Full Length Research Paper

Evaluation of morphometric and physiological seed quality traits of improved cowpea (Vigna unguiculata L. Walp) varieties in Sierra Leone

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A study was conducted at the Seed Laboratory of the Njala Agricultural Research Centre (NARC) to evaluate the seed quality traits of five cowpea genotypes at room temperature (25 ± 2°C). The five genotypes studied were Slipeas 1, 2, 4 and 5 and local Tabe. The trial was laid out in a Completely Randomized Design (CRD) in four replicates. The results indicated that the local variety (Tabe) had the highest percentage of seed coat damage (40%) followed by Slipea 5 (30%) whilst Slipea 1 had the lowest percentage seed coat damage (10%). The vigor and germination percentages of the improved cowpea varieties were higher than the local Tabe. Slipeas 2 and 4 had the highest vigor and germination percentages in this study. Highly positive correlation (r = 0.92, p < 0.001) was observed between vigor and germination percentages. From the findings of this study, the improved cowpea varieties Slipeas 2 and 4 with high vigor and germination indices can be recommended to farmers and seed dealers for long term storage and growing under stress conditions. Breeders can also use them as parents in breeding for stress tolerant cowpea varieties.

Key words: Genotype, seed quality, seed coat damage, germination, vigor.

INTRODUCTION

Cowpea (Vigna unguiculata (L) Walp) is the second most important grain legume grown in Sierra Leone after groundnut and is used mainly as a source of protein food and also supplements the income of many small scale farmers. It contains 23% protein by weight and plays an important role in providing protein requirements of Sierra Leone (MAFFS/NARCC/NUC, 2005). It helps to maintain soil fertility by fixing nitrogen in the soil. Cowpea is a cheap source of protein in the diet and an increased production and consumption will help reduce incidence of protein malnutrition especially in children. It is assumed that the name cowpea is derived from American farmers who used it as feed for their cows (IITA, 2009). Cowpea improvement has been intensified in Sierra Leone since 1988, with the inception of the Institute of Agricultural Research (IAR). This has led to the release of several improved varieties, notably Slipeas 1, 2, and 3 in 2002 and Slipeas 4 and 5 in 2014. The varieties mostly

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varieties to identify varieties using physiological traits that can withstand environmental stresses. This information will be useful to breeders and cowpea growers to ensure productivity of improved plant population in Sierra Leone. The aim of the study is to identify improved cowpea varieties with good seed quality traits that can withstand environmental stresses in the field.

Specific objectives

(i) To identify seed quality traits associated with high germination and vigor.

(ii) To identify suitable varieties with high vigor and germination traits that can withstand environmental stresses in the field.

MATERIALS AND METHODS

The experiment was conducted at the Njala Agricultural Research Centre Seed Laboratory in 2018 under normal room temperature and relative humidity. Seeds of the 4 released improved cowpea varieties and 1 local variety (Tabe) were used for the experiment (Table 1). Seeds were obtained from the seed store whilst the local variety was purchased from farmers. A completely randomized design with four replications was used in the study. Sterilised sand free from weed seeds was used as the medium for germination. For every 1 L of sand, 160 ml of water was added and mixed thoroughly with a hand trowel. The four replications were then placed under optimal germination conditions and 25 seeds were used for each of the four replications. The number of normal seedlings on the first count (5th day) and final count (8th day) was used to determine the vigor and germination ability respectively. Chlorox soaking test was used to determine percentage seed coat damage of the different varieties. 88.7 ml of Chlorox solution was dissolved in 1 gallon of distilled water. The mixture was poured in 5 petri-dishes. 100 seeds of each of the varieties were dropped in the Petri dishes containing the solution for 15 mins and the number of swollen seeds was counted to determine percentage of seeds with damaged seed coat.

Data were collected on the following seed quality parameters, Seed length, width and thickness, seed moisture Content, 100 seed weight, vigor percentage, germination percentage, speed of germination index, percentage seed coat damage, seedling root length and seedling shoot length. Seed length, width and thickness were measured using an electronic Vernier calliper. Seed moisture content was measured by moisture meter. 100 seed weight was done by counting 100 seeds of each variety and weighing using electronic compact scale (Virgo). Vigor percentage was calculated by dividing the number of seeds that germinated at first count that is, after 5 days against number of seeds sown. Germination percentages were calculated by dividing the number of emerged seedlings against total number of seeds sown after 8 days multiplied by 100.

Germination percentage = Number of emerged seedlings at final count / Total number of seeds sown × 100.

Speed of germination index was determined by number of normal seedlings (first count) / days to first count + Number of normal seedlings (final count) / days to final count. Percentage seed coat damage was determined using the Chlorox soaking test and seedling root length and shoot were determined by measuring the tap root and seedling height of 5 seedlings and means recorded.
Table 1. Some characteristics of released cow pea varieties in Sierra Leone.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Slipea 1</th>
<th>Slipea 2</th>
<th>Slipea 3</th>
<th>Slipea 4</th>
<th>Slipea 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to 50% flowering</td>
<td>31-42</td>
<td>41-44</td>
<td>40-45</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Days to maturity</td>
<td>65-75</td>
<td>70-80</td>
<td>60-70</td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td>Seed colour</td>
<td>Dark purple</td>
<td>White</td>
<td>White</td>
<td>white</td>
<td>White</td>
</tr>
<tr>
<td>Seed Shape</td>
<td>Kidney</td>
<td>Kidney</td>
<td>Kidney</td>
<td>Kidney</td>
<td>Kidney</td>
</tr>
<tr>
<td>Grain yield (t/ha)</td>
<td>1-1.5</td>
<td>1-1.5</td>
<td>1-1.5</td>
<td>1.1–2.0</td>
<td>1.1–1.8</td>
</tr>
</tbody>
</table>

Table 2. Mean seed length, width and thickness of the cow pea varieties.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Seed length (mm)</th>
<th>Seed width (mm)</th>
<th>Seed thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slipea 1</td>
<td>8.50</td>
<td>6.52</td>
<td>4.08</td>
</tr>
<tr>
<td>Slipea 2</td>
<td>9.03</td>
<td>6.29</td>
<td>5.20</td>
</tr>
<tr>
<td>Slipea 4</td>
<td>9.51</td>
<td>6.81</td>
<td>5.28</td>
</tr>
<tr>
<td>Slipea 5</td>
<td>9.95</td>
<td>6.78</td>
<td>5.64</td>
</tr>
<tr>
<td>Tabe (local)</td>
<td>8.11</td>
<td>5.46</td>
<td>3.8</td>
</tr>
<tr>
<td>Mean</td>
<td>9.02</td>
<td>6.37</td>
<td>4.97</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.46</td>
<td>0.64</td>
<td>0.51</td>
</tr>
<tr>
<td>CV (%)</td>
<td>3.3</td>
<td>1.3</td>
<td>6.8</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Morphometric seed characteristics of cowpea varieties

Seed length, width and thickness of cowpea varieties

Highly significant differences (P < 0.001) were observed in mean seed length among the cowpea varieties studied. The newly released improved cowpea variety Slipea 5 had the longest seed length (9.95 cm) whilst the local cultivar Tabe had the shortest seed length of 8.11 cm (Table 2). However, there was no significant (P < 0.001) difference at 5% level of probability between Slipea 5 and Slipea 4 although these two varieties were significantly different from Slipeas 1 and 2 in seed length. The results of the study showed significant (P = 0.004) differences between the four improved varieties and the local Tabe variety in mean seed width. The local cultivar Tabe had the least seed width (5.46 mm) whilst the improved varieties Slipea 4 (6.81 mm) and Slipea 5 (6.78 mm) had the highest and second highest seed width respectively (Table 2). Analysis of variance results show significant differences (P < 0.001) in mean seed thickness among the cowpea varieties. The improved varieties (Slipeas 4 and 5) which had the highest seed length and width also had the highest seed thickness (5.28 and 5.64 mm) respectively. The local Tabe cultivar had the least seed thickness of 3.8 mm (Table 2).

100 seed weight

The results of the study showed that the Local cultivar (Tabe) recorded the lowest 100 seed weight (13 g) whilst the improved cowpea varieties Slipea 2 and 5 had the highest 100 seed weights (23 g) (Figure 1). The higher 100 seed weights obtained by improved varieties could be related to the higher yields of the improved varieties over the local variety. The higher yield of improved cowpea over local variety was supported by work done by Singh et al. (2002) who showed that the use of improved varieties led to the realization of 4 tonnes per hectare. Local cultivars were found to be poor in resource capture and utilization resulting in lower seed weight.

Percentage seed coat damage

The results indicate that the local variety (Tabe) had the highest percentage seed coat damage (40%) followed by Slipea 5 (30%) whilst Slipea 1 had the least seed coat damage of 10% (Figure 2). The high percentage of seed coat damage observed in the local variety through the high number of swollen seeds could be due to poor handling of seeds during processing by the farmer. The results showed that the coloured variety had the least...
seed coat compared to the other white seeded Slipeas and Local Tabe. This trend of results also conform with Peksen et al. (2004) who reported that cowpea cultivars with completely or partially cream/beige testas imbibed water more rapidly than cultivars with coloured testas probably due to high seed coat ratio of the coloured variety. However, contrary results were reported by llunga (2014) who found out that Brown mix variety had more leakage (53.2%) than the White birch variety (18%), indicating that seeds of White birch variety had less cell membrane permeability compared with Brown mix variety.
Physiological seed traits of cowpea varieties

Vigor and germination percentages of the cowpea varieties

The results of the study indicated that Slipeas 2 and 4 had the highest vigor (93 and 95%) and also the highest germination percentage (96%). The improved dark purple variety Slipea 1 and white local cultivar Tabe had the lowest vigor (84 and 85% respectively). Generally, the vigor and germination percentages of the improved released cowpea varieties are higher than that of Tabe except the dark purple Slipea 1. These results are contrary to the findings of Ilunga (2014) who reported that coloured cowpea varieties had higher vigor and germination percentages and therefore keep longer. Similar trend was observed between vigor and germination percentages among the cowpea varieties. These findings are in agreement with McCormack (2004) who also noted that the relationship between vigor and viability is similar except that the vigor declines before viability. Martins et al. (2016) also reported that there is positive correlation between seed vigour and seedling field emergence (Figure 3).

Speed of germination index (SGI)

The results obtained for speed of germination index (SGI) are similar to those of vigor and germination percentages. The two varieties Slipeas 2 and Slipea 4 with the highest vigor and germination percentages also had the highest speed of germination (Table 3). These results confirm earlier studies by Spears et al. (2002) who also found out

![Figure 3. Vigor and germination percentages of the cowpea varieties.](image-url)
that seeds with high vigor can withstand stress during germination and early seedling development longer than low vigor seeds.

**Seedling and root length of cowpea varieties**

No significant difference (P = 0.62) was observed in mean root length whilst seedling length was significant (P= 0.038) among the cowpea varieties at the 5% level of probability. The local variety had the minimum root and seedling length compared to the improved varieties (Figure 4). This could be contributing factors to its low vigor and germination percent. The high yields obtained by the improved cowpea varieties could be attributed to their higher seedling growth and development. Similar observations were made by Igbal (2015) who stated that seedling growth and development determines the final yield as good seedling establishment constitutes the first and foremost step in achieving full potential of crops. The results of the study indicated that the improved cowpea varieties with large seeds and higher 100 seed weight were taller than Local Tabe with small seed size in the initial stages of growth. This could be attributed to the fact that large seeds had the capacity to mobilize storage reserves to growing seedling as was also reported by Ndunguru and Summerfield (1975b). The variation in plant height among varieties may be attributed to genetic makeup of the varieties. The results are similar to earlier work done by Gan et al. (2003).

**Pearson’s correlation of some seed quality traits of the cowpea varieties**

The results of the correlation analysis show that vigor and germination are significantly highly positively correlated (r = 0.92, P< 0.0001). This also confirms earlier report by McCormack (2004) that vigor and germination are strongly correlated. There was also a positive correlation between seed length, width and thickness and 100 seed weight. This indicates high dependence of seed weight on seed length and thickness. No correlation was observed between 100 seed weight and germination (Table 4).

**CONCLUSION AND RECOMMENDATIONS**

The study was conducted to identify seed quality traits of improved cowpea varieties in Sierra Leone. From the results obtained on the present study, the following conclusions can be made:

(i) The improved cowpea varieties are more vigorous and germinate faster than the local cultivar Tabe.
Table 4. Correlation matrix of seed quality traits analysed.

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
<th>seedwt</th>
<th>Vigor</th>
<th>Seedling Germ</th>
<th>Seedling It</th>
<th>Seedling Root lt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>1.00000</td>
<td>0.76612</td>
<td>0.84225</td>
<td>0.74453</td>
<td>0.29837</td>
<td>0.38009</td>
<td>0.18023</td>
<td>0.33657</td>
</tr>
<tr>
<td>Width</td>
<td>0.76612</td>
<td>1.00000</td>
<td>0.84307</td>
<td>0.73725</td>
<td>0.15941</td>
<td>0.11614</td>
<td>0.35992</td>
<td>0.31293</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.84225</td>
<td>0.84307</td>
<td>1.00000</td>
<td>0.88965</td>
<td>0.14261</td>
<td>0.21777</td>
<td>0.38985</td>
<td>0.31093</td>
</tr>
<tr>
<td>Seed weight</td>
<td>0.74453</td>
<td>0.73725</td>
<td>0.88965</td>
<td>1.00000</td>
<td>0.29742</td>
<td>0.34852</td>
<td>0.53581</td>
<td>0.33108</td>
</tr>
<tr>
<td>Vigor</td>
<td>0.29837</td>
<td>0.15941</td>
<td>0.14261</td>
<td>0.29742</td>
<td>0.5487</td>
<td>0.3564</td>
<td>0.0893</td>
<td>0.1821</td>
</tr>
<tr>
<td>Germ</td>
<td>0.38009</td>
<td>0.11614</td>
<td>0.21777</td>
<td>0.34852</td>
<td>0.91642</td>
<td>0.91642</td>
<td>0.29796</td>
<td>0.27686</td>
</tr>
<tr>
<td>Seedling lt</td>
<td>0.18023</td>
<td>0.35992</td>
<td>0.38985</td>
<td>0.53581</td>
<td>0.29796</td>
<td>0.31233</td>
<td>1.00000</td>
<td>0.07020</td>
</tr>
<tr>
<td>Root lt</td>
<td>0.33657</td>
<td>0.31293</td>
<td>0.31093</td>
<td>0.33108</td>
<td>0.27686</td>
<td>0.18414</td>
<td>0.07020</td>
<td>1.00000</td>
</tr>
</tbody>
</table>

(ii) The cowpea varieties, Slipea 2 and 4 with the highest vigor also had the highest germination. This clearly indicates that there is strong correlation between vigor and germination.

(iii) Seed coat damage of cowpea seeds affected vigor and germination of seed. Cowpea varieties with low seed coat damage had the highest vigor and germination.

(iv) Vigor and germination traits in cowpea are influenced by the type of variety.

From the findings of this experiment, the following recommendations can be made:

(i) The improved varieties Slipea 2 and 4 are the best in terms of vigor and germination and recommended for good plant establishment in the field.

(ii) Seeds of the local cultivar, Slipea 1 and 5 are prone to seed coat damage and should be handled with care during processing and storage.

(iii) Seeds of the improved varieties Slipea 2 and 4 have higher vigor and could therefore be stored for longer periods than the other varieties.

(iv) Future work should include field emergence test to establish relationship between laboratory germination and field emergence.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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