SEED YIELD AND PHYSIOLOGICAL SEED QUALITY OF COWPEA VARIETIES SOWN AT DIFFERENT PLANTING DATES IN MINNA, SOUTHERN GUINEA SAVANNA OF NIGERIA.

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ABSTRACT

Cowpea is the most important grain legume in Nigeria but its yield has remained low. Inappropriate sowing date as well as use of poor quality seeds by farmers have been identified as part of the factors responsible for the low yields obtained on famers' fields. A field and laboratory study was conducted to determine the yield and quality of seeds harvested from cowpea varieties planted at different dates within the growing season of 2017. The study was a two factor experiment consisting of nine planting dates (planting at 2 weekly intervals from 19th May to 8th September, 2017) and three cowpea varieties (IT93K-452-1, Oloyin and Kanannado). Data were collected on seed yield, 100-seed weight, germination percentage, germination speed, seedling weight and seedling vigour index. Data collected were subjected to analysis of variance and the treatments means were separated using least significant difference at 5% level of probability. Results revealed that Oloyin variety had the highest seed yield when sown on 19th May. The value was however at par with the seed yield of plants sown on 11th August. Kannanado variety had the highest seed yield when sown on 28th July which was equally at par with the yield obtained when sown on 11th August. IT93K-452-1 equally had the highest seed yield when sown on 19th May which was similar to value obtained in plants sown on1st July followed by the seed yield obtained in plants sown on 14th June and 11th August which had similar values. Seeds obtained from plants sown on 11th and 25th of August had significantly higher germination percentage, germination speed, seedling weight and seedling vigour index before and during storage than the seeds sown earlier or later in the three varieties. Among the varieties, Kanannado produced the heaviest seeds followed by Oloyin but IT93K-452-1 had the highest seed yield followed by Oloyin and the least seed yield was recorded in Kanannado variety. Though Kanannado variety had significantly higher germination percentage and seedling weight at early storage, IT93K-452-1 had significantly higher germination speed, seedling vigour index and stored better. Oloyin variety had the least values of all the quality indices measured. Therefore, for maximum seed yield and quality, planting around 11th of August is recommended for farmers in the study area and among the varieties tested, IT93K-452-1 is recommended for higher seed yield and quality.

KEYWORDS: planting date, cowpea varieties, seed yield, germination percentage, seedling vigour,

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) is the most economically important grain legume in Nigeria. Its seeds are consumed as the major source of protein in most homes in Nigeria. It is a major staple food crop in sub-Saharan African, especially in the savanna regions of West Africa (Dudge *et al*., 2009). Despite the importance of this crop, the yield obtained on farmers' fields is very low with an average of 450 kg ha^{-1} (Omotosho, 2014). This yield value is very low compared to the potential yield of 2-3 t ha^{-1} recorded in South Africa (Pule-Meulenberg *et al*., 2010). Use of poor quality seeds by farmers is one of the factors responsible for the low grain yield obtained on farmers' fields. Seed is the most crucial input for agricultural production. The response of other input in agricultural production depends on the quality of the seeds used. Seed quality is an important factor for

increasing yield. It is estimated that good quality seeds can contribute about 20-25% increase in yield. Viability and physiological vigour are the two most important factors required for high seed quality (Odindo, 2007). Seed vigour has been known as a comprehensive characteristic affected by many factor s, such as the genetics of the seeds, environmental factors during seed development and storage (Sun *et al*., 2007). The environmental conditions prevalent during seed formation affect the quality of the resultant seeds. This could be aggravated when crops are planted at the wrong time. Water is one of the most important climatic factors for crop production. Both its shortage and excess affect the growth and development of plants directly, and consequently its yield and quality. Plant water stress resulting from agronomic drought (lack of sufficient water to meet the demand of the crop) has been reported by many workers to affect seed yield and quality by reducing seed size, seed number and shortening the grain filling period (De-Souza *et al*., 1997). Smith and Zou (2016) reported that abiotic stresses, such as heat, cold, and drought, commonly affect floral organ development and fertility. The authors further reported that sterility is induced by abiotic stresses mostly in male floral organ development, particularly during meiosis, tapetum development, anthesis, dehiscence, and fertilization leading to reduced yield and quality of crops. Given the current scourges that threaten the world (food insecurity and water scarcity); many researchers urge to maximize crop yields with minimum possible water consumption. This involves several practices, including the selection of planting time that matches the crop species throughout the entire growing season (Elsnesr *et al*. 2013). Seed producers must often compromise between maximum seed yield and quality when selecting a planting date. Small holder farmers in Nigeria hardly buy seeds. They use seeds obtained from previous harvests. This small holder farmers account for the production of over 90% of the food consumed in Nigeria. There is therefore the need to inform farmers on the appropriate time to plant cowpea to obtain maximum seed yield of high quality. This study therefore aimed to determine the effect of planting date on the seed yield and quality on three cowpea varieties.

METHODOLOGY

The field trial was conducted on a farmer's field in Minna, Southern Guinea savanna of Nigeria with the geographical positioning system value of N $09^0$31.203 and E $06^0$27.678. It was a factorial combination of three cowpea varieties viz: Kanannado (late maturing), Oloyin (medium maturing) and IT93K-452-1 (early maturing), and nine planting dates (planting at two weeks interval) viz: 19th May, 2nd June, 16th June, 1st July, 14th July, 28th July, 11th August, 25th August, and 8th September. These were arranged in a randomized complete block design. Plants received 20 kg P and 20 kg K ha^{-1} at planting using single super phosphate and muriate of potash as source. There were four ridges per treatment plots and yield data were obtained from the 2 inner ridges. Intra and inter-row spacing of 20 x 75 cm was maintained except for Kanannado variety in which 30 x 75cm was maintained because it was a prostrate variety. At mass maturity (end of seed filling period), the seeds were harvested and the quality of the seeds were tested in the Department of Crop Production, Federal University of Technology Laboratory. Four replicates of hundred seeds were counted for each treatment and weighed on a Mettler balance to determine the 100-seed weight and means were recorded. The seeds were stored in the incubator in open plastic plates at 42^0C and 81% relative humidity for 8 weeks to accelerate the ageing. The physiological quality indices tested were the following:

Germination percentage (GP): Three replicates of 25 seeds from each treatment combination were counted and placed in paper towels moistened with distilled water. The paper towels were placed inside the germination chamber at 30ºC. A seed was considered to have germinated when radicles significantly emerge. Germinated seeds were recorded every day for 7 days. Germination percentage was calculated according to the formula:

$$GP = \frac{\text{Number of normal seedlings}}{\text{Total seeds tested}}$$

Speed of germination was determined using the formula:

$$\frac{\text{Number of germinated seeds at first count}}{\text{Days of first count}} + \frac{\text{Number of germinated seeds at final count}}{\text{Days of final count}}$$

Seedling weight: At 7 days, the fresh weight of the normal seedlings were determined on a Mettler balance after which they were oven dried at 70^0C for 48 hours to obtain the dry weight. The value was divided by the number of seedlings to obtain the seedling weight per plant

Seedling vigour index (SVI): Ten normal seedlings were randomly selected from each replicate and the plumule length measured. Seedling vigour index were calculated using the formula:

$$SVI = \frac{\text{Seedling plumule length x germination\%}}{100}$$

(Akintobi *et al*., 2017)

Data collected on all parameters were subjected to analysis of variance using statistical analysis system (SAS) and means were separated using least significant difference (LSD) at P=0.05. Data in percentages were transformed to arcsin values before statistical analysis. Where the interaction between planting date and variety was significant throughout the storage period, the table of interaction showing the performance before storage and late storage were presented.

RESULTS

Table 1 shows the 100-seed weight of the cowpea varieties sown at different planting date. Seeds harvested from Oloyin plants sown on August 11th and 25th were significantly heavier (24.72 and 24.01 g respectively) than the seeds obtained from plants of the same variety sown on other dates (20.94 – 22.13 g). Kanannado plants produced the heaviest seeds when sown on 1st July (28.59 g). The weight was however similar to the values obtained in plants sown on 19th May, 16th June and 14th July. The lightest Kanannado seeds were obtained in plants sown on 8th September (25.27 g). In IT93K-452-1 variety, plants sown on 19th May had the heaviest seeds (22.18 g) and the value was at par with the seeds obtained in plants sown on 1st July (21.18 g). Generally, Kanannado seeds were the heaviest (25.27 - 28.59 g) followed by Oloyin (21.27 – 24.72 g) and IT93K-452-1 had the lightest seeds (19.27 - 22.18g).

Kannanado variety sown on 28th July had the highest seed yield (997.99 kg ha^{-1}). The value was at par with the seed yield of plants sown on 11th August (637.34 kg ha^{-1}) (Table 2). The least seed yield in Kanannado variety was obtained in plants sown on 14th July (114.94 kg ha^{-1}) which was at par with the seed yield of plants sown on 19th May, 1st July, 25th August and 8th September. Oloyin variety sown on 19th May had the highest seed yield (1506.11 kg ha^{-1}) and the value was at par with the seed yield obtained in plants sown on 1st July, 14th July, 11th August and 16th June, (1447.23, 1155.44, 1066.35 and 1042.09 kg/ha respectively). The least seed yield in Oloyin variety was obtained in plants sown on 8th September (365.15 kg ha^{-1}) which was at par with the value obtained in plants sown on 25th August (429.67 kg ha^{-1}). In IT93K-452-1 variety, plants sown on 19th May had the highest seed yield (2013.50 kg ha^{-1}) which was at par with the value obtained in plants sown on 1st July (1927.11 kg ha^{-1}). The least seed yield in IT93K-452-1 variety was obtained in plants sown on 25th August and 8th September (486.79 and 570.82 kg ha^{-1} respectively).

Seeds obtained from plants that were sown in August (11th and 25th) generally germinated significantly higher both before and during storage than seeds obtained from plants sown earlier (Table 3). The value obtained was however at par with the value recorded in seeds harvested from plants that were sown on 8th September during the first four weeks of storage. After 4 weeks in storage (WIS), there was a significant decline in the germination percentage of seeds obtained from plants sown on 8th September. Seeds harvested from plants sown on 19th May were the least viable both before and during storage.

Table 4 shows the interaction between planting date and variety on the germination percentage at 0 and 8 weeks in storage. In Oloyin variety, germination percentage before storage (0 WIS) increased as planting date advances with the highest GP recorded in plants sown as from 11th August (98-100%). At late storage (8 WIS) however, seeds harvested from Oloyin plants that were sown between 19th May and 28th July had lost their viability (0% germination). The highest germination percentage in Oloyin seeds at 8 WIS was obtained in seeds harvested from plants sown on 25th August (22.68%) which was at par with the value recorded in seeds obtained from plants sown on 11th August (16.00%). In Kanannado variety, there was no significant difference between the germination percentage of seeds harvested from plants sown at different sowing dates and the GP ranged between 93 and 100% before storage. At late storage however, seeds obtained from plants sown on 11th and 25th August had the highest GP (17.33%) and the values were at par with the GP recorded in the other planting dates except seeds harvested from plants sown on 19th May, 14th July and 9th September which had completely lost their viability (Table 4). In IT93K-452-1 variety, seeds harvested from plants sown from 1st July up to 8th September had significantly higher GP (92-100%) than those sown earlier (69.33 - 89.33%) before storage. In late storage however, seeds harvested from plants sown on 28th July stored significantly better (with 33% GP) than those obtained from plants sown earlier and those sown after 11th August (9 -20%). Seeds obtained from plants sown on 19th May had the least germination percentage in IT93K-452-1 variety (9.33%).

Table 5 shows the seedling weight of three cowpea varieties at different storage period as affected by planting date. At zero storage, the seedlings of plants sown on 1st and 14th July had significantly higher seedling weight (1.01 and 1.03 g/plant respectively) than those sown earlier or later (0.64 -0.92 g/plant). The least seedling weight was obtained in plants sown on 19th May (0.64 g/plant). At 2 weeks in storage,

plants sown on 11th of August had significantly higher seedling weight (0.89 g/plant) than those planted on other dates (0.53 – 0.74 g/plant) except 28th of July. At 4 weeks in storage, plants sown on 11th August, 25th August, 28th July, 1st July and 16th June had significantly higher seedling weight (0.72 – 0.77 g/plant) than those planted on other planting dates (0.34 – 0.57 g/plant). At 6 and 8 WIS, seeds harvested from plants sown on 11th and 25th August had significantly higher seedling weight than those obtained in other planting date. Before and during storage, seeds of plants sown on 19th May had the least seedling weight. Generally, Kanannado variety had significantly higher seedling weight than the other two varieties in the first 4 weeks of storage. After 4 WIS however, IT93K-452-1 variety had significantly higher seedling weight than Kanannado. Oloyin consistently recorded the least seedling weight before and during storage.

Table 6 shows the interaction between planting date and variety on seedling weight of cowpea at 0 and 8 WIS. Before storage, seeds obtained from Oloyin plants sown between 1st July and 11th August had significantly higher seedling weight than other planting dates (0.82 – 0.98 g/plant). The least value was recorded in plants sown on 19th May (0.12 g/plant). In Kanannado variety, seeds obtained from plants sown on 14th July had significantly higher seedling weight (1.38 g/plant) than other planting dates (0.97 -1.16 g/plant) but the value was at par with what was recorded in plants sown on 1st July (1.29 g/plant). In IT93K-452-1 variety, seeds obtained from plants sown between 19th May and 11th August had similar seedling weight (0.81 -0.96 g/plant) which were significantly higher than the seedling weight obtained in seeds of plants sown on September 8th which had the least seedling weight (0.65 g/plant). At late storage however (8 WIS), all the Oloyin seeds irrespective of the planting dates had lost their vigour except those obtained from plants sown on 11th and 25th August (0.56 and 0.49 g/plant respectively). In Kanannado, seeds obtained from plants sown on 11th and 25th August had the highest seedling weight (0.52 and 0.48 g/plant respectively) which was at par with the seedling weight of seeds obtained from plants sown on 1st and 28th July (0.45 and 0.44 g/plant respectively). Seeds obtained from Kanannado plants sown on 19th May, 14th July and 8th September had completely lost their vigour at this storage period. Seeds obtained from IT93K-452-1 plants sown on 11th and 25th August had the highest seedling weight (0.59 g/plant). The value was at par with the weight obtained in seeds of plants sown on 16th June and 1st July (0.58 and 0.49 g/plant respectively). The least seedling weight was recorded in seeds of plants sown on 19th May (0.29 g/plant). Generally, IT93K-452-1 seeds had significantly higher seedling weight in late storage than the remaining varieties. Though generally in the three varieties, vigour reduced with age but none of the IT93K-452-1 seeds completely lost its vigour in storage irrespective of the planting date unlike the remaining varieties tested.

The speed of germination generally increased as planting date advances up to 25th of August after which there was a decline in plants sown on 8th September before and during storage (Table 7). Seeds obtained from plants sown on 11th and 25th August had similar speed of germination which were significantly higher than those obtained from plants sown earlier or later. Kanannado and IT93K-452-1 plants had similar speed of germination which were significantly higher than the speed of germination of Oloyin seeds before storage up till mid storage (4 WIS). At late storage however (6-8 WIS), IT93K-452-1 plants germinated with significantly higher speed than Kanannado. Throughout the storage period, Oloyin variety had the least speed of germination. Generally, the speed of germination reduced as the seeds aged.

The interaction between planting date and variety on speed of germination is shown on Table 8. The speed of germination of Oloyin seeds increased as the planting date of the mother plants advanced with seeds of plants sown from 11th August up to 8th September having significantly higher speed of germination (25.91 – 27.86) than plants sown earlier (1.32 -16.86). In Kanannado variety, plants sown on 1st July had the highest speed of germination (26.57) and the value was at par with the speed recorded in seeds obtained from plants sown on 19th May, 2nd June and 25th August. In IT93K-452-1 seeds however, seeds obtained from plants sown from 16th June up to 8th September germinated with similar speed (22.95 – 26.91)which were significantly higher than the speed of seeds obtained from plants sown earlier than 16th June (12.81 -16.91). At late storage however (8 WIS), the speed of germination of Oloyin seeds harvested from plants sown on 11th and 25th August were similar (3.24 and 4.48 respectively). Seeds of Oloyin variety harvested from plants sown on other planting dates had lost their viability. Seeds of Kanannado plants sown on 11th and 25th August had the highest speed of germination (3.95 and 4.62). Seeds obtained from Kanannado plants sown on 19th May, 14th July and 8th September were no longer viable at this storage period. Seeds obtained from IT93K-452-1 plants sown between 28th July and 25th August had significantly higher speed of germination (7.00 - 8.86) than seeds obtained from plants sown earlier (1.52 – 5.38).

Generally, IT93K-452-1 seeds had higher speed of germination in late storage than the remaining varieties.

Before storage, plants sown on 11th August had the highest seedling vigour index (21.49) followed by those sown on 25th August (15.75) which had similar values with seeds obtained from plants sown on 14th and 28th July (Table 9). The least vigour was obtained from seeds obtained from plants sown between 19th May and 16th June (6.94 – 7.96). At 2 weeks in storage, seeds obtained from plants sown on 11th August maintained the highest vigour (20.81) followed by seeds obtained from plants sown on 28th July and 25th August (15.38 and 14.33 respectively). The least vigour was recorded in plants sown on 8th September (8.04). At 4 WIS, seeds obtained from plants sown between 14th July and 11th August (20.55 -22.39) had similar vigour and were significantly higher than the vigour of the seeds obtained from the other planting dates. The least was obtained in plants sown between 19th May and 2nd June (7.00 and 5.98 respectively). At 6 and 8 WIS however, seeds obtained from plants sown in August (11th and 25th) had significantly higher vigour than seeds obtained from plants sown on other dates. Before and throughout the storage period, the order of vigour among the varieties was IT93K-452-1 > Kanannado > Oloyin.

The interaction between planting date and variety on seedling vigour index is presented on Table 10. Before storage, Oloyin seeds obtained from plants sown in August (11th and 25th) had the highest vigour (20.90 and 18.63 respectively) followed by seeds of plants sown on 14th and 28th July and 8th September which had similar vigour index (12.19 -14.03). The least vigour was obtained in seeds of plants sown on 19th May and 2nd June (0.00). In Kanannado variety, seeds of plants sown on 11th August had the highest vigour index (19.77) followed by the seed of those sown in July (1st, 14th and 28th) and 25th August (11.50 – 14.5). The least vigour was recorded in those sown on 19th May, 16th June and 8th September (6.27 – 8.7). In IT93K-452-1 variety, plants sown on 28th July and 11th August had the highest vigour (20.53 and 23.80 respectively) followed by plants sown on 1st and 14th July and 25th August (16.31, 17.90 and 16.61 respectively). The least was obtained in seeds of plants sown on 16th June and 8th September (10.04 and 10.92 respectively). At late storage (8 WIS), only Oloyin seeds obtained from plants sown on 11th and 25th August maintained their vigour (1.62 and 1.94 respectively). Oloyin seeds obtained from plants sown on other planting dates had already lost their vigour at this storage period. Kanannnado seeds obtained from plants sown on 19th May, 14th July and 8th September had equally lost their vigour. The highest vigour in Kanannado was obtained in seeds of plants sown on 11th and 25th August as well as 1st July (1.79, 1.81 and 1.31 respectively). None of IT93K-452-1 seeds completely lost its vigour throughout the storage period. However, the highest vigour was recorded in seeds of plants sown between 28th July and 25th August (3.61 -4.07) followed by those sown on other planting dates (1.40 -2.16) except seeds produced by plants sown on 19th May which had the least vigour (0.42) at late storage.

DISCUSSION

The significantly lower grain yield recorded in Kanannado plants sown early could be attributed to the photoperiod sensitivity of the variety which made those planted early to flower late. This conforms with the earlier report of Dudge *et al*. (2009) who reported that when cowpeas are planted early, photosensitive varieties (semierect and prostrate varieties) will not flower but grow very leafy and yield may be reduced. The significantly higher GP and seedling weight recorded in Kanannado during early storage in this study could be as a result of its larger seed size. Genetic variation is the cause of variation in size of seed between varieties. This is caused by flow of nutrients into the seed on the mother plant. Larger seeds mobilize food reserves better to the growing seedlings (Creech, 2012). Roy *et al.* (1996) reported that germination rate and seedling vigour index values increased with increase in seed size of rice. Though Kanannado seeds had the significantly highest GP at early storage, this did not translate to highest vigour in Kanannado seeds. This result is similar to the report of Creech (2012) who asserted that seeds can be viable and have low vigour which results in low rates or speed of germination. Causes of low seed vigour can include any combination of the following: genetic constitution, environment and nutrition of mother-plant, stage of maturity at harvest, seed size and weight, mechanical integrity, deterioration and ageing, and pathogens (AOSA, 2002). Highly vigorous seeds can withstand severe field conditions which increase the yield of crop.

The variation in the viability, vigour and longevity of the three varieties is in line with the report of Ibrahim *et al.* (2017) who reported that seed quality vary with genotype. Stewart *et al.* (1999) equally observed that germination characteristics are driven by the genetics of each plant and also influenced by maternal environment.

The decline in viability and vigour of seeds with storage time suggests that deterioration sets in as the seeds age. Deterioration of seeds occur as decrease in

germination percentage, production of weak seedlings, loss of vigour, which leads to reduced viability and ultimately seed death. The rate of deterioration in seeds flunctuates critically from one variety to the other (Akintobi *et al*., 2017). In this study, the rate of deterioration was faster in Oloyin followed by Kanannado and IT93K-452-1 had the least, indicating that IT93K-452-1 is of higher longevity than the other two varieties. The significantly higher seed yield, vigour and longevity recorded in IT93K-452-1 is not surprising because it is an improved variety compared to the other two which are landraces. This indicates that it is of superior physiological and genetic quality. This further confirms the need to use improved varieties to improve the yield of cowpea.

CONCLUSION AND RECOMMENDATIONS

It is concluded from this study that IT93K-452-1 had the highest seed yield and quality among all the tested varieties and planting around 11th of August is recommended for cowpea farmers in the study area for optimum seed yield and quality.

Table 1: 100-seed weight of three cowpea varieties sown at different planting date

	Variety		
Planting date	Oloyin	Kanannado	IT93K-452-1
19th May	20.94hij	27.55abc	22.18gh
2nd June	21.27ghi	26.98bc	20.30ijk
16th June	22.23gh	27.72abc	19.75jk
1st July	21.94gh	28.59a	21.18ghi
14th July	21.27ghi	28.22ab	19.77jk
28th July	22.40g	26.68cd	20.38ijk
11th August	24.72ef	27.21bc	19.27k
25th August	24.01f	27.02bc	19.82jk
8th September	22.13gh	25.27de	20.32ijk
SE+		0.46	

Means with dissimilar alphabets are significantly different using LSD at P=0.05, SE- standard error of the mean.

Table 2: Seed yield of three cowpea varieties sown at different planting date

	Variety		
Planting date	Oloyin	Kanannado	IT93K-452-1
19th May	1506.11bc	175.51kl	2013.501a
2nd June	790.81e-j	461.09jkl	1270.50c-e
16th June	1042.09c-g	548.25h-k	1424.32cd
1st July	1447.23bcd	180.97kl	1927.11ab
14th July	1155.44c-e	141.94l	1183.41cde
28th July	975.24d-i	997.99d-h	1137.40c-e
11th August	1066.35c-f	637.34f-k	1307.23cd
25th August	429.67jkl	261.20kl	486.79i-l
8th September	365.15jkl	198.75kl	570.82g-k
SE+		173	

Means with dissimilar alphabets are significantly different using LSD at P=0.05, SE- standard error of the mean.

Table 3: Germination percentage of cowpea varieties at different storage period as affected by planting date

		Weeks in storage			
Treatments	**0**	**2**	**4**	**6**	**8**
Planting date (P)					
19th May	60.44f	57.77d	30.66c	14.66e	3.11d
2nd June	61.33f	58.66d	28.00c	16.00e	9.77bc
16th June	74.66e	83.11c	60.00b	32.88cd	11.55bc
1st July	80.00d	80.44c	65.33b	27.55cd	9.33bc
14th July	90.22bc	94.66b	77.77a	32.44cd	6.66cd
28th July	88.89c	93.77b	84.00a	37.77c	14.66b
11th August	97.77a	100.00a	99.22a	50.66b	20.44a
25th August	99.11a	99.55a	86.66a	61.33a	23.11a
8th September	95.11ab	97.33ab	82.22a	23.11de	6.66cd
Varieties (V)					
Oloyin	59.25c	64.88c	48.59b	17.33c	4.29c
Kanannado	98.66a	98.37a	76.00a	24.00b	9.18b
IT93K-452-1	91.25b	91.85b	77.03a	57.48a	21.63a
Interaction					
P x V	**	**	**	**	**

Means with dissimilar alphabets are significantly different using LSD at P=0.05, ** -significant at P=0.01.

Table 4: Interaction between planting date and variety on germination percentage of cowpea at 0 and 8 weeks in storage (WIS)

	Variety					
	Oloyin		Kanannado		IT93K-452-1	
Planting date	**0 WIS**	**8 WIS**	**0 WIS**	**8 WIS**	**0 WIS**	**8 WIS**
19th May	7.33g	0.00h	100.00a	0.00h	81.33c	9.33g
2nd June	14.67f	0.00h	100.00a	14.67efg	69.33d	14.67efg
16th June	34.67e	0.00h	100.00a	10.67g	89.33bc	24.00bcd
1st July	42.67e	0.00h	100.00a	12.00fg	97.33ab	16.00d-g
14th July	72.00d	0.00h	98.67a	0.00h	100a	20.00c-f
28th July	70.67d	0.00h	96.00ab	10.67g	100a	33.33a
11th August	98.67a	16.00d-g	100.00a	17.33d-g	94.67ab	28.00abc
25th August	100.00a	22.68b-c	100.00a	17.33d-g	97.33ab	29.33ab
8th September	100.00a	0.00h	93.33ab	0.00h	92.00ab	20.00c-f

Means with dissimilar alphabets are significantly different using LSD at P=0.05, WIS- weeks in storage

Table 5: Seedling weight of cowpea varieties at different storage period as affected by planting date

	Weeks in storage				
	0	**2**	**4**	**6**	**8**
Treatments					
Planting date (P)					
19th May	0.64d	0.53e	0.34c	0.18d	0.10d
2nd June	0.85bc	0.69cd	0.49b	0.23d	0.22c
16th June	0.78c	0.73bc	0.72a	0.35d	0.30bc
1st July	1.01a	0.64cd	0.76a	0.34c	0.31b
14th July	1.03a	0.60ed	0.57b	0.45b	0.13d
28th July	0.89b	0.81ab	0.74a	0.47b	0.29bc
11th August	0.92b	0.89a	0.77a	0.72a	0.55a
25th August	0.78c	0.73c	0.76a	0.69a	0.51a
8th September	0.78c	0.74bc	0.57b	0.52b	0.14d
SE±	0.010	0.011	0.015	0.011	0.008
Varieties (V)					
Oloyin	0.67c	0.58c	0.31c	0.31c	0.11c
Kanannado	1.09a	0.87a	0.76a	0.45b	0.27b
IT93K-452-1	0.80b	0.68b	0.64b	0.56b	0.47a
SE±	0.031	0.034	0.045	0.033	0.027
Interaction					
P x V	**	**	**	**	**

Means with dissimilar alphabets are significantly different using LSD at P=0.05, SE- standard error of the mean, ** - significant at P=0.01.

Table 6: Interaction effect of planting date and variety on seedling weight at 0 and 8 WIS

	Variety					
	0 WIS			8 WIS		
Planting date	**Oloyin**	**Kanannado**	**IT93K-452-1**	**Oloyin**	**Kanannado**	**IT93K-452-1**
19th May	0.12o	1.06cd	0.88f-j	0.00i	0.00i	0.29gh
2nd June	0.46n	1.16bc	0.96d-i	0.00i	0.25h	0.43ef
16th June	0.66m	0.93d-l	0.77j-m	0.00i	0.32fgh	0.58abc
1st July	0.90e-j	1.29ab	0.83g-k	0.00i	0.45c-f	0.49a-e
14th July	0.89f-j	1.38a	0.82h-l	0.00i	0.00i	0.41efg
28th July	0.82i-l	1.05cde	0.82h-l	0.00i	0.44def	0.46b-e
11th August	0.98d-g	0.97d-h	0.81i-l	0.56a-d	0.52a-e	0.59a
25th August	0.69k-m	1.00def	0.68lm	0.49a-e	0.48a-e	0.59a
8th September	0.72km	0.97dh	0.65m	0.00i	0.00i	0.44def
SE±		0.05			0.05	

Means with dissimilar alphabets are significantly different using LSD at P=0.05, SE- standard error of the mean, WIS- weeks in storage

Table 7: Speed of germination of cowpea varieties at different storage period as affected by planting date

Treatments	Weeks in storage				
	0	2	4	6	8
Planting date (P)					
19th May	13.94e	9.17e	5.76d	2.86de	0.56f
2nd June	13.64e	11.98d	5.22d	2.02e	1.12ef
16th June	17.67d	14.19c	12.70c	4.29cd	2.63c
1st July	19.30cd	13.76cd	13.44c	4.54cd	2.56cd
14th July	21.67bc	17.60b	18.44b	4.94c	1.46def
28th July	19.62cd	18.13b	20.89ab	5.57c	3.86b
11th August	25.38a	22.68a	22.22a	7.92b	4.73ab
25th August	26.10a	22.67a	21.98a	11.97a	5.83a
8th September	22.51b	18.37b	20.27ab	4.05cd	1.79cde
SE±	1.01	0.77	1.13	0.69	0.40
Varieties (V)					
Oloyin	14.89b	12.84b	10.85b	2.69b	0.86c
Kanannado	22.19a	18.25a	18.60a	3.26b	2.07b
IT93K-452-1	22.85a	18.43a	17.53a	10.09a	5.22a
SE±	0.59	0.44	0.66	0.40	0.23
Interaction					
P x V	**	**	**	**	**

Means with dissimilar alphabets are significantly different using LSD at P=0.05, SE- standard error of the mean, ** - significant at P=0.01.

Table 8: Interaction effect of planting date and variety on speed of germination at 0 and 8 WIS

Treatments	Variety					
	0 WIS			8 WIS		
Planting date	Oloyin	Kanannado	IT93K-452-1	Oloyin	Kanannado	IT93K-452-1
19th May	1.32j	24.91abc	16.91gh	0.00h	0.00h	1.67gh
2nd June	3.52ij	24.57abc	12.81h	0.00h	1.52gh	1.52gh
16th June	7.24i	20.57c-g	25.19abc	0.00h	2.38fg	5.52bc
1st July	6.86i	26.57ab	24.48a-d	0.00h	3.43d-g	4.24c-f
14th July	18.57e-g	19.52d-g	26.91ab	0.00h	0.00h	4.38cde
28th July	16.86gh	17.76fgh	24.24a-d	0.00h	2.71efg	8.86a
11th August	27.86a	22.24b-f	26.05ab	3.24e-g	3.95c-f	7.00a
25th August	27.24a	24.91abc	26.14ab	4.48cde	4.62cde	8.38a
8th September	25.91ab	18.67e-g	22.95a-e	0.00h	0.00h	5.38bcd
SE±		1.75			0.70	

Means with dissimilar alphabets are significantly different using LSD at P=0.05, SE- standard error of the mean, WIS- weeks in storage

Table 9: Seedling vigour index of cowpea varieties at different storage period as affected by planting date

Treatments	Weeks in storage				
	0	2	4	6	8
Planting date (P)					
19th May	7.47e	10.27ef	7.00d	1.36f	0.14d
2nd June	7.96de	10.20ef	5.98d	1.56f	0.89c
16th June	6.94e	12.64cd	12.63c	4.77de	0.85c
1st July	10.76c	9.21fg	15.59bc	4.10e	0.96c
14th July	15.47b	11.68de	20.55a	6.12d	0.47cd
28th July	15.66b	15.38b	20.85a	8.43c	1.67b
11th August	21.49a	20.81a	22.39a	11.30b	2.27a
25th August	15.75b	14.33bc	17.11b	13.62a	2.45a
8th September	10.11cd	8.04g	17.39b	4.44de	0.72c
SE±	0.83	0.67	1.10	0.68	0.20
Varieties (V)					
Oloyin	9.73c	9.77c	10.86c	2.52c	0.40c
Kanannado	11.68b	11.43b	14.98b	3.97b	0.77b
IT93K-452-1	15.79a	16.32a	20.65a	12.07a	2.31a
SE±	0.48	0.39	0.64	0.40	0.12
Interaction					
P x V	**	**	**	**	**

Means with dissimilar alphabets are significantly different using LSD at P=0.05, SE- standard error of the mean, ** - significant at P=0.01.

Table 10: Interaction effect of planting date and variety on seedling vigour index at 0 and 8 WIS

	Variety					
		0 WIS			8 WIS	
Planting date	**Oloyin**	**Kanannado**	**IT93K-452-1**	**Oloyin**	**Kanannado**	**IT93K-452-1**
19th May	0.00l	8.67ij	13.74fgh	0.00g	0.00g	0.42ef
2nd June	0.00l	11.63ghi	12.24ghi	0.00g	0.67d-g	1.99b
16th June	4.28k	6.53jk	10.04hij	0.00g	0.40fg	2.16b
1st July	4.48k	11.50ghi	16.31def	0.00g	1.31b-f	1.58bcd
14th July	14.03e-h	14.67efg	17.90b-e	0.00g	0.00g	1.40b-e
28th July	12.19ghi	14.25efg	20.53abc	0.00g	0.93c-g	4.07a
11th August	20.90ab	19.77a-d	23.80a	1.62bcd	1.79bc	3.40a
25th August	18.63bcd	12.00ghi	16.61c-f	1.94b	1.81bc	3.61a
8th September	13.13fgh	6.27jk	10.92ghi	0.00g	0.00g	2.16b
SE±		1.43			0.35	

Means with dissimilar alphabets are significantly different using LSD at P=0.05, SE- standard error of the mean, WIS- weeks in storage

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