Vol. 10(5), pp.35-42, September 2019
DOI: 10.5897/JSPPR2019.0281
Article Number: 7CAD42D61960
ISSN: 2141-6567

http://www.academicjournals.org/JSPPR

ACADEMIC JOURNALS
expand your knowledge

Journal of Stored Products and Postharvest Research

Full Length Research Paper

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

Ernest G. Kamara[1*], Saidu D. Mansaray[2], Milton K. Kabbia[1], Moses T. Moseray[1] and Jigba M. Jabbie[2]

[1]Sierra Leone Agricultural Research Institute, Njala Agricultural Research Centre, P.M.B. 540, Freetown, Sierra Leone.
[2]School of Agriculture, Njala University, Sierra Leone.

Received 26 March, 2019; Accepted 14 August, 2019

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

*Corresponding author. E-mail: ernestgkamara@yahoo.com. Tel: +23276633747.

cultivated by the farmers are Tabe and Hundweh (IITA, 2011) both local varieties are preferred by the consumers because of their good taste.

Despite the development of improved cowpea genotypes in Sierra Leone, yields are still low (less than 2 t/ha) compared to yields as high as 4 t/ha obtained in Nigeria. In the evaluation and testing of genotypes most of the traits considered are morphometric and agronomic traits only germination indices such as seed vigor, germination percent, speed of germination index which measure the sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence are not considered. According to Shaibu and Ibrahim (2016), one of the factors that may affect crop production is the physiological quality of the seeds, which has an indirect influence on the speed and percentage of seedling emergence and final stand, or a direct influence on plant vigour. Therefore, the use of seeds of high physiological quality is paramount to increasing productivity and improving the technological level of bean cultivation (Adebisi et al., 2013). Generally, vigor tests have proven to be more useful as predictors of field emergence than the standard germination test. When planted in fields with stressed environmental conditions, especially cool, wet conditions, a high vigor seed lot can withstand the stress during germination and early seedling development longer than a low vigor seed lot (Spears et al., 2002). Thus, emergence is generally higher and seedling growth is more rapid. Vigor tests are used extensively in the seed industry to provide a sensitive, consistent, fast, simple and economic method that can be used to predict the seed performance in the field environment (McDonald, 1980). It is well known that decline in seed vigour precede those observed in germination as seed deterioration progresses. This phenomenon underscores the importance of using seed vigour tests as a more sensitive measure of seed quality and plant emergence capability of a seed lot (Copeland and McDonald, 2001). There is lack of data on these traits in the evaluation of these varieties. Sierra Leone is the third most vulnerable country affected by climate change as the rainfall patterns are currently unpredictable with rising temperatures, flooding and periodic droughts. There is therefore, a need to develop varieties that are not only early maturing to escape drought but also tolerant to multiple abiotic stresses. Seed vigor can be used to predict the field performance of a variety under stressful environmental conditions and recommendation for period of storability. Variations in genetic make-up of crops have been reported as one of the major causes of differences observed in seed quality and yield (Ajala et al., 2006; Okelola et al., 2007). Stahr (2012) stated that seed lots with similar standard germination results may emerge differently in the field due to differences in their seedling vigor. This study is therefore conducted to evaluate the seed quality of released improved cowpea 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 (5^{th} day) and final count (8^{th} 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 cowpea varieties in Sierra Leone.

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

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

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

respectively.

Data were subjected to analysis of variance (ANOVA) using Genstat Release Version 10.3DE and Least Significant Difference (LSD) test was used for mean separation at 5% level of probability. Regression and correlation analysis were explored to examine relationships among various parameters (Table 1).

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

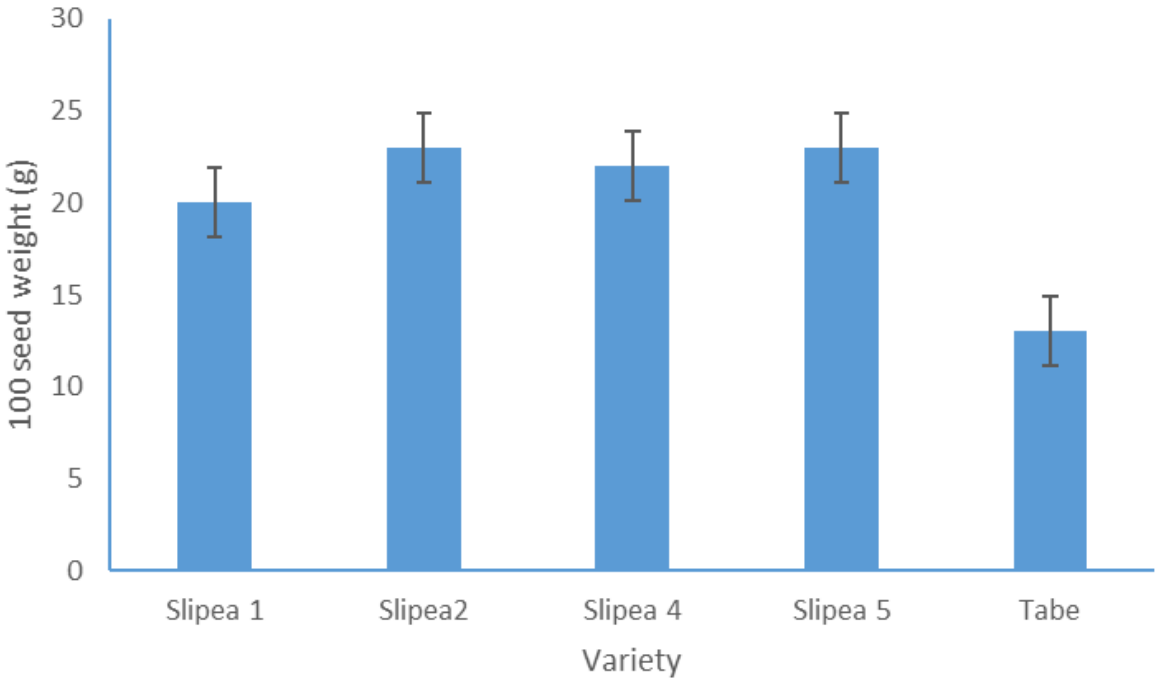

Figure 1. 100 seed weight of cowpea varieties.

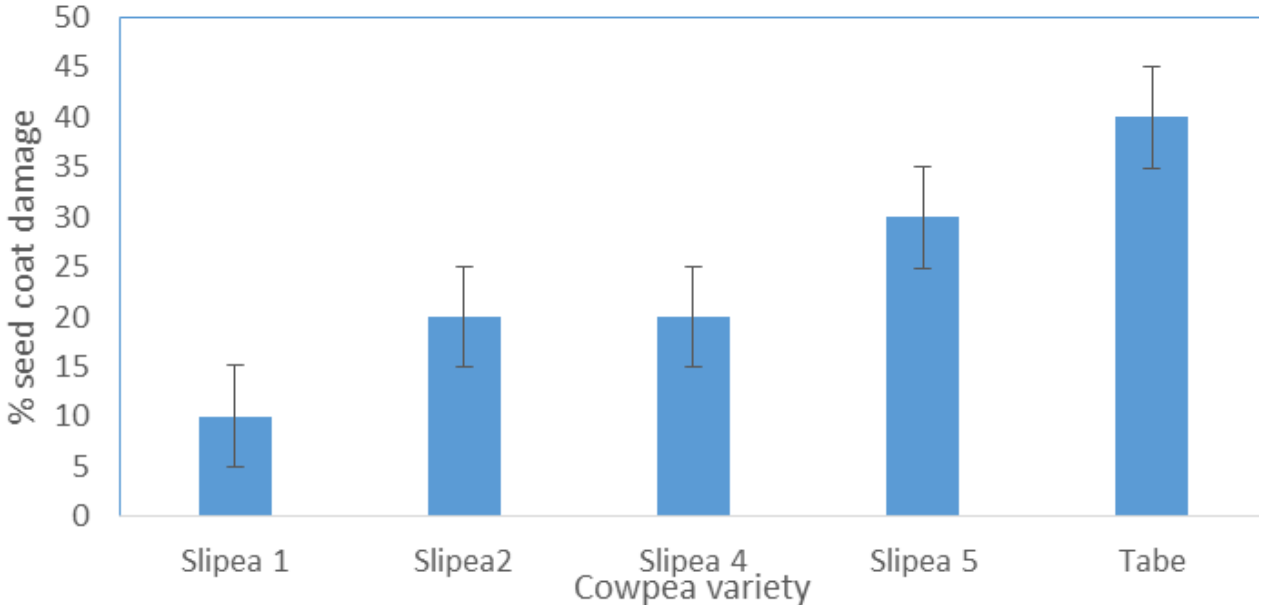

Figure 2. Percentage seed coat damage of cowpea varieties.

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 Ilunga (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.

Figure 3. Vigor and germination percentages of the cow pea varieties.

Table 3. Mean speed of germination indices of cow pea varieties.

Variety	Speed of germination index
Slipea 1	27.42
Slipea 2	30.60
Slipea 4	31.00
Slipea 5	28.28
Tabe	28.00
Mean	29.05
LSD (0.05)	2.45
CV (%)	5.5

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

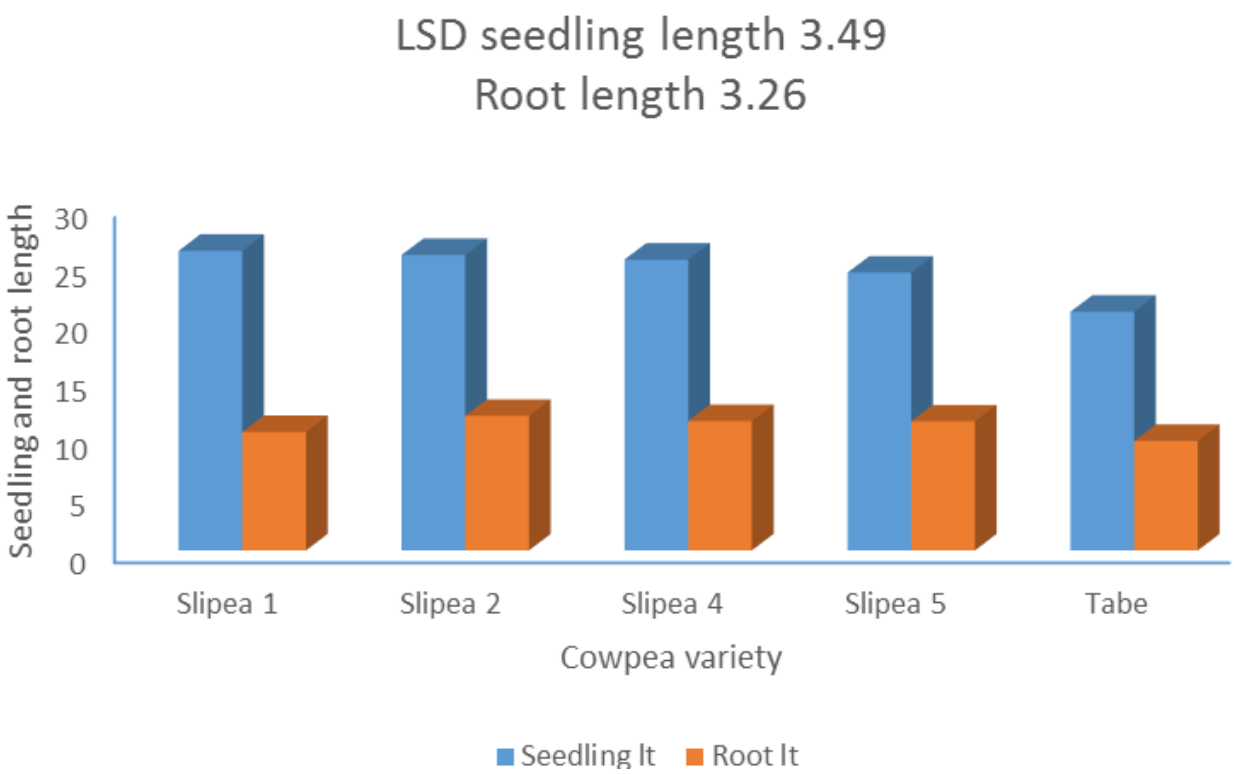

Figure 4. Seedling and Root length of cow pea varieties.

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.

	Length	Width	Thickness	seedwt	Vigor	Seedling_		
						Germ	lt	Root_lt
Length	1.00000	0.76612	0.84225	0.74453	0.29837	0.38009	0.18023	0.33657
		<.0001	<.0001	0.0002	0.2013	0.0983	0.4470	0.1468
Width	0.76612	1.00000	0.84307	0.73725	0.15941	0.11614	0.35992	0.31293
	<.0001		<.0001	0.0002	0.5020	0.6258	0.1191	0.1791
Thickness	0.84225	0.84307	1.00000	0.88965	0.14261	0.21777	0.38985	0.31093
	<.0001	<.0001		<.0001	0.5487	0.3564	0.0893	0.1821
Seed weight	0.74453	0.73725	0.88965	1.00000	0.29742	0.34852	0.53581	0.33108
	0.0002	0.0002	<.0001		0.2028	0.1321	0.0149	0.1539
Vigor	0.29837	0.15941	0.14261	0.29742	1.00000	0.91642	0.29796	0.27686
	0.2013	0.5020	0.5487	0.2028		<.0001	0.2020	0.2373
Germ	0.38009	0.11614	0.21777	0.34852	0.91642	1.00000	0.31233	0.18414
	0.0983	0.6258	0.3564	0.1321	<.0001		0.1800	0.4371
Seedling_lt	0.18023	0.35992	0.38985	0.53581	0.29796	0.31233	1.00000	0.07020
	0.4470	0.1191	0.0893	0.0149	0.2020	0.1800		0.7687
Root_lt	0.33657	0.31293	0.31093	0.33108	0.27686	0.18414	0.07020	1.00000
	0.1468	0.1791	0.1821	0.1539	0.2373	0.4371	0.7687	

(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.

ACKNOWLEDGEMENTS

The authors wish to appreciate Messrs Murray Kaikai and George Puvandi of Njala Agricultural Research Centre Seed Laboratory for assisting in setting up the experiment and collecting data.

REFERENCES

Adebisi MA, Kehinde TO, Pobeni JBO, Oduwaye OA, Bilaminu K, Akinde SA (2013). Seed and seedling vrigor in tropical maize inbred lines. Plant Breeding and Seed Science 67(3):88-101.
Ajala MA, IO Daniel, KO Fasan (2006). Pres-sowing treatment for improving seed quality in West African rice varieties seedling emergence and seedling growth. Nigerian Agricultural Journal 37:159-167
Copeland LO, McDonald MB (2001). Seed science and technology. Kluwer Press, 4th edition P 409.
Gan YT, Miller PR, McDonald CL (2003). Response of kabuli chickpea to seed size and planting depth. Canadian Journal of Plant Science 83:39-46.
Igbal MA (2015). Improving Germination and Seedling Vigour of

Cow pea (*Vigna Unguiculata* L.) w ith Different Priming Techniques. American-Eurasian Journal of Agricultural and Environmental Sciences 15(2):265-270

Ilunga K (2014). Physiological responses of cowpea (*Vigna unguiculata*) to w ater stress under varying w ater regimes (Masters Thesis submitted School of Agricultural, Earth and Environmental Sciences University of Kw aZulu-Natal)Pietermaritzburg, South Africa

International Institute of Tropical Agriculture (IITA) (2009). Cow pea http://w w w .iita.org/cow pea. International Institute of Tropical Agriculture.

International Institute of Tropical Agriculture (IITA) (2011). Identification and Characterization of Cow pea technologies. IITA

MAFFS/NARCC/NUC (2005). Crop Production Guidelines for Sierra Leone P 47.

McCormack JF (2004). Seed Processing and Storage: In Principles and practices of seed harvesting, and storage: An organic seed production manual for seed growers in the Mid- Atlantic and Southern U US. McCormack.

McDonald MB (1980)). Assessment of seed quality. HortScience 15:784-788.

Ndunguru BJ, Summerfield RJ (1975b). Comparative laboratory studies of cow pea (*Vigna unguiculata*) and soybean (Glycine max) under tropical temperature conditions. I. Germination and hypocotyls elongation. East African Agricultural and Forestry Journal 41:58-64

Okelola FS, Adebisi MA, Kehinde OB, Ajala MO (2007).Genotypic and Phenotypic variability for seed vigor traits and seed yield in West African rice (*oryza sativa* L.). The Journal of American Science 3(30):34-41.

Peksen A, Peksen E, Bozoglu H (2004). Relationships among some seed traits, laboratory germination and field emergence in cow pea ((L.) Walp.) genotypes. Pakistan Journal of Botany 36(2):311-320

Shaibu AS, Ibrahim SI (2016) Genetic variability and heritability of seedling vigor in common beans (*Phaseolus vulgaris* L.) in sudan savanna. International Journal of Agricultural Policy and Research 4(4):62-66.

Singh BB, Ehler, EJD, Sharma B, FreireFiho, FR (2002). Recent progress in cow pea breeding. In: Fatokun CA, Taraw ali SA, Singh BB, Kormaw a PM, Tamo M (Eds), Challenges and opportunities for enhancing sustainable cow pea production. Proceedings of the World Cow pea Conference III held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. IITA Ibadan, Nigeria.

Spears JP, Jordan, DC, Barley JE (2002). Peanut seed production. A guide for producers of Virginia type peanut seed. North Carolina Cooperative Extension Service AG- 662, pp. 1-7.

Stahr MG (2012). Seed Vigor and Vigor testing. In SEMI's Seed Quality Assurance. SEMI's Short Course. University of Nairobi, Kenya.