**Original Research Paper**

**Evaluation of *Moringa oleifera* powders for the control of bruchid beetles during storage**

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The present study evaluated the insecticidal effects of powders of *Moringa oleifera* from different plant parts for the control of bruchid beetles in cowpea seeds under ambient condition of temperature and relative humidity (30°C and 72%). A synthetic pesticide (Pirimiphos-methyl) and four *Moringa oleifera* plant powders (leaf, stem, root and flower) were tested in cowpea seeds infested with virgin adults of bruchid beetles using completely randomized design. The results obtained showed a significant difference in the eggs laid, eclosed and the number of adults that emerged from each treatment (P ≤ 0.05). The lowest mean number of eggs of 6.40 was laid when 0.5 g *Moringa oleifera* flower powder was applied, which was significantly different from the control treatment where no plant product was applied. Similarly, the highest number of eggs hatched of 43.31 was recorded in the control treatment, which was also significantly different from the mean eggs hatched of 2.64 and 0.31 obtained when the leaf and flower powders were applied respectively (P ≤ 0.05). The results obtained also revealed a significant effect in the mean number of adults that emerged at various treatments applied with different plant part powders. The total developmental period of 23.5 days was obtained at the control which was significantly reduced to 16.3 days and 17.3 days when stem and leaf powders were applied respectively. The highest percentage of mortality 100 % was recorded in the treatment when Actellic dust was applied, whereas the mortality percentages were 85 and 70 % within the twenty-four hours of the insect infestation. This showed that the flower of *Moringa oleifera* powder could be used as bio-insecticide for the control of bruchid beetles in cowpea seeds during storage.

**Key words:** Cowpea, oviposition, eclosion, Moringa, Callosobruchus, maculatus, Pirimiphos-methyl

**INTRODUCTION**

Cowpea (*Vigna unguiculata* Walp.), is cultivated in a range of ecologies and cropping systems in the tropics. It is most commonly grown in dry areas along with sorghum and millet (Singh and Jackai, 1990). Cultivated cowpea is a herbaceous annual, belonging to the sub-tribe Phaseolineae, the tribe Phaseoleae, family Papilionaceae and order Leguminosales. The potential yield of cowpea grain in Africa is around 1.5 – 3.0 t. ha⁻¹, but current average yields are in the range of 0.2 – 0.3 t. ha⁻¹ (Romain, 2001). In tropical Africa, cowpea is consumed mostly in the form of dry grain or young pods. It is a relatively cheap source of protein and provides adequate complement to a cereal-based diet (Singh, 1980). In many parts of Eastern and Western Africa, the young leaves are eaten cooked or used as a condiment. The green or chopped pods are not used widely in Africa, but are popular throughout the far East. The roots are also eaten in Sudan and Ethiopia (Duke, 1981).Like other grain legumes, cowpeas are infested by insect pests during growth and in storage (Singh, 1980; Faleiro and Singh, 1985; Mariaga et al., 1985; Santos et al., 1982). In general, pest problems are more severe in Africa than in other continents. Several species of bruchids have
been identified as pests of cowpea (Wightman and Southgate, 1982; Santos and Quindere, 1988). *Callosobruchus maculatus* (Fabricius) is the most important storage pests of cowpea throughout the tropics (El-Sawaf, 1954; Oliveira and Santos, 1983; Singh et al., 1980). In Nigeria alone, yield losses caused by this insect pest in storage are estimated at US $30 million each year (Caswell, 1973).

Infestation often occurs in the field when pods are near maturity. Eggs are laid on the pods, but weevils prefer to enter inside the pods through holes made by other pests and lay eggs directly on the seed (Prevelt, 1961). After the crop is harvested, the bruchids multiply and do considerable damage to stored cowpeas (Singh and Emechebe, 1990). Howe and Currie (1964) studied the biology of *C. maculatus* and reported that temperature of 35°C and 70% relative humidity were ideal for oviposition. The female of *Callosobruchus maculatus* laid 71 to 117 eggs with an average of 97 eggs (Adenekan, 2001). The adult lifespan was from 8 to 16 days and averaged 10 days. The eggs are glued to the top of the seed in storage. They are glossy and oval when fresh and hatch in about 3 to 5 days. The larvae penetrate the seed and do extensive damage by feeding within the seed. Four larval instars, each being from 2 to 4 days are followed by a 2-day pre-pupal and a 5-day pupal stage (Osuji, 1982). After the pupal stage, adults emerge through an exit hole made by the larvae before pupation. Owusu-Agyaw (1987) reported in a study carried out on the biology of this pest at IITA and discovered that more bruchid eggs were laid on cowpea intercropped with maize than on cowpea planted as a monocrop. The author observed that bruchid eggs laid on pods, a maximum of 50% were parasitized by *Usca**na* sp. and discovered differences in pod wall resistance to bruchid and reported that variety with a tough pod wall suffered the least damage. Singh and Jackai (1985) reported that damage is done by larva feeding inside the seed. Often, farm storage for 6 months is accompanied by about 30% loss in weight with up to 70% of the seeds being infested and virtually unfit for consumption. The genetics of bruchid in cowpea have been studied by Redden et al., (1983) and Adjadi et al., (1985) observed that two recessive genes are required in the homozygous condition to confer resistance to bruchid. At IITA in 1974, studies were initiated to identify resistance to bruchids in cowpea by screening a world germplasm collection of about 12,000 accessions. Researchers identified Tvu 207 as moderately resistant and the mechanism of resistance was found to be antibiosis resulting in larval mortality (Singh, 1980). The resistance to bruchids in Tvu 207 was investigated by Gatehouse et al., (1979). Gatehouse and Boulter (1983) showed the level of trypsin inhibitor, C<sub>5</sub>T<sub>1</sub>, within the cowpea seeds correlated with the resistance to insect infestation.

*Moringa oleifera*, commonly called “Miracle Plant” belongs to a monogeneric family of shrubs and trees, Moringaceae and is considered to have its origin in North West region of India (Faizi et al., 1999). This plant has many potential uses both in agriculture and industries (Faidi et al., 2001). Moringa benefits are quite plentiful, and these are clearly evident in its exceptional nutritional values and remarkable medicinal properties. This miracle plant is overflowing with vitamins such as vitamins A, B, C, D and E and minerals which include potassium, calcium, iron, selenium and magnesium. According to Madukwe et al., (2012), the moringa leaves are completely safe for consumption and have no known negative side effect or toxic element. However, the use of synthetic chemicals in pest control is eliciting much concern owing to the undesirable side effects emanating from their uses (Tovignan et al., 2001).

Emphasis in recent times has been laid on non-chemical strategies to protect 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. The use of moringa for controlling insect pest during storage has not been evaluated in Nigeria; hence, this research work was aimed at evaluating the insecticidal effects of moringa plant parts for the control of bruchid beetles on cowpea seeds during storage.

**MATERIALS AND METHODS**

The research was carried out at the Entomology Laboratory of the Federal College of Agriculture, Ibadan, Nigeria. A laboratory culture of *Callosobruchus maculatus* was established from already infested cowpea seeds obtained from the Entomology Laboratory of the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. The culture was maintained in a Kilner jar under an ambient temperature of 28 ± 3°C and 70 – 75 % relative humidity. The insect culture was maintained as described by Adenekan and Shosanya (2006). The Ile Brown variety of cowpea seeds used for this experiment was obtained from the IITA. The untreated seeds were cleaned and sorted according to sizes as checked by their weights. These were kept in the refrigerator at a temperature of 10°C in order to prevent insect infestation until they were needed for the experiment.

The moringa plant parts tested for pesticidal properties were collected from growing stands of *Moringa oleifera* in the National Horticultural Research Institute of Nigeria (NIHORT), Ibadan a month before the commencement of the experiment. The leaves, stem bark, roots and flowers of the plant were separately collected and air-dried before grinding to powdery form. The untreated cowpea seeds kept in the refrigerator were taken out and allowed to acclimate for about twenty-four hours under ambient laboratory condition before being used. Thirty grammes (30 g) 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, root and flower of *M. oleifera*, Pirimiphos-methyl (Standard check) and untreated cowpea seeds which served as the control experiment. The plant part powders and Pirimiphos-methyl were administered on cowpea seeds in each petri dish at the rate of 0.5 g per 30 g of seeds. Three males and three females of adult stage of *C. maculatus* less than ten hours old were introduced and confined in each Petri dish for five days. The experiments were arranged in Completely Randomized Design (CRD) and each group contained six treatments with the control experiment were set aside in the laboratory for seven days before data collection commenced. The bruchid beetles were left to oviposit on the seeds for seven days and were carefully shifted out after they had died. Each group of the experiment was suspended in a bowl of water so as to prevent predation of eggs laid by red ants. 

Data were collected on the total number of egg oviposited, number of eggs hatched (eclosion) and number of adults that emerged from each treatment. The total developmental period (egg - adult) and the sex ratio of the emerged adults were also recorded and analyzed using analysis of variance (SPSS,1990), while treatment means were separated with the aid of Duncan multiple range tests at $P \leq 0.05$ level of significance.

### RESULTS AND DISCUSSION

*M. oleifera* powders were found to have insecticidal effects on the oviposition, eclosion and development of bruchid beetles on cowpea seeds. The results indicated that the flower powder of moringa plant recorded the lowest number of eggs laid of 6.40, which was significantly different from the highest of 48.15 obtained at the control experiment where no plant powder was applied. Other results on number of eggs laid revealed that mean number of eggs laid where 0.5 g of moringa leaf, stem and root powders were applied, were 14.32, 13.61 and 11.38, respectively (Table 1). However, all the bruchid beetles exposed to seeds treated with *M. oleifera* powders survived at various levels to period of adult emergence (Table 2). The mean number of eggs hatched (eclosion) was significant with the highest eclosion of 43.31 recorded at the control experiment, which was significantly different from the eggs hatched of 0.31 recorded at the

### Table 1. Insecticidal effect of Moringa powders from different plant parts and Pirimiphos-methyl on oviposition, eclosion and development of bruchid beetles on cowpea seeds

<table>
<thead>
<tr>
<th><em>M. oleifera</em> product</th>
<th>Mean No. of eggs laid ± SE</th>
<th>Mean No. of eggs hatched ± SE</th>
<th>Mean No. of dead bruchid beetles ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf</td>
<td>14.32 ± 2.12b</td>
<td>2.64 ± 0.94c</td>
<td>2.10 ± 0.20c</td>
</tr>
<tr>
<td>Stem</td>
<td>13.61 ± 3.61b</td>
<td>2.30 ± 1.23c</td>
<td>2.01 ± 0.38c</td>
</tr>
<tr>
<td>Root</td>
<td>11.38 ± 4.32b</td>
<td>4.21 ± 1.23b</td>
<td>3.04 ± 1.01b</td>
</tr>
<tr>
<td>Flower</td>
<td>6.40 ± 2.10c</td>
<td>0.31 ± 0.11d</td>
<td>4.13 ± 1.46b</td>
</tr>
<tr>
<td>Actellic dust*</td>
<td>0.12 ± 0.03d</td>
<td>0.00 ± 0.00d</td>
<td>6.00 ± 1.36c</td>
</tr>
<tr>
<td>Control</td>
<td>48.15 ± 6.17a</td>
<td>43.31 ± 3.16a</td>
<td>1.20 ± 1.23c</td>
</tr>
</tbody>
</table>

n = 30 g of cowpea seed  
r = 4 replicates  
rate = 0.5 g powder / 30 g of cowpea seed  
+= Pirimiphos-methyl  
Sample means followed by the same alphabets are not significantly different from each other (DMRT 0.05)

### Table 2. Insecticidal effect of Moringa powder from different plant parts and Pirimiphos-methyl on the developmental period and sex ratio of bruchid beetles on cowpea seeds

<table>
<thead>
<tr>
<th><em>M. oleifera</em> product</th>
<th>Mean No. of eggs laid ± SE</th>
<th>Mean No. of adult emergence ± SE</th>
<th>Total developmental period (egg - adult) (days)</th>
<th>Sex ratio (M:F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf</td>
<td>14.32 ± 2.12b</td>
<td>2.11 ± 0.34c</td>
<td>18.4 ± 2.97c</td>
<td>8:7</td>
</tr>
<tr>
<td>Stem</td>
<td>13.61 ± 3.61b</td>
<td>3.10 ± 0.19c</td>
<td>16.3 ± 2.41c</td>
<td>10:1</td>
</tr>
<tr>
<td>Root</td>
<td>11.38 ± 4.32b</td>
<td>2.34 ± 0.61c</td>
<td>20.5 ± 3.24c</td>
<td>6:6</td>
</tr>
<tr>
<td>Flower</td>
<td>6.40 ± 2.10c</td>
<td>0.00</td>
<td>17.3 ± 1.89c</td>
<td>0:7</td>
</tr>
<tr>
<td>Actellic dust*</td>
<td>0.12 ± 0.03d</td>
<td>0.00</td>
<td>23.5 ± 5.26c</td>
<td>-</td>
</tr>
<tr>
<td>Control</td>
<td>48.15 ± 6.17a</td>
<td>40.31 ± 8.15a</td>
<td>0.00</td>
<td>4:6</td>
</tr>
</tbody>
</table>

n = 30 g of cowpea seed  
r = 4 replicates  
rate = 0.5 g powder / 30 g of cowpea seed  
+= Pirimiphos-methyl  
Sample means followed by the same alphabets are not significantly different from each other (DMRT 0.05)
Table 3. Mortality of bruchid beetles on cowpea seeds treated with Moringa powder from different plant parts.

<table>
<thead>
<tr>
<th>M. oleifera product</th>
<th>% mortality after infestation (hrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Leaf</td>
<td>20</td>
</tr>
<tr>
<td>Stem</td>
<td>25</td>
</tr>
<tr>
<td>Root</td>
<td>10</td>
</tr>
<tr>
<td>Flower</td>
<td>40</td>
</tr>
<tr>
<td>Actellic dust*</td>
<td>80</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
</tr>
</tbody>
</table>

No. of insects introduced = 10  
\( n = 30 \) g of cowpea seed  
\( r = 4 \) replicates  
rate = 0.5 g powder / 30 g of cowpea seed  
+= Pirimiphos-methyl

The results obtained in Table 1 also showed the mean number of dead bruchid beetles when different plant powders of \( M. \) oleifera were applied respectively, but was significantly different from eggs hatched of 4.21 obtained when the root powder of \( M. \) oleifera was applied (Table 1). The results obtained in Table 1 showed the mean number of dead bruchid beetles when different plant powders of \( M. \) oleifera was applied. The mean number of dead bruchid beetles of 1.20 recorded at the control treatment was significantly different from the mean mean total developmental period of 23.5 days obtained at the control experiment, but not different when compared with 18.4 and 17.3 days obtained when the leaf and flower powders were applied respectively (Table 2).

The results obtained for the sex ratio (male: female) indicated that the powders of the plant affected the sex ratio of bruchid beetles. The 0:7 ratio is a clear indication that the flower powder affected the number of males produced when compared with the control treatment where 28 males and 20 females were produced (Table 2). The exact mechanism of activity of the powders of \( M. \) oleifera on the sex ratio of the progeny of bruchid beetles is poorly understood and may require further scientific investigation. The mortality of bruchid beetles on cowpea seeds treated with moringa plant part powders are reported in Table 3. The results showed that all bruchid beetles treated with Pirimiphos-methyl died within 10 hrs when the insects were introduced. This was followed by the flower powder which recorded 100% mortality at 24 hrs of insect infestation. The control experiment recorded the lowest mortality of 10%, while the leaf and stem powders of \( M. \) oleifera recorded 85 and 70% insect mortality, respectively after 24 hrs of infestation (Table 3). This result is similar to the mortality reported by Abdullahi et al., (2012) who stated that Zingiber officinale and Allium sativum had mortality on the larvae of Dermestid maculatus reared in Clarias garepinus.

Results of this study indicated that the powder of \( M. \) oleifera flower showed potentials in the control of bruchid beetles on cowpea seeds as bio-insecticide. Although no plant part matched the efficacy of Pirimiphos-methyl the undesirable side effects emanating from its use pose problems to the human environment and danger of mammalian toxicity; hence, \( M. \) oleifera flower powder is recommended to farmers for the preservation of cowpea seeds against infestation of bruchid beetles during storage. The insecticidal activities of the moringa plant extract for the control of storage insect pests merit further scientific investigation.
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