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Effects of panicle position on seed viability and vigor in some selected castor seed accessions

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ABSTRACT

Castor bean is widely cultivated around the world because of the commercial importance for its oil. The fruits of castor are set on a panicle-like structure called raceme. The racemes are classified into the primary, secondary and tertiary racemes as a result of their different time of initiation on the mother plant. The possibility that the raceme initiation points could affect seed viability attributes through its association with time to seed set exists. This study, therefore, determines variation in seed viability and vigor of seeds originating from different racemes positions on the same mother plant. The germination study was conducted in a screen house with 7 castor accessions using sand as a substratum. They were planted in the field under rain-fed conditions in a randomized complete block design with three replications. The castor seeds were planted in 3 rows plot with intra- and inter-row spacing of 1 m. Three seeds from each accession were sown per hole. The racemes were found to be statistically similar in terms of germination ability. However, secondary racemes had the highest mean (64.4%) for the germination percentage and germination rate index (GI) of 5.9. Accession NKAN had the higher germination ability with mean germination percentage of 68.9 and germination rate index (GI) of 6.4. In conclusion, the seed viability and vigor of castor seeds are not significantly affected by raceme positions on the mother plant.

Keywords: Castor; Raceme; Accessions; Seeds; Germination

INTRODUCTION

Castor bean is widely cultivated around the world because of the commercial importance for its oil. It is also widely grown as ornamentals (Phillips and Rix., 1999). Castor seed is the source of castor oil, which has a wide variety of uses. It is the second highest oil seed crop, average 45% after palm which is 52% (Weiss, 2000; Baldwin and Cossar, 2009). The high oil content and its quality makes it an attractive candidate for biodiesel production (Daniel *et al.*, 2017), lubricants, nylon and plastic. Castor is also used for the production of "ogiri" a popular condiment in the eastern parts of Nigeria because of its strong aroma. The extract of the plant has also been reported to have ascaricidal and insecticidal properties. The

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seed cake is an excellent source of fertilizer containing high levels of nitrogen, phosphorous and potassium while the stalks of the plant are good sources of paper pulp. The fruits of castor are set on a panicle-like structure called raceme. The racemes are classified into the primary, secondary and tertiary as a result of their different time of initiation on the mother plant. The primary raceme is borne and matures first before the secondary raceme then the third on different positions as the plant grows (Plates 1 and 2). In wheat, different positions of seeds on tillers head had been reported to influence seed weight and mineral content (Nik *et al.*, 2012). In castor, therefore, there is a possibility that the raceme initiation points could affect seed viability attributes through its association with time to seed set. This study determines variation in seed viability of seeds originating from different racemes positions on the same mother plant.

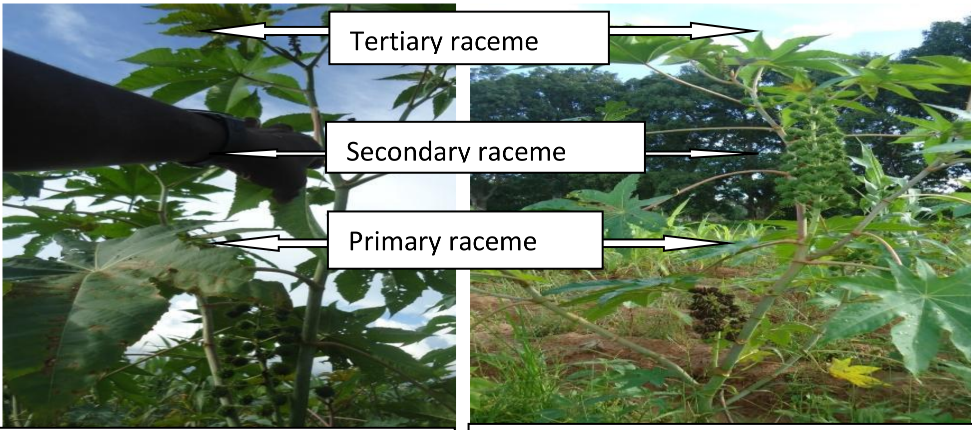

Plate 1: Mother plant showing the different points of raceme initiation

Plate 2: Mother plant showing matured primary raceme

MATERIALS AND METHOD

Study Area

The study was conducted at the Department of Plant Breeding and Seed Science, University of Agriculture, Makurdi. The site is located at latitude 7.41°N and longitude 8.35°E and at an altitude of about 97m above sea level, within the Southern Guinea Savannah agroecological zone of Nigeria.

Collection of Accessions and Experimental Design

Seven accessions with varying characteristics were obtained from the Department of Plant Breeding and Seed Science, University of Agriculture, Makurdi. The description and origin of the accessions is given in Table 1. The seven accessions were planted in the field under rain-fed conditions in a randomized complete block design with three replications. The soil at the research farm is sandy clay with 0.98% organic matter, 1.6mg/kg P/ha, 0.51Cmol (+) K/ha, and a pH of 5.65. The land was ploughed and ridged. The castor seeds were planted in 3 rows plot with intra- and inter-row spacings of 0.5m and 1m respectively. Three seeds from each accession were sown per hole. After emergence, the seedlings were thinned to one plant per stand at two weeks after planting (WAP) to give a plant population of 15 plants per plot. The plot size was 6 m^2 for each entry. Weeds were controlled by hand pulling at 4 and 10 weeks after planting.

Data Collection

At maturity, all the seeds of the panicles in the first position from the base of the mother plant in each plot were harvested on individual plant basis. The second and third panicles were also harvested. After shelling/threshing, the seeds were air dried in the laboratory at ambient temperature. The germination test was carried out in a screen house using the sand germination method. River sand was used as a substratum. About 1.5 kg of sand was placed in each germination tray (Plate 3). The experiment was arranged in a 3 x 7 factorial combination to give 21 treatments. Fifty (50) seeds of each of the 21 treatments were planted in the seed tray, replicated three times in a complete randomized design (CRD) to give a total of 63 trays. The seeds trays were watered to field capacity on daily basis. Germination count was taken at seven (7) days after sowing (DAS) and progresses to four (4) weeks after sowing. Germination percentage and germination rate index were calculated.

Plate 3: Germination test using sand method

Data Analysis

Data were collected on:

Germination percentage (seed viability) was calculated using the formula described by (Don *et. al.* 2009).

$$\frac{\text{Number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

The germination rate index (seed vigor) was calculated using the formula developed by (Hydecker, 1972).

GRI=$G1/T1 + G2/T2 + \ldots\ldots\ldots Gn/Tn$
Where GRI = germination rate index
G1 G2…..Gn = are the number of seeds germinated at T1 T2……Tn the time interval respectively.

Analysis of variance (ANOVA) was performed for the data collected. The least significant difference of means (LSD) was used for means separation.

Table 1: Description and origin of the accessions

Accession	Collection site	Stem colour	Shattering ability	Seed size
AKN1	Akwanga	Green	Indehiscent	Small
AKN2	Akwanga	Red	Indehiscent	Small
KTAN	katanza	Green	Indehiscent	Small
NKAN	Nunku	Green	Indehiscent	Small
UWYK	Wayo	Red	Dehiscent	Small
GTK	Gitata	Red	Indehiscent	Small
GTKK	Gitata	Red	Dehiscent	Small

RESULTS AND DISCUSSION

Results from analysis of variance showed that there was a highly significant (P<0.01) difference of means among accessions for germination percentage at week 3 and for germination index also at week 3 (Table 2). There was no significant difference (P>0.05) in the effect of raceme positions on germination percentage and index except in week 3 of germination index. The interaction (accession x raceme position) was also only significant on germination index at 3 weeks after planting (Table 2).

Table 2: Mean square from the analysis for germination percentage at different weeks and germination index at different weeks for seven accessions derived from three raceme positions on mother plant in North central Nigeria.

Source of variation	Df	Germination %				Germination index			
		WK1	WK2	WK3	WK4	WK1	WK2	WK3	WK4
Accession	6	21.3ns	330.4ns	84.8**	16.1ns	0.45ns	4.01ns	1.00**	0.04ns
Raceme	2	7.6ns	141.4ns	33.4ns	20.9ns	0.37ns	1.25ns	0.54*	0.11ns
A* R	12	9.3ns	246.9ns	32.3ns	8.7ns	0.29ns	3.31ns	0.36*	0.02ns
Error	42	13.0	277.8	18.4	9.7	0.23	3.26	0.15	0.04

ns, not significant at p < 0.05; *significant at p <0.05; ** highly significant at p <0.01

Table 3 showed the effect of accessions on germination percentage. At weeks 1 and 2, accession GTK had the highest germination percentage, followed by NKAN at week 2. NKAN had the highest total germination ability followed by GTK. On the other hand, AKN1 had the least germination percentage in almost all the weeks.

Table 3: Seed germination percentage of seeds of castor collected from various accessions

Accessions	Germination percentage				
	Week 1	Week 2	Week 3	Week 4	Total
AKNI	1	39	4	1	45
AKN2	2	49	11	3	65
GTK	4	56	3	2	65
GTTK	4	49	9	4	67
KTAN	2	49	9	2	62
NKAN	2	55	8	4	69
UWYK	0	43	7	5	55
Mean	2	49	7	3	61
LSD 5%	3	16	4	30	17

With regards to raceme position, secondary raceme had the highest germination percentage across the accessions in weeks 2, 3 and 4 followed by the tertiary raceme except in week 1 and 4 (Table 4). However, this observed difference was not statistically significant.

Table 4: Seed germination percentage of seeds of castor collected from various raceme positions

Raceme	Germination Percentage				
	Week 1	Week 2	Week 3	Week 4	Total
Primary raceme	3	46	6	3	57
Secondary raceme	2	51	8	4	64
Tertiary raceme	2	49	8	2	61
Mean	3	49	7	3	61
LSD 5%	2	10	3	2	11

Test of seed vigor showed that accession GTK had the highest germination rate index at week 2 followed by NKAN, and GTTK, while accession AKN1 had the least germination rate index at week 1 (Fig. 1). At week three (WK3), accession NKAN had the highest germination rate index followed by GTK, and KTAN. Accession AKN1 had the least as in WK1 and WK2.

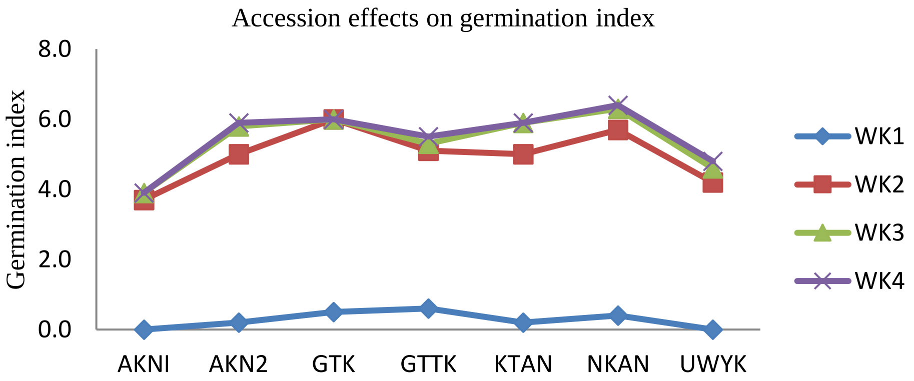

Fig 1: Effect of accessions on germination rate index

Figure 2 shows the effect of raceme position on germination rate index. At WK1, the primary raceme (basal panicle) had the higher germination rate index followed by the tertiary raceme. Middle and upper Panicles (racemes 2 and 3) had the higher germination rate index with equal mean of 5.1 at WK2. At WK3 and WK4, secondary raceme also had higher germination rate index followed by tertiary raceme while primary raceme had the least germination rate index. This could probably be due to what Tekrony *et al. (*1980) and Dornbos Jr, (1995) reported, that deterioration of seed is commonly observed on a crop level when harvest is delayed longer after seed have reached physiological maturity. This result is also similar to the findings of Pereira (1975) working on okra seed in which they reported that as the seeds aged, the germination percentage continued decreasing. However, the observed difference was not statistically significant (p>0.05). On the other hand, germination ability and vigor of castor seed were significantly affected by genotype potentials of the accessions.

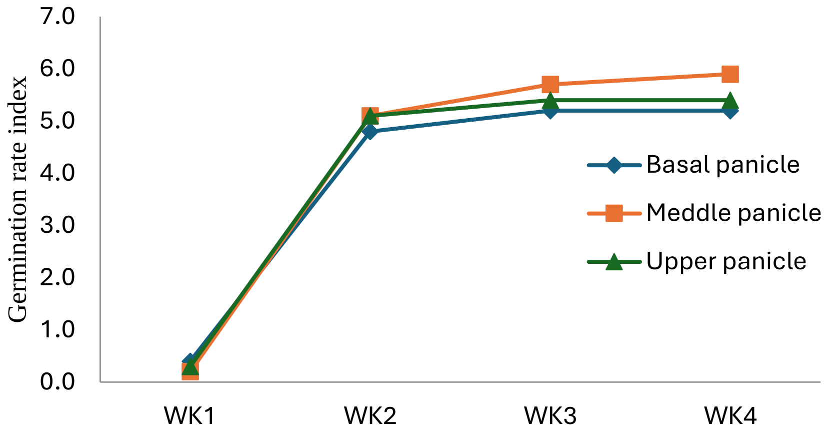

Fig 2: Effect of raceme positions on germination rate index

CONCLUSION

In conclusion, this study has shown that the seed viability and vigor of castor seeds are not significantly affected by the raceme positions on the mother plant.

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