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Evaluation of Genetic Variations and Agronomic Performance of Some Cultivars of White Yam (*Dioscorea rotundata*) in Obio Akpa, Nigeria

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Abstract:
Field experiments were conducted in 2020 and 2021 at Teaching and Research Farm of Akwa Ibom State University, Ikot Ekaideh, Obio Akpa Campus, Oruk Anam Local Government Area of Akwa Ibom State to assess Genetic Variability and the Agronomic Performance of ten different cultivars of White Yam (Dioscorea rotundata). The experiments were laid out in a Randomized Complete Block design (RCBD) and replicated three times. Data analysis was done using statistical software (SPSS 20 version). Results indicated differences for some of the traits studied. However, there was a significant difference (P<0.05) for the number of tubers, the weight of tubers, stem number plant, and sprout length. The genetic variability assessment indicated that the phenotype of Variation (PCV) was higher than the Genotypic Coefficient of Variation (GCV) in all the traits, which suggests the influence of the environment on the study genotypes. Moderate heritability and genetic advance values were recorded for sprout length, plant vigor at 8 weeks, plant vigor at 16 weeks, plant vigor at 32 weeks, and number and weight of tubers suggesting that these traits as a good selection for improvement. However, high heritability and Genetic Advance value were recorded for sprout length suggesting the selection for improvement on this trait will be successful. Hence, cultivar TDR110180, TRD 1401593, TDR 1401785, and TDR 1100128 tend to be the preferred cultivars of white yam for improvement as they exhibited the longest sprout length, maximum mean number, and weight of yam tuber and were earliest to attend plant vigor at 8, 16 and 32 weeks after planting respectively.

Keywords: *Dioscorea rotundata, variability, heritability, genetic advance, cultivars*

1. Introduction

Yam is one of the tuber crops of Dioscoreaceae origin. Yam has many species, but the species that have economic values are white yam (*Dioscorea rotundata)*, also known as white guinea yam in some parts of West African countries; water yam (*D.alata), D.cayenensis, D.dumetorum, D.bulbifera,* and *D.esculenta*. White yam (*D.rotundata)* is the most widely cultivated among these yam species. According to Food and Agricultural Organization statistics, the Global yam production was projected at 58.7million tons in 2012, with West Africa generating more than 92 percent as Nigeria and Ghana produced about 66percent of the world's yam supplies (FAOSTAT, 2014).

The production of yam starts when whole seed tubers are planted on mounds or ridges, and it is done at the onset of the rainy season. High productivity in yam depends on the way and the place the sets are planted, sizes of mounds, plant density, and availability of staking materials for the twinning vines, the varieties of yam and tuber sizes desired at harvest. West and Central Africa farmers, especially macro-farmers, usually intercrop yams with cereals and vegetables (IPGRI/IITA, 1997). This discouraged sufficient yield during harvest.

The seed yams can decay easily, and it is bulky to transport. After harvesting, farmers reserved about 30% of the yield for the next planting season. Farmers are faced with storage problems as yam seeds are widely known to decay within a short period, and yam crops are largely affected by insect pests and fungal and viral diseases. Yam growth and dormant phases relate to the period (wet and dry seasons). Calverly (1998) suggests that yams require a humid tropical environment with annual rainfall over 1500 mm evenly distributed throughout the growing season for high yield. Characteristically, white, yellow, and water yams produce a single large tuber of about 5-10kg annually.

The main aim of plant breeders in any crop improvement programme is to develop and release cultivars that can be stable in a wide range of different environments (Alghamdi, 2004). This can be achieved when consumers accept the improved varieties. Over time, plant breeding programmes were mostly based on high-yielding cultivars, but in recent times, stable and sustainable yields under different conditions have gained importance over increased yield. However, despite the economic significance of white yam as food and source of income, there exists an insignificant number of improved species for cultivation by local farmers, as the case in Akwa Ibom State. This development left many farmers with no choice or inadequate knowledge of the preferred white yam cultivar that is suitable and favours our immediate environmental conditions, eventually leading to massive and marketable yield.

In view of the issue raised above, this study investigates the comparative performance of different white yam cultivars in relation to agronomic and genetic variations to identify superior genotypes with desirable growth and yield characteristics that befit the environmental conditions of Obio-Akpa.

2. Materials and Methods

The study was conducted at the Teaching and Research Farms, Department of Crop Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus, Akwa Ibom State, Nigeria, which lies between the latitude $4^o31'$ and $5^o30'$ and Longitude $8^o30'$ and $8^o00'$E. It has an annual rainfall of about 2000mm-2500mm per annum. The rainfall in this area is binomial, with a long rainy season from April to August and a short dry season from late August to September (usually termed August break). The temperature range is between $25-27^0C$, Relative humidity is 75-79%, and the soil is sandy loam.

Ten cultivars of white yam were used for the study. The choice of materials was based on their acceptability by consumers and widespread cultivation in Obio Akpa, Oruk Anam Local Government Area. The planting materials were obtained from the National Root Crops Research Institute (NRCRI) Umudike, Abia State.

The experiments were laid out in a Randomized Completely Block Design (RCBD) with three replicates and ten genotypes namely; TDr110028, TDr1100180, TDr0900135, TDr1000021, TDr1401220, TDr8902665, TDr0900295, TDr1400537, TDr1401785, and TDr1401593. The plots were 34m long and 12m wide. The ridges were 25 cm high, and interplant spacing was 1 m with 1 m lagging between the last plant on each row and the end of the row. Inter-row spacing was also 1 m, with 1 m spacing between replicates. This gave an experimental unit of 408m².

Planting of the cultivars was done in June 2020 and June 2021. Ridges were made using hand hoe (Land Preparation). The yam setts used weighed 150g each and were planted at a plant spacing of 1m x 1m by hand, and this gave a plant population of 100 plants/experimental unit and 300 plants/hectare. After emergence, routine weed was carried out to reduce competition for the soil nutrient. Fertilizer (NPK) was applied at 40g/plant. Vine twinning was provided with adequate support by staking upon emergence. White yam was harvested manually after seven months of planting. Harvested tubers were washed of soil adhered to it and weighed immediately.

Also, data were collected on agronomic and yield parameters. Data collected on agronomic parameters were:

- Days of First Sprout Emergence,
- Days to 50 percent Emergence,
- Sprout length (cm),
- Days to First Flower Invitation,
- Date of 50 percent flowering,
- Plant Vigor at 8, 16, and 32 Weeks after Planting,
- Stem Number per Plant,
- Days of 50 percent Senescence,
- Senescence stage and
- Days to 100% senescence

Data collected on yield parameters were the total number of tubers per genotype and the weight of tubers (kg). In addition, field data were computed and subjected to Analysis of variance (ANOVA) using the Generalized Linear Model. SPSS software version 20 was used for the analysis and means to select the best yam cultivars and traits, various variance components of the genotype were also estimated, namely: The Phenotypic Coefficients of Variation (PCV), Genotypic Coefficients of Variation (GCV), Phenotypic Variance (δ_p^2), Genotypic Variance (δ_g^2), Heritability (h_b^2), Genetic Advance (GA) and Percentage Mean (GAM), Correlation coefficient (r) defined as:

i. Environmental variance $(\delta_e^2) = MS_e = \frac{SS_e}{(t-1)(r-1)}$ (1)

ii. Phenotypic variance $(\delta_p^2) = \delta_g^2 + \delta_e^2$ (2)

iii. Genotypic variance $(\delta_g^2) = \frac{MS_g - MS_e}{r}$ (3)

iv. Phenotypic Coefficient of Variance (PCV) $= \frac{\sqrt{\delta_p^2}}{\bar{X}} * 100$ (4)

v. Genotypic Coefficient of Variance (GCV) $= \frac{\sqrt{\delta_g^2}}{\bar{X}} * 100$ (5)

vi. Heritability in Broad Sense $h_b^2 = \frac{\delta_g^2}{\delta_p^2} * 100$ (6)

vii. Genetic Advance $GA = \frac{K * \sqrt{\delta_p^2 * \delta_g^2}}{\delta_p^2}$ (7)

Where:

MS_e = Mean square error.

MS_g = Mean square Genotype.

MS_r = Mean square Genotype

r = $number\ of\ replicates$
$\bar{X}$ = Grand mean of a Parameter

viii $$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2(y-\bar{y})^2}} \quad (8)$$

$x =\ of\ variable\ x$
$y = variable\ x$
$\bar{x} = mean\ value\ of\ variable\ x$
$\bar{y} = mean\ value\ of\ variable\ y$
$r = Correlation\ coefficient$

3. Results and Discussion

3.1. Agronomic Performance

The ten cultivars of *D. rotundata* evaluated exhibited some degrees of variations in some of the quantitative and qualitative traits. Phenotypic diversity was high in stem number and plant vigors at various stages of development. All the cultivars had determined growth habits. The Agronomic characteristics of the evaluated cultivars are presented in table 1. Consequently, the *First Sprout Emergence* was recorded in TDr 1401593 (16 days), which was followed by TDr 1401785 (16 days), TDr 1000021 (16 days), and TDr 1100180(16 days), while the last sprout emerged by TDR 1401220 after 19.4 days. The earliest flowering at 50 percent was recorded in TDr 0900295(72.7 days), which was followed by TDr 1100180 (85.7 days), TDr 1401220 (80.5 days). While TDr 1100128 was the last to attain 50 percent flower with a record of 94.8 days. Also, genotype TDr 1401220 first attained 50 percent emergence in 29.4 days, followed by TDr 0900135 (30 days) and TDr 0900295 (30.7 days). However, genotype TDr 1401593 recorded the highest average day (40.8 days) to attain days to 50 percent emergence.

The white yam cultivars spent an average of 177.2 days to attain 100 percent Senescence, TDR 8902665 earliest attain 100 percent senescence in 173.5 days, followed by TDR 0900135 (174.4 days), TDr1401785 (174.4 days), but, TDr 1401593 was the last to attained 100% senescence in 181.5 days.

The Combine Analysis for 2020 and 2021 showed an insignificant difference in the mean values recorded for plant vigor at eight (8), sixteen (16), and thirty-two (32) weeks after the plant of among the different white yam cultivars. Maximum sprout length was recorded in TDr 1100180 (197.1 cm) followed by TDr 1401220 (122.2 cm), TDr 0900295 (101.5 cm). Maximum number of tubers was recorded in TDr 1401593 (39), followed by TDr1401785 (30), TDr 1401220 (30), and TDr 1100180 (30). Tuber weight ranged from 10kg (TDr 0900295) to 18kg (TDr 1100128) per genotype followed by TDr 1100180 (16kg), and 1401220 (16kg).

Estimates of genetic variability of vegetative and yield components of the investigated yam genotypes are presented in table 2. The combined analysis of the variance components showed significant variation in the environmental and genotype effect in some of the attributes considered.

The genetic variation for days to 50 percent flowering, days to 50 percent senescence, days to 100 percent senescence, plant vigor at 8, 16, 32 WAP, days to first sprout emergence, and days to 50 percent emergence were not significant as the $p>0.05$. However, Sprout Length, number of tubers, the weight of tubers, and stem number of the plant were significant at $p<0.05$

The estimate of the correlation coefficient of vegetative components of the investigated yam genotypes is presented in table 3. The combined analysis using the Pearson correlation test results found that some of the vegetative components considered are not significantly correlated. However, there was a significant relationship among the parameters like days to first sprout emergence (DAYFE) and Day to 50 percent Emergence (DAYSE): (-0.825**); Senescence (days) (DAYHS) and Days to 50 percent Senescence (DATS): (0.669*); Plant Vigor at 16 WAP (PLNV16) and Plant Vigor 8WAP (PLNV8): (0.929**); Plant Vigor at 32 WAP (PLNV32) and Plant Vigor 8WAP (PLNV8): (0.929**); Plant Vigor at 32 WAP (PLNV32) and Plant Vigor 16WAP (PLNV16): (1.000**).

The analysis further showed that the average number of yam tubers is strongly related to the average weight of the tubers (Kg).

The Coefficient of variation studied indicated that estimates of Phenotypic Coefficient of Variation (PCV) were higher than the corresponding Genotypic Coefficient of Variation (GCV) for all the traits in the combined years 2020 and 2021, as shown in table 4. This suggested that all the genotypes in both years interacted with the environment to some extent. This corresponds with the finding of Bhadru *et al.* (2012), who investigated the agronomic and genetic performance of rice. The PCV ranged from 2.16% for Days to 50 percent Senescence to 44.55% for Sprout Length. Similarly, GCV ranged from 1.6% for Days to 50 percent Senescence to 27.98% for Sprout Length. According to Deshmukh et al. (1986), PCV and GCV values greater than 20% are considered high. In contrast, values less than 10 percent are considered low, and values between 10 percent and 20 percent are considered medium. Based on this argument, the combined analysis of 2020 and 2021 revealed that PCV values for Sprout Length (44.55%), Stem number plant (33.99%, 33.85%), Plant Vigor at 8 WAP (30.23%), Plant Vigor at 16 WAP (28.29) and Plant Vigor at 32 WAP (28.078%) were high. On the other hand, medium PCV values were recorded for only Days to 50% Emergence (11.66%), the number of tubers (12.99%), and weight of tuber (11.32%); while days to 50 percent flowering, days to 50 percent senescence and days to 100 percent senescence recorded low PCV.

GCV values for Sprout Length (27.98 %) were high. Medium GCV values were recorded for Plant vigor at16 WAP (14.64%), Plant vigor at 32 WAP (114.20%). Plant Vigor at 8 WAP (17.03%) and plant stem (13.33%). In contrast, the number of tubers, the weight of tubers, days to 50 percent emergence, days to first sprout emergence, days to 50 percent flowering, and days to 50 percent senescence were low.

These results suggest that selection may be effective based on parameters with high or medium PCV and GCV values. In addition, their phenotypic expression would be a good indication of genetic potential. These parameters are; Sprout Length, Stem number plant, Plant Vigor at 8 WAP, Plant Vigor at 16 WAP and Plant Vigor at 32 WAP, Weight of tubers, and Number of Tubers.

The estimates of heritability act as a predictive instrument in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular trait. Heritability is classified as low (below 30%), medium (30-60%), and high (above 60%), as suggested by Johnson *et al.* (1955). The high heritability was noted in genotypes like Days to 50 percent flowering (71.26%), Days to 50 percent Senescence (54.7%), Weight of Tubers (48.9%), Sprout Length (39.45), days to 100 percent Senescence (37.98%) and Plant Vigor at 8 WAP (31.72%). On the other hand, the Days to First Sprout Emergence, the weight of tuber, Plant vigor at 16 WAP, plant vigor at 32WAP, days to 50 percent emergence, and stem number of the plant were observed to possess the lowest heritability. This showed that these traits are highly affected by the environment, and genetic improvement through selection will be slow.

However, moderately high heritability values indicate that the environment less influences the traits under study in their expression and that selecting such traits/genotype(s) will be effective. The plant breeder, therefore, may make his selection safely based on the phenotypic expression of these traits in the individual plant by adopting simple selection methods.

This finding is similar to results earlier reported by Bihari *et al.* (2004) for days to 50 percent flowering and test weight, Sankar *et al*. (2006) for days to 50 percent flowering, plant height, panicle length, grains per panicle, and test weight and Karthikeyan *et al.* (2009) for days to 50 percent flowering and 1000 grain weight. Similarly, Gidey et al. (2012) reported high heritability values for days to 50% flowering, and Siva et al. (2013) reported a similar result.

Nevertheless, Jones et al. (1986) suggested that a heritability above 60% in sweet potatoes is quite adequate for good selection advance. Estimates as low as 40% could also be considered favourable, provided the selection procedure has enough precision. Therefore, the selected parameters are:

- Days to 50% Flowering,
- Days to 50% Senescence,
- Sprout Length,
- Days to 100% Senescence and
- Plant Vigor at 8 WAP

When heritability estimates are high, the traits are expected to remain stable in different environmental conditions and could easily be improved through selection (Siddique et al., 2006). However, Johnson et al. (1955) and Shulka et al. (2006) accentuated the use of both heritability and genetic advance for reliability selection. They did it because a high amount of heritability alone is insufficient to improve selection in breeding programmes.

Hence, high heritability and genetic advance mean observed for sprout length (39.45% and 38.95%) suggest that selection for improvement of this character will be successful. Similarly, Cultivar TDr 1100180 was the preferred genotype and can be used for improvement through selection as it exhibited the longest sprout length.

Clonal Names/ Genotypes	Days to 1st Sprout Emergence	Days to 50 Percent Emergence	Days to 50 Percent Flowering	Days to 50 Percent Senescence	Days to 100 Percent Senescence	Senescence Stage	Sprout Length
TDR 1100128	18.5	33.2	94.8	154.7	176.4	3.7	98.9
TDR 1100180	18.0	33.9	85.7	154.7	179.4	4.9	197.1
TDR 0900135	18.8	30.0	90.0	152.8	174.4	4.5	93.8
TDR 1000021	18.0	33.4	87.9	154.7	179.4	4.5	106.7
TDR 1401220	19.4	29.4	80.5	153.5	176.7	3.4	122.2
TDR 8902665	18.4	34.2	86.5	154.2	173.5	4.0	86.7
TDR 0900295	18.8	30.7	72.7	159.0	180.5	3.7	101.5
TDR 1400537	19.0	35.7	90.2	155.3	176.4	3.9	75.6
TDR1401785	18.0	34.5	88.2	154.7	174.4	5.0	96.2
TDR1401593	16.7	40.8	89.4	156.4	181.5	4.9	95.6
Total	183.5	335.5	865.8	1549.7	1772.3	42.3	1074.1
$\bar{X}$	18.3	33.5	86.6	155.0	177.2	4.2	107.4
SE(+/-)	0.2	1.0	1.9	0.5	0.9	0.2	10.7
CV%	4.1	9.8	7.0	1.1	1.6	13.9	31.4

Table 1: Combine Analysis for 2020 and 2021 Average Values of Agronomic Trait of Yam

Where $\bar{X}$ Grand mean, SE (+/-): Standard Error, CV%: Coefficient of Variation

Clonal Names/ Genotypes	PV at 8 Weeks After Planting	PV at 16 Weeks After Planting	PV at 32 Weeks After Planting	Stem Number Plant
TDR 1100128	2.50	2.50	2.50	1.00
TDR 1100180	2.50	2.50	2.50	1.35
TDR 0900135	2.50	2.35	2.35	1.85
TDR 1000021	2.17	2.35	2.35	1.15
TDR 1401220	2.34	2.35	2.35	1.30
TDR 8902665	2.17	2.15	2.15	1.50
TDR 0900295	2.50	2.35	2.35	1.70
TDR 1400537	2.17	2.15	2.15	1.35
TDR1401785	1.67	1.65	1.65	2.00
TDR1401593	2.34	2.35	2.35	1.30
Total	22.83	22.70	22.70	14.50
$\bar{X}$	2.28	2.27	2.27	1.45
SE(+/-)	0.08	0.08	0.08	0.10
CV%	11.47	10.90	10.90	21.63

Table 2: Combine Analysis for 2020 and 2021 Average Values of Agronomic Trait of Yam

S/N	Clonal Names/ Genotypes	No. of Marketable Tubers	No. of Non-Marketable Tubers	Total No. of Tuber	Marketable Weight (Kg)	Non-Marketable Weight (Kg)	Total Weight (Kg)
1	TDR 1100128	7	22	29	7	11	18
2	TDR 1100180	3	27	30	4	12	16
3	TDR 0900135	4	13	17	5	6	11
4	TDR 1000021	4	16	20	6	6	12
5	TDR 1401220	4	26	30	7	9	16
6	TDR 8902665	2	26	28	3	7	10
7	TDR 0900295	5	21	26	4	6	10
8	TDR 1400537	5	16	21	8	7	15
9	TDR1401785	6	24	30	7	8	15
10	TDR 1401593	8	31	39	10	9	19
	TOTAL	48.00	222	270.0	61.00	81.0	142.0
	$\bar{X}$	4.80	22.2	27.00	6.10	8.10	14.20
	SE	0.60	1.80	2.00	0.70	0.70	1.00
	CV%	37.78	25.82	23.49	34.95	26.32	22.95

Table 3: Combine Analyses for 2020 and 2021 for the Average Number and weight (kg) of yam

$\bar{X}$ *Where: Grand mean, SE (+/-)**:** Standard Error, CV%: Coefficient of Variation*

Parameter	$\bar{X}$	MS_g	MS_r	δ_e^2	p-value (g)
Number Of Tubers	27	**19.08***	3.85	8.91	**0.029**
Weight Of Tubers	14.2	**5.11***	23.66	1.32	**0.001**
Plant Vigor at 8 WAP	2.3	0.79	0.02	0.33	0.801
Plant Vigor at 16 WAP	2.3	0.65	0.35	0.31	0.628
Plant Vigor at 32 WAP	2.3	0.63	0.35	0.31	0.722
Days to 1st Sprout Emergence	18.3	1.61	11.45	1.29	0.062
Days to 50 percent Emergence	33.5	19.75	357.27	13.02	0.082
Days to 50 percent Flowering	86.6	21.77	1.19	2.58	0.080
Stem Number Plant	1.5	0.34*	0.17	0.22	0.003
Days to 50 percent Senescence	155	23.48	1.09	5.08	0.085
Days to 100percent Senescence	177.2	85.8	59.93	30.24	0.092
Sprout Length	107.4	4096.23*	4417.9	1386.29	0.015

Table 4: Combined Analysis of Variance for Agronomic and Yield Trait for 2020 and 2021

$\bar{X}$ *=Mean,* MS_g *=Mean square of genotype,* MS_r*=Mean square of Replicate,* $MS_e = \delta_e^2$ *= Mean Square of Error*

** Significant at 0.05 Significance Level as Their P-Value Less Than 0.05, (For a Parameter to Be Significant the P-Value Must Be Less than 0.05)*

	DAYFE	DAYSE	DATF	DATS	DAYHS	SPLENG	PLNV8	PLNV16	PLNV32	STNP	No of Yam	Weight of Yam
DAYFE	1	-0.825**	-0.31	-0.23	-0.47	-0.76**	-0.11	0.17	0.05	0.05	-0.58	-0.39
DAYSE	-0.825**	1	0.44	0.25	0.34	0.53	-0.14	-0.27	-0.16	-0.16	0.56	0.52
DATF	-0.31	0.44	1	-0.55	-0.35	0.33	-0.20	-0.17	-0.05	-0.05	-0.05	0.45
DATS	-0.23	0.25	-0.55	1	0.66*	-0.09	-0.09	0.13	0.06	0.06	0.28	-0.07
DAYHS	-0.47	0.34	-0.35	0.66*	1	0.15	0.35	0.40	0.50	0.50	0.36	0.29
SPLENG	-0.765**	0.53	0.33	-0.09	0.15	1	0.28	-0.35	-0.30	-0.30	0.20	0.18
PLNV8	-0.11	-0.14	-0.20	-0.09	0.35	0.28	1	0.33	0.41	0.41	0.23	0.22
PLNV16	0.17	-0.27	-0.17	0.13	0.40	-0.35	0.33	1	0.935**	0.935**	-0.06	0.02
PLNV32	0.05	-0.16	-0.05	0.06	0.50	-0.30	0.41	0.935**	1	1.000**	-0.02	0.13
STNP	0.05	-0.16	-0.05	0.06	0.50	-0.30	0.41	0.935**	1.000**	1	-0.02	0.13
No of Yam	-0.58	0.56	-0.05	0.28	0.36	0.20	0.23	-0.06	-0.02	-0.02	1	0.650*
Weight of Yam	-0.39	0.52	0.45	-0.07	0.29	0.18	0.22	0.02	0.13	0.13	0.650*	1

Table 5: Correlation between Average Yield and Yield Related Components of the Investigated Different Yam Cultivars

DAYFE: Days of First Sprout Emergence (date), DAYSE: Days to 50% Emergence (date) SPLENG: Sprout length (cm), DATFI: Days to First Flower Initiation (date), DATF: Date of 50% flowering (date), PLNV: Plant Vigor (Scale), STNP: Stem Number per Plant (number), DATS: Days of 50% Senescence (date), DAYHS): Days to 100% senescence (days)

Parameter	δ_G^2	δ_P^2	PCV (%)	GCV (%)	h^2 (%)	GA	GAM (%)
Number of Tubers	12.3	3.39	12.99	6.82	27.56	1.99	7.39
Weight of Tubers	2.58	1.26	11.32	7.92	48.9	1.62	11.42
Plant Vigor at 8 WAP	0.48	0.15	30.23	17.03	31.72	0.46	19.78
Plant Vigor at 16 WAP	0.42	0.11	28.29	14.64	26.77	0.37	16.28
Plant Vigor at 32 WAP	0.42	0.11	28.07	14.2	25.6	0.34	14.82
Days to 1st Sprout Emergence	1.4	0.11	6.46	1.78	**7.64**	0.19	**1.02**
Days to 50 percent Emergence	15.26	2.24	11.66	4.47	14.7	1.18	3.54
Days to 50 percent Flowering	8.98	6.4	3.46	2.92	**71.26**	4.4	5.09
Stem Number Plant	0.26	0.04	33.99	13.33	15.38	0.16	10.79
Days to 50 percent Senescence	11.21	6.13	2.16	1.6	54.7	3.78	2.44
Days to 100 percent Senescence	48.76	18.52	3.94	2.43	37.98	5.47	3.09
Sprout Length	2,289.60	903.31	44.55	27.98	39.45	38.95	36.26

Table 6: Estimate of Variability, Heritability, and Genetic Advance for the Trait in Yam
***. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).*

Where; δ_g^2 =Genotypic variances, δ_p^2 = Phenotypic variances, h^2= heritability $GCV =$ Genotypic Coefficient of Variation, $PCV =$Phenotypic Coefficient of Variation, $GA =$ Genetic Advance, $GAM =$ Genetic Mean percent

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