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Genetic variability evaluation in yield and yield components in contrasting castor seed lines

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Abstract
A field trial was carried out in Enugu State University of Science and Technology, research farm to evaluate the genetic variability of nine genotypes of castor bean plant. Eight (8) accessions were selected from different areas within the agro-ecological zone under study, while a standard check was obtained from Ahmadu Bello University, Zaria.The study was carried out using a randomized complete block design with four replications. Genotypes grouping techniques was used to characterize the genotypes on group basis. Data was collected on number of pods/plant, 100 seed weight, capsule yield, seed yield/ plant and seed yield/plot. The results of the study showed that Zaria accession in 2012 show no significant (P<0. 05) yield difference to all the accessions. The significant and comparable large genotypic and phenotypic variance among the genotypes for all the characters considered in the study implies that there would be adequate gains in selecting these characters. The phenotypic co-efficient of variation was higher than the genotypic coefficient of variance for all the character studied indicated the influence of environment towards the total variance. Six accessionswere found to be high yielding and stable and is grouped under group one (1) using the genotype grouping technique. These accessions are; Zaria, Enugu, Nkpologwu, Awka, Agbani and Owa. These accessions were found to perform very well in Enugu agro- ecological zone southeast, Nigeria and they are recommended to be grown in this region.
Keywords:Castor, coefficient of variation, heritability, genotype, phenotype*

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I. Introduction

For a good crop improvement to be carried out there must be sufficient genetic resources whose potentials for use in crop improvement are known. Genetic resources are useful to scientists and plant breeders only if it has been properly characterized and evaluated (NG, 1991);such characterization and evaluation enable the crop breeders to provide genetic variability in a breeding program.Perino and Manti, (1990) explained characterization as those crop fruits that have high heritability and can easily be selected. Simpson and Withers (1986) categorized the characters into morphological, botanical, agronomical and chemicals. While Smith and Smith, (1992) argued that descriptive data collected based upon fruits that reflect genetic variations can be linked to monitor and promote efficient conservation and utilization of genetic diversity.

Conventionally breeders often tend to improve two or more traits simultaneously, such as yield and quality or height and resistance to lodging. Often, such traits show corrected responses in that yield may improve but quality may decline. In such situation only those of important values are retained while traits that is of little values are discarded or bulked for trial in another environment. Thus in practices selective are rarely purely based on yield. Comparison of old and contemporary cultures according to Austin, (1993) can yield valuable information on the progress made by breeders in crop improvements and on the trend in characters associated with yield improvement. Yield is a complex quantitative trait that is highly influenced by both the phenotypic qualities and environment factors. As individual yield components are less prone to the yield determining factors, selection for each yield component according to Bordia et al. (1973) may be useful in acquiring accession with better yield potentials. However, yield is outcome of several processes of all stages in the growth and development of the crop.

Though according to Evans (1993) no one process holds the key to greater yields. Evidence from his work suggests that in a high yielding crop both source and sink may be limiting and that they are likely to be more or less imbalance in the environment to which the variety is adapted. Plant breeders are faced with the demands for crop varieties better adapted to changing conditions with an option either to select for closely defined ecological conditions or for more extensive conditions which include considerable range of environments (Becker and Leon 1988). This approach requires the development of varieties possessing general adaptability, since even in a uniform edaphic environment a considerable degree of general adaptability will be important as noted by Finlay and Wilkinson (1993) because of the marked condition of the climatic condition from season to season. Increased yield of adapted plant materials is accounted for in part by the improved genetic potential while improved agronomic/cultural practices including the use of better soil management cause the other part; improved cultural practices however, is not an end in itself but must be related to absolute yield levels. Thus before selection can be made potential accession should be evaluated in different environments such as location and years before selection for desirable and adapted accessions are made (Nguyen etal.(1980). According to Baiyeri, (1998) stability performance of crop varieties/ accessions across contrasting environment is essential to the successful selection of high yielding and consistent performing accessions. This is because stable accessions are less dependent upon good environments to perform well and this makes their yield more predictable (Dashiell et al, 1994).

The seed yield in castor has shown to be highly dependent on the genotypic make up of individual castor plants. However, phenotypic variations in many of the characters will be largely non- genetic and broad sense heritability estimate will be relatively low for some of the traits. Hence, Uguru (2000) argued that there will be strong indication that the improvement of quantitative characters in castor may not be achieved by direct selection from the existing accessions. One of the primary objectives of castor breedersis to increase the oil yield. Generally yield represents the final character resulting from many developmental and biochemical processes which occur between germination and maturity; since bacterium in environment generally affects yield through it component, yield improvement can be realised if the breeders can identify the causes of variability in oil yield in any given environment (Grafius, 1960).Considering the wide genetics track ground of castor oil plant coupled with its high yield potentials, great improvement can be achieved through breeding of this wonderful plant especially with regard to different seed lines grown in different parts of southeast agro-ecological zone of Nigeria. Hence the essence of the study,genetic variability evaluation in yield and yield component in contrasting castor seedlines.

II. Materials and Methods:

The study was carried out at the Department of Agronomy and Ecological Management Experimental Farm Faculty of Agriculture, Enugu State University of Science and Technology Enugu. The meteorological data used in the study such as relative humidity, ambient temperature, rainfall, solar radiation, wind velocity and soil fertility status were collected from the Department of Geography Faculty of Natural Science, Enugu State University of Science and Technology Enugu.

Field Preparation, Planting and Cultural Practices

The experimental field was cleared and debrisremoved. Plot size measuring $300m^2$ was prepared and used for the planting. Nine (9) accessions of castor to be evaluated for high yield and adaptation were obtained from various parts of Enugu State and standard check obtained from the germplasm of the Ahmadu Bello University, Zaria. Three seeds of these accessions were planted per hill and were later thinned down to one seedling per hill. Plant spacing of 1mx1m was used for the study.Theexperimental field was layered out in randomized complete block design (RCBD) with four replications. Weeding was carried out as and when due with the aid of traditional African hand hoe. Thinning and supplying were done simultaneously one week (7days) after planting. The same procedures were observed for the two years planting seasons (2011 and 2012 crop seasons).

Data Collection

Data were collected on the following attributes:

Numbers of pods/plant, 100 seed weight, capsule yield, seed yield/ plant and seed yield/plot. The estimate of broad sense heritability (H^2) was calculated using the formula of Burtonand Devane (1953).

$$H^2 = \sigma g^2 / \sigma g^2 + \sigma e^2$$

Where H^2= Heritability

σg^2= Genotypic variance

σe^2 = Environmental variance

Phenotypic and genotypic co-efficient of variance in percentage was estimated using the formula of Burotnand De vane (1953)

$$P.C.V (\%) = \frac{\sigma^2 ph}{X} \times \frac{100}{1}$$

$$G.C.V (\%) = \frac{\sigma^2 g}{X} \times \frac{100}{1}$$

Where $\sigma^2 ph$=Phenotypic variance

σg^2 = genotypic variance
X = Sample mean of each trait
The difference between the phenotypic and environmental variance were used to estimate the accessions variance.
The data collected from the study were subjected to the analysis of variance (ANOVA) as outlined for the design using Gensat 3.0 release (2005) to test for differences in the treatments, while mean separation was done using least significant difference as outlined by Obi (2002).

III. Results

Number of pod/plant for each of the castor genotype studied

The result of number of pod/plant presented in Table 1 indicated that the value recorded varied among the 9 castor accessions studied. The highest (48) and least (11) value of number of pod/plant were recorded from Zaria and Agbani accessions respectively for 2011 cropping season. The recorded values also show significant ($P < 0.050$) different among the accessions, however the result obtained from Enugu accessions (20.5) Igboeze (28.20) Nkpologwu (21.20) and Udi (20.5)were statistically similar. The second year (2012) cropping season shows that among the 9 castor accessions the Zaria accessions recorded the highest number of pod/plant (33.25) followed by Nkpologwu (26.0) Igboeze (23.75) Enugu (23) Owa (22.75), Udi (22), Awka(22), Agbani (21) and Eke(20). When the two cropping seasons 2011 and2012 are compared, the 2012 result showed higher values compared in the number of pod/plant recorded in 2011 in all the accessions studied except for Zaria and Igboeze that shows reduction in number of pod/plant in 2012 result of which the percentage reduction relative to their 2011 value were 44.36% and 18.74% respectively. There was higher number of pod/plant in 2012 compared to 2011 result.

Table 1Number of pods/plantfor each of thegenotype studied in 2011 and 2012

Accessions	Number of Pods	
	2011	2012
1 Zaria	48	33.25
2 Enugu	20.5	23
3 Igboeze	28.20	23.75
4 Nkpologwu	21.20	26.0
5 Awka	14.80	22.0
6 Agbani	11.0	21.0
7 Eke	13.0	20.0
8 Owa	13.8	22.75
9 Udi	20.5	22.0
Mean	21.22	23.75
LSD0.05	13.55	3.75

Estimate of phenotypic, genotypic, environmental and genotype x year interaction

The result presented in Table 2, showed that for 2011 cropping season heritability estimate for number of pod/plant was 56%, phenotypic variance estimate, 194.26, genotypic variance estimate 108.12, environmental estimate,84.14 while phenotypic and genotypic co-efficient of variation were 66% and 49% respectively. These parameters measured in 2012 showed drastic reduction in their recorded values compared with their 2011 values except for heritability estimates and genotypic co-efficient that showed increased value. The recorded values for the parameters in 2012 are as follows; phenotypic variance ($\sigma^2 ph$) 20.53, genotypic variance($\sigma^2 g$)13.93, environmental estimate (σe^2), 6.61, heritability estimate (H^2) 68%, phenotypic coefficient of variation (PCV), 19%, and genotypic coefficient of variation (GCV), 65% respectively. For the genotypic x year interaction, the recorded values were 149, 102.83 and 46.18 for $\sigma^2 ph$, $\sigma^2 g$ and σe^2 respectively.

Table 2 Estimate of Phenotypic, Genotypic, Environmental and Genotype x year Interaction Variation, percentage broad sense heritability, phenotypic and genotypic coefficient of variation for number of pods/plant

Parameter	Year		GXY
	2011	2012	
□^{2}ph	194.26	20.53	149.0
□ ^{2}g	108.12	13.93	102.83
□ ^{2}e	84.14	6.61	46.18
H^2 (bc)%	56%	68%	
PCV %	66%	19%	
GCV%	49%	65%	

100 seed weight (g) for each of the castoraccession

The 100 seed weight result in Table 3 varied among the castor accessions. The result scenario shows Zaria (31.22)> Enugu (28.41)> Agbani (28.11) >Awka (26.92)>Igboeze (26.00)> Eke(25.21)/Nkpologwu (25.21)> Owa (24.90)> Udi (24.80). The 2012 result of seed weight indicated highest value (30.21) in Zaria accession and lowest (23.92) value in Owa accession respectively. In comparing the 2011 and 2012 results, Zaria, Owa, Nkpologwu and Eke accessions show reduction in recorded value in 2012 while other accessions recorded increased value.

Table 3 100 Seed weight (g) for each of the castor accessions studied

Accessions	**100 seed weight (g)**	
	Year	
	2011	2012
1 Zaria	31.22	30.21
2 Enugu	28.41	29.63
3 Igboeze	26.00	26.21
4 Nkpologwu	25.21	24.32
5 Awka	26.92	27.41
6 Agbani	28.11	29.32
7 Eke	25.21	24.61
8 Owa	24.90	23.92
9 Udi	24.80	24.88
Mean	26.75	26.72
LSD 0.05	10.32	12.76

Estimated of phenotypic, genotypic, environmental and genotype x year interaction, for 100 seed weight (g)

The heritability estimates for 2011 and 2012 result in Table 4 were 35% and 45% respectively. The phenotypic variance estimate showed result variation of 135 and283 for 2011 and2012 respectively and 311 for genotype x year interaction. Genotypic variance estimates were 52 and 291 for 2011 and 2012 respectively and 285 for genotype x year interaction. The environmental variance estimates for seed weight recorded 73 and 83 for 2011 and 2012 respectively and 93 for genotypex year interaction. The genotypic and phenotypic coefficient of variation for 100 seed weight respectively recorded 12% and 18% for 2012 and 17% and 32% for 2012 (Table 4).

Table 4 Estimate of Phenotypic, Genotypic, Environmental and Genotype x year Interaction Variation, percentage broad sense heritability, phenotypic and genotypic coefficient of variation for 100 seed weight (g)

Parameter	Year		GXY
	2011	2012	
□^{2}ph	135	283	311
□ ^{2}g	52	291	285
□ ^{2}e	72	83	93
H^2 (bc)%	35%	45%	
PCV %	18%	32%	
GCV%	12%	17%	

Capsule yield/plant for capsule yield of the castor

The 2011 result recorded in Table 5 indicated that among the 9 castor accessions studied, Zaria accession recorded the highest value of which was statistically the same with Enugu accession(325), Awka (331), Nkpologwu (320), Eke (320),Owa (318) and Udi accessions (311), but significantly ($P<0.05$) different from Igboeze (285) and Agbani(285). Nkpologwu and Eke accessions recorded the same value for capsule yield/plant. In 2012 inTable 5, Zaria accession was the highest capsule yield of 340 relative to their accessions, through the value showed reduction in value compared to 2011 value. The least value was obtained from Agbani accession of which recorded the same value with 2011 result.The mean value recorded indicated no difference in yield of 2011 and 2012 result. However, when the genotype means and year means were compared the result showed significant ($P<0.05$)difference among castor accessions studied.

Table 5: Capsule yield/ plant for the castor accessions studied.

Accessions	**Capsule yield/plant (g)**	
	Year	
	2011	2012
1 Zaria	345	330
2 Enugu	325	289
3 Igboeze	285	289
4 Nkpologwu	320	321
5 Awka	331	330
6 Agbani	285	285
7 Eke	320	310
8 Owa	318	312
9 Udi	311	320
Mean	315	315
LSD0.05	35.32	49.47

Estimates of phenotypic, genotypic, environmental and genotype x year interaction variation for capsule yield

The phenotypic variation result showed to be 120.11 and 213 for 2011 and 2012 respectively and 320 genotype x year interaction (Table 6) thegenotypic variance estimates were 53 and 285 for 2011 and 2012 respectively and 245 for genotype x year interaction. The environmental variance estimates for capsule yield were 62 and 85 for 2011 and 2012 respectively and 777 for genotype x year interaction; while the heritability estimates for capsule yield were 35% and 63% for 2011 and 2012 respectively. The result presented in Table 6 also indicated that PCV and GCV for capsule yield were 18% and 12% and 22% and 14% respectively for 2011 and 2012 cropping seasons. In all the parameters the recorded value in 2012 showed much increased value relative to 2011 values.

Table 6Estimate of Phenotypic, Genotypic, Environmental and Genotype x year Interaction Variation, percentage broad sense heritability, phenotypic and genotypic coefficient of variation for capsule yield

Parameter	**Years**		**GXY**
	2011	2012	
□ $^{2}_{ph}$	120.11	213	320
□ $^{2}_{g}$	53.0	285	245
□ $^{2}_{e}$	62.0	85	777
H^2 (bc)%	35%	63%	
PCV %	18%	22%	
GCV%	12%	14%	

Seed yield/plant (g) of the castor accessions studied

The result of seed yield/plant recorded for 2011 cropping season presented in Table 7 showed that Zaria accession recorded the highest seed yield/plant (185.21g) of which the value is significantly ($P<0.05$) different from Nkpologwu (163.11g), Owa (160.61g), Awka (160.12g), Igboeze (154.21g) and Eke (150.41g). The yield value obtained from Zaria (185.21g). Enugu (180g) and Agbani (166.32g) accessions were statistically the same. In 2012 result on the same Table 7 higher values (184.21g) and least value (153.54g) in Zaria and Eke accessions respectively. The mean value for all the accessions for 2011 was164.23gwith a range of 150.41-185.21g and 165.36g with a range of 153.54g-184.21g in 2012 season. The mean value however, indicated that the seed yield value for 2011 and 2012 were relatively alike as the difference between the two years yield were merely 1.13g.

Table 7 Seed yield/plant (g)for the castor accessions studied

Accessions	**Seed yield/plant (g) Year**	
	2011	2012
1 Zaria	185.21	184.21
2 Enugu	180.00	180.22
3 Igboeze	154.21	161.22
4 Nkpologwu	163.11	160.41
5 Awka	160.22	159.52
6 Agbani	166.32	162.62
7 Eke	150.41	153.54
8 Owa	160.61	162.62
9 Udi	158.00	158.72
Mean	164.23	165.36
LSD0.05	10.32	12.76

Estimates of phenotypic, genotypic, environmental and genotype x year interaction variation for seed yield/plant

The seed yield/plant result varied among the parameters assessed (Table 8) the result scenario for 2011 indicated □^{2}ph (110), □^{2}g (54),□^{2}e (73),H^2 (45%), PCV(18%) and GCV (10%) respectivelywhile 2012 result showed □^{2}ph (210), □^{2}g (245),□^{2}e (182), H^2 (81%), PCV (22%)| and GCV (14%) respectively. The 2012 result showed increased value in all the parameters relative to 2011 results.The GXY variation result for □^{2}ph, □^{2}g and □^{2}e were 320.11, 217.21 and 63.21 respectively.

Table 8 Estimate of Phenotypic, Genotypic, Environmental and Genotype x year Interaction Variation, percentage broad sense heritability, phenotypic and genotypic coefficient of variation for seed yield/plant

Parameter	**Years**		**GXY**
	2011	2012	
□$^{2}_{ph}$	110	210	320.11
□^{2}g	54	245	217.21
□^{2}e	73	182	63.21
H^2 (bc)%	45%	81%	
PCV %	18%	22%	
GCV%	10%	14%	

Seed yield /plot (g) of the castor genotype studied.

The result presented in Table **9** show the seed yield/plot for both 2011 and 2012 seasons. The Zaria accession in 2011 recorded the highest seed yield/plot (740.84g) followed by Enugu accessions (720g). The Eke accessions have the lowest seed yield/plot (451.43). In 2012 result seed yield/plot equally showed that the Zaria accession has the highest value (736.84g) and the Eke accession has the lowest value(532.53g). Also, 2012 result showed highest value in most of the accessions result relative to 2011 result.Significant ($P<0.05$) different among the accessions were recorded when genotype and year means and were compared.

Table 9 Seed yield/plot (g) of the castor genotype studied

Accessions	**Seed yield/plant (g)**	
	Year	
	2011	2012
1 Zaria	740.84	736.84
2 Enugu	720.00	720.88
3 Igboeze	616.84	645.28
4 Nkpologwu	652.44	641.64
5 Awka	640.88	638.08
6 Agbani	665.32	673.27
7 Eke	451.43	532.53
8 Owa	588.32	630.32
9 Udi	632.36	634.63
Mean	634.30	650.39
LSD 0.05	73.63	58.46

Estimates of phenotypic, genotypic, environmental and genotype x year interaction for seed yield/plot

The phenotypic variance estimates were 115 and 183 for 2011 and 2012 respectively and 295.20 for genotype x year interaction, while the genotypic variance estimates were 64 and 237 for 2011 and 2012 respectively and 212.83 for genotype x year interaction. The environmental variance estimates were 72 and 180 for 2011 and 2012 respectively and 65.21 for genotype x year interaction. The heritability estimates for seed yield/plant were 46% and 80% for 2011 and 2012 respectively (Table 10). Also the PCV and GCV recorded in Table 10 indicated result variation of 21% and 11% for 2011 and 23% and 14% for 2012 respectively.

Table 10 Estimate of Phenotypic, Genotypic, Environmental and Genotype x year Interaction variation, percentage broad sense heritability, phenotypic and genotypic coefficient of variation for seed yield/plot

Parameter	**Years**		**GXY**
	2011	2012	
□ ^{2}ph	115	183	295.20
□ ^{2}g	64.0	237	212.83
□ ^{2}e	72	180	65.21
H^2 (bc)%	46%	80%	
PCV %	21%	23%	
GCV%	11%	14%	

Grand mean yield and the coefficient of variation (CV) of the castor accessions studied in 2011 and 2012

The cumulative grandmean yield and coefficient of variation of the castor accessions presented in Table 11 indicated Zaria accession to be higher in yield (1472.31g) among the other accessions. The next in rank were Enugu (1420.66g) and Agbani (1338.50g) accessions respectively. The percentage decrease in yield in Eke and Udi accessions relative to Zaria accession were 49.93% and 26.28% respectively. Stable genotype is sometimes used to describe a genotype that has constant performance over environment. Exposed to different fertility levels a variety that responds to increasing fertility will have greater yield variance across these levels than one that does not. The responsive one is not necessarily unstable and is usually more desirable given that a response variety that respond to increasing fertility will have a greater yield variance across these levels than one that does not. The responsive one is not necessarily unstable and is usually more desirable. Given that a responsive variety will have a large variance, what is required is a measure of consistence that will account for yield. An obvious statistical method for such measurement is the coefficient of variation (CV).

Table 11 Grand mean yield and the coefficient of variation of the castor accession studied in 2011 and 2012

Accessions	Grand mean yield g	Coefficient of variation
Zaria	1472.31	10.8853
Enugu	1420.66	13.2346
Igboeze	1262.73	16.1132
Nkpologwu	1290.35	11.6953
Awka	1278.96	12.6871
Agbani	1338.50	12.6871
Eke	981.97	12.1135
Owa	1216.64	10.4236
Udi	1165.94	13.3211
Mean	1280.8956	13.7229

Using the Table 11 result the grand mean yield and CV are divided into four (4) groups:
Group 1- High yield, small variation (high yielding and stable)
Group 2- High yield large variation (high yielding and unstable
Group 3- low yield, small variation (poor yielding and stable)
Group 4- low yield, large variation (poor yielding and highly unstable)
It was based on this grouping that the genotype grouping for the accessions were based and explained in Table 12

Table 12 Genotype grouping technique for the castor accessions studied

Group 1	**Group 2**
High yield, small variation (high yielding and stable)	High yielding long variation unstable.
1(Zaria)	3(Igboeze)
2(Enugu)	9 (Udi)
3(Nkpologwu)	
5(Awka)	
6(Agbani)	
8(Owa)	
Group 3	**Group 4**
7(Eke)	None

Group 1 genotypes appear to be the most desirable. A stable genotype is the one that provides high and consistent performance. Only group 1 can be considered as stable. Although group 3 is consistent, it is deemed unstable because it performs poorly in most environments. No genotypes appeared in group 4.

The mean yield –CV method used here was designed primarily to aid in studies on the physiological basis for yield stability. It is more practical to characterize accessions on a group basis rather than individually. However, the method could be used in the plant breeding context. It represents a simple, descriptive method for grouping large number of accessions from yield data collected over several environments. Based on the result obtained, It is clearly shown that only six (6) accessions fell within group 1. The accessions within the group included treatment 1 (Zaria). 2 (Enugu), 4(Nkpologwu), 5(Awka), 6(Agbani) and 8(Owa). Group II contains only two accessions and these were 3(Igboeze) and 9(Udi). Only one genotype fell within group III, 7(Eke) none of the genotype fall within group IV.

IV. Discussion

In well organized and planned breeding programme to improve yield potentials of crops is necessary to obtain adequate information on the magnitude and type of genetic variability and their corresponding heritability. This is important because selection of superior accession is proportional to the amount of genetic variability present and the extent to which the characters are inherited (Omoigui et al., 2006). The value of a germ plasma collection depends not only on the number of accession it contains, but also upon the diversity present in those accessions (Ren et al., 1995). The observed significant variation in yield and component among the castor accessions in this study is an indicative of the differences among the possible genetic divergence in the castor plant. The high level of variability in this population suggests that heterosis could be utilized to produce superior accessions. Phonological trends are strongly influenced by weather especially lack of or excess of soil moisture. For the present study, moisture rather than temperature was major determination of castor performances. Shortage of water restricts crop productivity all over the world, not just in those areas classified as arid or semi-arid, but in any area in which, the evaporative demand greatly exceeds rainfall during the growing season. The unfavourable environmental conditions experienced in the 2011 planting season resulted in with-holding of water supply and this led directly to changes in the physical environment of the castor plants.Those changes subsequently affected the crops physiology. To survive stress, a plant may reduce the number of seeds generated by producing a smaller quantity of viable seeds. Such a productive adjustment may be differential among accessions. For example, during the stress period as experienced in 2011, all the accessions except accession 1 and 3 produced less number of pods/plant when compared to those produced in the unstressed period of 2012. Such entries like accessions 5,6,7 and 8 which produced 14, 11, 132 and13.8g pods were able to produce in 2012 as much as 22, 21 20 and 22.75g pods/plant respectively. It should be noted that the final yield of stressed crops differ from that of an unstressed crop as a result of the integrated effect of many changes in crop physiology.Environment influences crop productivity directly via the physiology of the plant and the determinant of yield. But the greatest scopes for yield increase have in increasing the amount of resources captured.The relative combination of the various components of the environment and the physiological changes of crop coupled with its phonological trends influence ultimate crop performancefor example genotype 1(Zaria) had short vegetative growth but high pod filling potential. It should be noted that long vegetative growth could mean higher potential forbiomass production which may or may not translate to higher yield. This was evidence in genotype 1 (Zaria) and genotype 9 (Udi). The former had short vegetative growth period but high yield in contrast to longer growth character of the latter and lower yield. The time of flowering is firstly a function of maturity time which encompasses the pod filling period when photosynthesis would have to be manufactured adequately and transported efficiently. Secondly, a function of genotype and environment reflects the maturity period of the various accessions. This mean that pod filling will start if the environment is favourable in some cases. The delay in flowering time of some of the accessions may be attributed to a reduction in photosynthetic and sink activities due to reduced light intensity as well as reduced air temperature.Many of the accessions were relatively short with a range of 124cm-156cm short plants are generally preferred in agriculture because it helps to prevent lodging. Many of the accessions matured within 100 to 116 days apart from genotype 1 which matured within 100 days. Nweke (2019) made similar observations in Abakaliki agro ecological zone of southeast, Nigeria. Majority of the entries matured earlier in 2011 than in 2012. For example, accessions 1 and 6 which matured within 106 and 111 days in 2011 respectively matured 108 and 116 days respectively in 2012. The greater100 seeds weight of 31.22g was obtained from genotype 1 in 2011 and 30.04g in 2012 while the genotype 8 which had 24.9g in 2011 was the least in 2012. The weight of the seed an index of its size is determined by the amount of photosynthesis that takes place in the plant as well as how efficiently those products of photosynthesis were transported or translocated to the seeds which represent thesink.

Virtually the control out yield all the other accessions for both capsule and seed yield for both years,for example, genotype 1 which gave the highest yield of 345g for the 2011 also gave the best yield of 340g for 2012. It is not surprising that the same genotype gave the highest seed yield/plant of 185.21g and 184.21g in 2011 and 2012 respectively. Similarly genotype 3 which gave the highest yield of 284g in 2011 also gave the poor seed yield of 154.21g in 2012. Yield for the two planting seasons provided information on resource capture and conversion efficiency of the different accessions over a two year cropping season. These were a high genotypic plasticity for seed yield/plant and cumulative yield over the two years due to genetic differences of the accessions.

V. Conclusion:

Within the limits of the experimental site, the accessions x year interaction observed was a positive interaction that is the yield for the second year was greater than that of the first year for most of the accessions. Resource base of each environment dictated accessions performance and subsequently final yield. Final yield is an outcome of various other processes which are subject to changes with the environment that selection based on genotype-grouping technique is better than selection on individual basis.Genotype-grouping technique is an insightful tool for enhancing reliable genotype recommendation. Plant breeding and agronomists would find it a useful tool for recommending accessions that have consistent performance over environments although with below average yields based solely on yield. Hence castor oil bean cultivation within agro- ecological zone should be intensified and encouraged, we recommend the following based on the cumulative yield using the genotype-grouping techniques, six accessions that fall within group 1 are highly recommended, they are 1 (Zaria), 2 (Enugu), 4 (Nkpologwu), 5 (Awka), 6 (Agbani) and 8 (Owa). These entries are high yielding and very stable. They will perform very well within the Enugu ecological zone. The two genotype that fall within group 11, 3(Igboeze) and 9 (Udi) gave very good yield (high yield) but they could be very unstable. The genotype that fall within group 111, 7(Eke) is not recommended for the Enugu agro-ecological zone. Though it is stable, but it is poor yielding based on the findings of the study, it is of the opinion that the Enugu agro-climate zone would be good and favourable for the cultivation of high yielding castor bean accessions.

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