SUSCEPTIBILITY OF SOME COWPEA, VIGNA UNGUICULATA (L.) WALP, CULTIVARS TO COWPEA SEED BEETLE, CALLOSOBRUCHUS MACULATUS (FAB.), DURING STORAGE

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ABSTRACT
This study was undertaken to assess the susceptibility of cowpea cultivars (VITA - 1, 84E - 1108, VITA - 4, LOCAL, 82E - 18, 820-699, TVx - 3236, and 82D - 716) to C. maculatus during storage. Results indicate variations among cultivars in mean % damage (8.9 ± 1.9 - 78.8 ± 3.3), mean developmental period (18.8 ± 0.3 - 30.7 ± 0.7 days), mean weight loss (3.1 ± 0.5 - 20.4 ± 1.5g), mean number of emerged adults (107.5 ± 8.9 - 577.5 ± 13.8) and index of susceptibility (6.7 - 14.5). A significant difference (P<0.05) existed among these means. Cultivars 82D - 716 recorded the highest mean developmental period, the least mean % damage, mean weight loss, numbers of emerged adults, and index of susceptibility. VITA - 1, 84E - 1108, and VITA - 4 were the most susceptible while the local cultivar was moderately susceptible by the end of the trials. There was a significant increase (P<0.01) in % moisture and protein content and a significant decrease (P<0.01) in viability in all the cultivars. The possible reasons for difference in susceptibility and the implications of these results in the choice of cultivars are discussed.

INTRODUCTION
Cowpea, Vigna unguiculata (L) Walp, is one of the five most important legumes in the tropics and provides the protein for most people in the region and nitrogen to the soils (Duke, 1990). Cowpea is infested by insect pests during growth and in storage (Singh et al., 1990). The most important storage pest of cowpea throughout the tropics is the cowpea seed beetle. Callosobruchus maculatus (Fab.) (Akingbohungbe, 1976; Caswell, 1981; NRI, 1996). Infestation often occurs in the field when pods are close to maturity (Prevett, 1961).

Fumigation and insecticides have been used to control this pest (Caswell and Akibu, 1980; NRI, 1996). However, concerns about insecticidal residues in stored products are even more serious in developing countries where most of the farmers are illiterate and lack the technical knowledge to apply these chemicals according to recommended guidelines. Furthermore, Institutions that regulate the use of these chemicals are neither efficient nor effective. As a result, these countries have become recipients of fake, adulterated, expired, and banned chemicals (Abate et al., 2000). For instance, between 1994 and 1997, FAO registered 10,099 metric tons of obsolete, unwanted and/or banned insecticides in 34 African countries (FAO, 1998). These chemicals when available are also expensive for peasant farmers in developing countries (FAO, 1998).

As a result of the problems associated with chemical insecticides, researchers have focused on alternate means of control, which include the use of resistant cultivars. It offers a simple, safe and cheap means of controlling C. maculatus in stored cowpea. Cowpea cultivars TVu 625, TVu 2027, TVu 4200, TVu 11952, and TVu 11953 had been identified as moderately resistant to C. maculates (Singh, 1977; Adjadi et al., 1985; Jackal et al., 1988). Three other cultivars IT84S - 2246 -

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4, IT85F - 2205, and IT90K - 391 had also been confirmed resistant to C. maculatus (Ofuya and Adeduntan, 1999). New cowpea cultivars are continually being developed to satisfy the requirements of high yield, acceptable taste, and resistance to insect pests and diseases. This study was undertaken to assess the susceptibility of some new cowpea cultivars in storage to C. maculatus.

**MATERIAL AND METHODS**

Seven improved and one local cowpea, Vigna unguiculata (L.) Walp, cultivars were used. The improved cultivars (VITA - 1, 84E - 1108, VITA-4, 82E - 18, 820-699, TVx - 3236 and 82D - 716) were obtained from the International Institute of Tropical Agriculture (IITA), Onne, near Port Harcourt, Nigeria while the local cultivar, ‘Rotiscum,’ was purchased from a local market in Port Harcourt. The local cultivar (white) was used as a reference because it is considered very susceptible to C. maculatus damage. The test samples were disinfested by fumigation with phostoxin, subsequently cleaned by sieving and aerated for four days. Fifty grams of each aerated cultivar were introduced into a 2L-Kilner jar. The jars were replicated thrice for each of the eight cultivars. Eight male and 12 female, day-old C. maculatus adults, obtained from an existing laboratory culture, were introduced into each jar containing the test samples. The mouths of the jars were covered with mesh, held in place with rubber bands. The setup was left for seven days under fluctuating laboratory conditions (26.4 - 29°C and 74.5 - 83% r.h.) for the adults to oviposit. Within the seven days each jar was inspected daily for dead adults. These were removed and replaced with live ones of the same age. After the 7-day period, the adults were sieved out and the experimental jars left undisturbed for 20 days in the laboratory. Thereafter, the jars were inspected daily for the emergence of F1 progeny which were removed, counted and recorded. Inspection of the jars was continued until no adult emergence was recorded for three consecutive days.

**Data Collection and Analysis**

Before the trials, the colours of the test cultivars and sizes (length) of 50 seeds from each cultivar, measured with Vernier calipers, were recorded. The 50 seeds were selected randomly by picking every other seed. The indices of susceptibility were calculated after Howe (1971).

\[
\text{Index of Susceptibility} = \frac{\log F_1}{D} \times 100
\]

Where,

\[F_1 = \text{Total number of emerged adults.}\]
\[D = \text{Median developmental period estimated as the time from the period of mid-oviposition to emergence of 50% of the F1 generation.}\]

Before placing the samples in the jars and at the end of the trials, 100 seeds, obtained by quartering and random selection from every cultivar were planted and the number of germinated seeds counted to determine per cent viability; additional 100 seeds were selected to determine per cent insect damage. The quartering was used to reduce sample sizes, in which every other seed was picked until 100 seeds were selected. Per cent insect damage was based on the number of emergence holes per 100 seeds. Prior to and after the trials, two 10g - samples were drawn from every cultivar to determine per cent protein and moisture content. Per cent protein content was determined by the Kjeldahl digestion and semi-micro Markham distillation techniques (Markham, 1942; AOAC, 1984). Per cent moisture content was determined by the oven method as outlined in AOAC (1984). Weight loss assessment involved finding the difference between the uninfested samples of each cultivar at the end of the trials. The developmental period (days) and the number of C. maculatus adults that emerged from each cultivar were
recorded. The data on per cent damage and per cent viability were subjected to arcsine transformation prior to analysis (Sokal and Rohlf, 1981). The data were subjected to Analysis of variance, Student - Newman - Keuls Procedure (Gomez and Gomez, 1984) and Student's t-test.

RESULTS AND DISCUSSION
C. maculatus damage before treatment was zero on all the cultivars. Observations at the end of the experiment revealed an infestation level of 1-6 exit holes per seed. At the end of the trials, the mean % damage for cultivars VITA - 1, 84E - 1108, VITA - 4, LOCAL, 82E - 18, 820 - 699, TVx - 3236 and 82D - 716 varied, 8.9±1.9 - 78.8±3.3 (Table 1). Analysis of variance and Student - Newman - Keuls Procedure indicated that a significant difference (P<0.05) existed among these means (Table 1). Cultivars 82D - 716 and TVx - 3236, with mean % damage of 8.9±1.9 and 17.7±3.2, respectively were the least damaged while VITA-1, 84E -1108, and VITA - 4, with mean % damage of 78.8±3.3, 76.1±5.4 and 73.2±2.5, respectively were the most susceptible. The local cultivar with mean % damage of 50.2±3.2 was moderately infested.

Mean developmental period of C. maculatus in all the cultivars varied, 18.8±0.3 - 30.7±0.7 days (Table 1). A significant difference (P<0.05) existed among these means (Table 1). The longest period of 30.7±0.7 days was recorded in 82D - 716; on the other cultivars, the period varied, 18.8±0.3 - 21.8±0.3 days (Table 1).

Mean weight loss on all cultivars varied, 3.1±0.5 - 20.4±1.5g (Table 1). A significant difference (P< 0.05) existed among these means (Table 1). The weight losses of 3.1 + 0.5 and 6.0±0.4g on 82D - 716 and TVx - 3236, respectively were significantly lower than those of other cultivars. The highest weight loss of 20.4±1.5g was recorded on VITA - 1; the local cultivars with a weight loss of 14.2±1.2 was intermediate.

Mean number of emerged C. maculatus adults on all cultivars varied, 107.5±8.9 - 577.5±13.8 (Table 1). A significant difference (P < 0.05) existed among these means (Table 1). The mean number of 107.5±8.9 recorded on 82D - 716, was the lowest and significantly different; on the other cultivars, the numbers varied, 383.3 ± 36.7 - 577.5±13.8. Cultivar 82D - 716 with a susceptibility index of 6.7 was the least susceptible compared with all other cultivars of a susceptibility indices range of 12.0 - 14.5 (Table 1).

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Mean percentage damage (± S.E.)*</th>
<th>Mean developmental period (Days) (± S.E.)*</th>
<th>Mean weight loss (g) (± S.E.)*</th>
<th>Mean no. of emerged adults (± S.E.)*</th>
<th>Index of susceptibility (S.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITA - 1</td>
<td>78.8±33(a)</td>
<td>20.7±0.3(b)</td>
<td>20.4±1.5(a)</td>
<td>523.0±42.8(a)</td>
<td>13.6</td>
</tr>
<tr>
<td>84E - 1108</td>
<td>76.1±5.4(ab)</td>
<td>19.2±0.7(c)</td>
<td>15.6±0.7(b)</td>
<td>577.5±13.8(a)</td>
<td>14.5</td>
</tr>
<tr>
<td>VITA - 4</td>
<td>13.2±2.5(ab)</td>
<td>19.5±0.6(c)</td>
<td>14.5±1.0(b)</td>
<td>556.0±25.7(a)</td>
<td>14.1</td>
</tr>
<tr>
<td>LOCAL</td>
<td>50.2±3.2(ab)</td>
<td>19.2±0.7(c)</td>
<td>14.2±1.2(b)</td>
<td>468.0±30.7(a)</td>
<td>14.1</td>
</tr>
<tr>
<td>82E - 18</td>
<td>69.7±3.2(b)</td>
<td>21.7±0.2(b)</td>
<td>14.2±1.5(b)</td>
<td>383.3±36.7(b)</td>
<td>12.2</td>
</tr>
<tr>
<td>820 - 699</td>
<td>53.5±2.1(c)</td>
<td>18.8±0.3(c)</td>
<td>10.4±0.1(c)</td>
<td>505.3±57.7(a)</td>
<td>14.4</td>
</tr>
<tr>
<td>TVx - 3236</td>
<td>17.7±3.2(d)</td>
<td>21.8±0.3(b)</td>
<td>6.0±0.4(d)</td>
<td>400.3±16.9(b)</td>
<td>12.0</td>
</tr>
<tr>
<td>82D - 716</td>
<td>8.9±1.9(e)</td>
<td>30.7±0.7(a)</td>
<td>3.1±0.5(d)</td>
<td>307.5±8.9(c)</td>
<td>6.7</td>
</tr>
</tbody>
</table>

* Means in the same column followed by the same alphabet are not significantly different (P<0.05; Student - Newman - Keuls Procedure).
<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Seed colour</th>
<th>Mean seed size (cm)</th>
<th>Mean % moisture</th>
<th>t - value</th>
<th>df</th>
<th>Mean % protein</th>
<th>t - value</th>
<th>df</th>
<th>Mean % viability</th>
<th>t - value</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>VITA - 1</td>
<td>Red</td>
<td>1.031</td>
<td>12.8</td>
<td>16.8**</td>
<td>254.430</td>
<td>4</td>
<td>23.3</td>
<td>26.2**</td>
<td>291.029</td>
<td>4</td>
<td>90.0</td>
</tr>
<tr>
<td>84E - 1108</td>
<td>White</td>
<td>1.049</td>
<td>12.5</td>
<td>15.3**</td>
<td>14.681</td>
<td>4</td>
<td>25.0</td>
<td>26.9**</td>
<td>218.315</td>
<td>4</td>
<td>100.0</td>
</tr>
<tr>
<td>VITA - 4</td>
<td>White</td>
<td>0.731</td>
<td>12.9</td>
<td>16.9**</td>
<td>208.157</td>
<td>4</td>
<td>22.4</td>
<td>26.9**</td>
<td>284.376</td>
<td>4</td>
<td>100.0</td>
</tr>
<tr>
<td>LOCAL</td>
<td>White</td>
<td>1.020</td>
<td>13.8</td>
<td>16.0**</td>
<td>131.964</td>
<td>4</td>
<td>23.0</td>
<td>23.3**</td>
<td>6.545</td>
<td>4</td>
<td>100.0</td>
</tr>
<tr>
<td>82E - 18</td>
<td>White</td>
<td>1.041</td>
<td>12.2</td>
<td>14.8**</td>
<td>82.089</td>
<td>4</td>
<td>22.3</td>
<td>27.3**</td>
<td>290.538</td>
<td>4</td>
<td>100.0</td>
</tr>
<tr>
<td>820 - 699</td>
<td>White</td>
<td>1.027</td>
<td>12.4</td>
<td>16.4**</td>
<td>19.512</td>
<td>4</td>
<td>23.3</td>
<td>26.7**</td>
<td>322.091</td>
<td>4</td>
<td>100.0</td>
</tr>
<tr>
<td>TVx - 3236</td>
<td>Brown</td>
<td>0.793</td>
<td>12.4</td>
<td>15.0**</td>
<td>172.887</td>
<td>4</td>
<td>22.1</td>
<td>25.7**</td>
<td>219.018</td>
<td>4</td>
<td>85.0</td>
</tr>
<tr>
<td>82D - 716</td>
<td>Brown</td>
<td>0.810</td>
<td>12.6</td>
<td>13.8**</td>
<td>30.086</td>
<td>4</td>
<td>22.1</td>
<td>26.3**</td>
<td>286.781</td>
<td>4</td>
<td>70.3</td>
</tr>
</tbody>
</table>

1 n per cultivar = 50;
2 Initial and final means followed by ** are significant (P<0.01: Student’s t-test).
The seed colour and the mean seed size of the cultivars varied, 0.731 - 1.091 cm (Table 2). Before the trials, the mean % moisture content range of the cultivars was 12.2 - 13.8, while at the end of the trials, the mean % moisture content range rose to 13.8 - 16.9 (Table 2).

Student’s t-test indicated that a highly significant difference (P < 0.01) existed between the initial and final mean % moisture content of each cultivar (Table 2). The initial mean % protein content range of the cultivars was 22.1 - 25.0, while the final mean % protein content range increased to 23.3 - 27.3 (Table 2). A highly significant difference (P < 0.01) existed between the initial and final mean % protein content of each cultivar (Table 2). Before the trials, the % viability of the cultivars varied, 70.3 - 100, while at the end of the experiment, % viability range was 15.5 - 65.1 (Table 2). Student’s t-test also indicated that a significant difference (P < 0.01) existed between the initial and final mean % viability in each cultivar (Table 2).

The highly significant increase in moisture content at the end of the trials might be attributed to the respiratory activities of C. maculatus within the seeds. Similarly, the significant increase in % protein content at the end of the experiment could be due to the synthesis of some proteins by C. maculatus from non-protein materials in the seeds. The significant decrease in viability of test samples might be attributed to the destruction of seed embryos by the feeding activities of C. maculatus during development. It might also be due to seed shrinkage; it was observed that the seeds of VITA-1 shrank by the end of the trials.

The two most discriminating variables for the assessment of cowpea seed susceptibility to C. maculatus are the mean developmental period and the number of emerged adults (Redden and McGuire, 1983). Based on these criteria, 82D - 716 was the least susceptible of all the cultivars tested. The mean developmental period recorded in this study for 82D - 716 is similar to those of IT84S - 2246-4, IT85F - 2205, and IT90K - 391 confirmed resistant to C. maculatus (Ofuya and Adenduntan, 1999). Furthermore, data on the mean % damage, mean weight loss, and index of susceptibility indicated that this cultivar was the least susceptible.

TVx - 3236, resistant to thrips, by low-level antibiosis and non-preference (Salifu et al., 1988a; Salifu et al., 1988b) did not show any appreciable level of resistance to C. maculatus VITA - 1, 84E - 1108, and VITA-4 were the most susceptible; they recorded the highest numbers of emerged adults and low mean developmental periods, indicating that the nutritional composition on these cultivars probably accelerated development. Conversely, an unfavourable nutritional composition might be responsible for the prolonged developmental period and the low number of emerged adults in 82D - 716. The local cultivar, which was regarded as very susceptible to C. maculatus was in an intermediate category.

84E-1108, with the largest mean seed size, recorded the highest number of emerged adults. However, VITA-4, with the smallest mean seed size, did not record the lowest number of emerged adults, indicating that cowpea susceptibility to C. maculatus might not be related to seed size. In fact, Satya (1981) reported that the mechanism of cowpea resistance to C. maculatus was not governed by the morphological characters (size, colour, etc) of the seed but by its nutritional composition.

Of all the eight cowpea cultivars assessed for susceptibility to C. maculatus, 82D - 716 was the least susceptible. It recorded the highest mean developmental period, which was similar to those of other cultivars, confirmed resistant to C. maculatus. The cultivation of
such resistant cultivar by farmers would significantly reduce the impact of C. maculatus infestation, which forces them to sell their cowpea soon after harvest when market prices are generally very low.

REFERENCES


