculatus* adults emerged. The latter was therefore, the most effective plant material, followed by ALP and MWA. The present work corroborates that of Oparaeke and Daria (2005), who found that clove powder reduced or completely inhibited emergence of F1 and F2 progeny of *C. chinensis.*

Effects of treating cowpea seeds with plant materials and PMD on hatching inhibition rate, development period and per cent holed cowpea seed
PMD and CLP were similar in their effectiveness on inhibiting the hatching of *C. chinensis* eggs. The presence of volatile/essential oil in CLP could be responsible for its ovicidal action against *C. maculatus* eggs. The present finding corroborates with that of Ramzan (1994) whoreported that edible oils from cotton seed, sunflower, groundnut, soy bean and mustard, when mixed with

cowpea completely suppressed adult emergence of *C. chinensis*. Sha'aya *et al*. (1997) also reported that edible oils are potential control agents against *C. maculatus* and can play an important role in stored grain protection. There was no significant difference among treatments in suppressing the development period of *C. maculatus*, even though the longest development period was observed with GP, followed by PMD and ALP. The present work corroborates that of Ogunwolu and Odunlami (1996) who reported that developmental duration of *C. maculatus* on seeds treated with *Zanthoxylum* spp root bark powder, neem seed powder or PMD did not differ significantly from those of *C. maculatus* on untreated check. The lowest per cent holed cowpea seeds was recorded in the synthetic insecticide, PMD, followed by CLP. Thus CLP was superior to other plant materials in protecting cowpea seeds against damage by *C. maculatus*. The present finding corroborates that of Abolusoro (2001) who reported the effectiveness of *Piper guineense* and citrus peel against bruchid damage on cowpea seeds by reducing its population through mortality. Onu and Aliyu (1995) also reported that seeds treated with botanical extract oils were effective in reducing damage by *C. maculatus*. On the other hand, the present investigation did not find chilli pepper effective in reducing damage caused by *C. maculatus* to cowpea seeds in storage. This is similar to the findings of Mejule (1974) and Ivbijaro and Agbaje (1986).

Table 2. Bioefficacy of plant materials and pirimiphos-methyl on the suppression of *C. chinensis* development and its damage to cowpea seeds.

Treatment	Mean no. of dead	Mean no. Adults emerged	Mean no. of eggs/20g seeds	Mean no. hatching	Mean no. development	Mean no. seed with hole
CLP	9.25c	166.75	146.75	23.50f	80.65a	33.25
ALP	7.75c	150.75	162.25	43.00e	64.59b	33.00
OLP	9.50c	143.25	154.50	58.75c	51.65d	31.75
MBP	8.00c	166.75	155.25	49.50d	59.26c	32.50
HPP	9.25c	150.75	165.25	58.25c	52.06d	35.00
GP	7.25c	143.25	163.75	67.00b	44.85e	32.25
MWA	14.75b	166.75	155.25	44.25e	63.58b	32.25
PMD	26.75a	143.25	155.25	22.25f	81.67a	32.25
CNTL	9.75c	166.75	153.75	121.50a	------	31.25

**1 CLP= citrus Leaf powder, ALP= Acacia leaf powder, OLP= Occimum spp. leaf powder, MBP= mahogany bark powder, HPP= hot pepper powder, GP= ginger powder, MWA= mahogany wood ash, PMD= pirimiphos-methyl dust, CNTL= control. 2 PMD was applied at the rate of 0.1/20g cowpea seed (0.5% w/w). Means in column followed by the same letter (s) are not significantly different (P<0.05) using Student Newman- Keul's Test (SNK).*

CONCLUSION

The findings of the present investigations indicated that relative to control all the seven plant materials tested were to some degree not only effective in reducing oviposition, but have also appreciably inhibited hatching rates thereby leading to a significant reduction in the number of emerged adults from the treated cowpea seeds. However, in all the highest percentage progeny inhibition and minimal cowpea seed damage was observed in the grains treated with CLP during the study period. Therefore, application of citrus peel powder at the rate of 50 g/kg of cowpea seeds is recommended for the control of *C. chinensis* development and damage to cowpea seeds while in storage.

REFERENCES

[1] Abolusoro S.A. *Journal of Agricultural Technology* **2001**, 9: 1-6.
[2] Bandara K.A.N.P, Saxena R.C. *Journal of Stored Products Research.* **1995**, 31: 97 – 100.
[3] Banks H.J, Annis P.C, Rigby G.R. Controlled atmosphere storage of grain: The known and the future. Pages 695-706. In: Fleurat-Lassard, F. and Ducom, P. (Eds.). Proceedings of the 5th working conference on stored products protection. Bordeaux, France **1990**.
[4] Booker R.H, *Bulletin of Entomological Research* **1965**, 55: 663 – 672.
[5] Caswell G.H, Samaru *Journal of Agricultural Research* 1: 1 – 11.
[6] Cobbinah, J. R. and Kwarteng- Appiah, J. **1989**. *Insect Science and its Application* 1981,10(1): 89-92.
[7] Dike M.C, Mshelia G.B. *Samaru Journal of Agricultural Research* **1997**,14:11-18.
[8] Dushland R.C, *Journal of Economic Entomology* **1939**,32: 430- 431.
[9] Elhag E.A, *International Journal of Pest Management.* **2000**,46(2): 109-119.
[10] Golob P, Mwambula J, Mbango V, Ngulube F. *Journal of Stored Products Research* **1982**,20(1): 25-29.
[11] Golob P, Webley D.J. The use of plants and minerals as traditional protectants of stored products. Report of the Tropical Products Institute, G **1980**,138 (vi), 32pp. 50
[12] Huignard ,J, Leroi B, Alzouma I, Germain J.F. *Insect Science and its Application* **1985**,6: 691 –699.
[13] Huis A .V, *Insect Science and its Application* **1991**,12: 87-102.
[14] Ivbijaro M.F, Agbaje M. *Insect Science and itsApplication* **1986**,7: 521-524.
[15] Iwuala M.O.E, Osisiogu I.U.W, Agbakwuru E.O.P. *Journal of Economic Entomology* **1981**,74: 249-252.
[16] Jackai LEN, Daoust RA. *Annual Review of Entomology* **1986**,31: 95 – 119.
[17] Karungi J, Nampala M.P, Adipala E, Kyamanywa S, Ogenga-Latigo MW. *African Crop Science Journal* **1999**,7: 487 – 495.
[18] Lale N.E.S, Mustapha A. *Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz* **2000**,107(4): 399- 405.
[19] Mejule F.O. An investigation into the insecticidal effect of *Capsicums*. 12th Annual Report of Nigerian Stored Products Research Institute (Issued 1977). *Technical Report No*. **1974**,11: 89-90.
[20] Mueke M.J. *East African Agricultural and Forestry Journal* **1985**,49: 84 –88.
[21] Ogunwolu E.O, Odunlami A.T. *Crop Protection* **1996**,15: 603-607.
[22] Ohiagu C.C, Storage of food grains in the savannah zones of Northern Nigeria. Pages 361-368. In: Menyonga, J. M. Bezunah, T and Youdeowei A. (Eds). *Food grain production in semi arid Africa*. SAFGRAD. Ouagadougou, Burkina Faso **1987**.
[23] Onu I, Aliyu M, *International Journal of Pest Management* **1995**, 41(3): 143-145.
[24] Oparaeke A.M Evaluation of comparative efficacy of some plant powders for the control of *Callosobruchus maculatus* F. (Coleoptera: Bruchidae) on stored cowpea. Unpublished M. sc. Thesis, Ahmadu Bello University, Zaria, Nigeria. **1997**,105 pp.
[25] Opareake A.M, Daria VS. *Nigerian Journal of Entomology* **2005**,22: 76 – 83. 51
[26] Rahman A, Talukder F.A. *Journal of Insect Science* **2006**, 6: 1-18.
[27] Ramzan M, *Journal of Insect Science* **1994**, 7(1): 37-39.
[28] SAS System for Windows V8 SAS Institute Inc. Cary, NC 27613 USA. Sha'aya **2000**.

[29] Kostjukovski M, Eilberg J, Sukprakam C. *Journal of Stored Products Research* **1997**,33(1): 7- 15.
[30] Seck D, Gemblou B, Singh, S.R. *Tropical Grain Legume Bulletin* **1994**,9: 3 – 7.
[31] Singh SR, Jackai LEN, Dos Santos JHR, Adalla CB. Insect pests of owpea. In: Singh, S. R. (ed.). Insect Pests of Tropical Food Legumes. John Wiley and Sons Ltd. **1990**,43-89 pp.
[32] Chichester U.K, Stoll G. Natural crop protection in the tropics – Letting information come to life. Margraf Verley. **2000**,376 pp.
[33] Su HCF, *Journal of Economic Entomology* **1977**,70: 18-21.
[34] Yusuf S.R, Ahmed B.I, Chaudhary J.P, Yusuf A.U. Laboratory evaluationofsome plant products for the control of maize weevil (*Sitophilus zeamais* Mots.) in stored maize. *Entomological Society of Nigeria Occasional Publication* **1998**, 31: 203– 213.