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Effect of raceme initiation points on castor seed viability and vigor

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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 screenhouse with 7 castor accession using sand as a substratum. The racemes were found to be statistically similar in terms of germination ability. However, secondary racemeshad 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.

INTRODUCTION

Castor bean is widely cultivated around the world because of the commercial importance for its oil. It is also widely grown as ornamentals[8]. 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%[1,10]. The high oil content and its quality makes it an attractive candidate for biodiesel production[2], 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 seed cake is an excellent source of fertilizer containing high levels of Nitrogen, Phosphorous and Potassium while the stalks of the plant are good source 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 racemes 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 repored to influence seed weight and mineral content[6]. 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.

MATERIALS AND METHODS

Seven accessions with varying characteristics were

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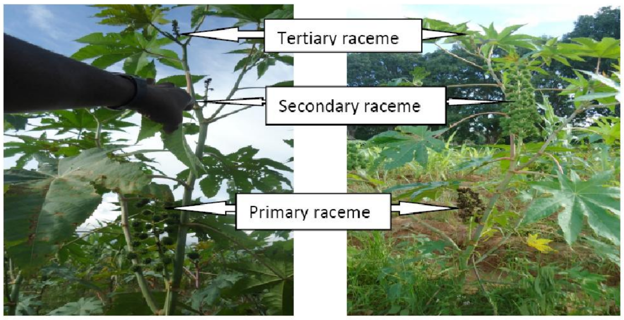

Plate 1: Mother plant showing the different points of raceme initiation

Plate 2: Mother plant showing matured primary raceme

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. Field experiment was set up at the University of Agriculture Makurdi research farm (N10^0 30.78', E012^0 03.56', 749m altitude) located in the derived Guinea savanna of north central Nigeria in 2009. The seven accessions were planted in the field under rainfed 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 spacing of 1 meter. 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 fifteen plants per plot. Weeds were controlled by hand pulling at 4 and 10 weeks after planting. 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. 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 treatment 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

Germination percentage (seed viability) was calculated using the formula described by[3]

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

The germination rate index (seed vigor) was calculated using the formula developed by[5]

GRI = G1/T1 +G2/T2 + ………..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	Angwanwayo	Red	dehiscent	Small
GTK	Gitata	Red	indehiscent	Small
GTTK	Gitata	Red	dehiscent	Small

Key : AKN= Akwanga, KTAN= Katanza, NKAN=Nunku, UWYK=Angwanwayo, GTK=Gitata

RESULTS AND DISCUSSION

Results from analysis of variance showed that there was a highly significant difference of meansamong accessions for germination percentage at week 3 and for germination index also at week 3 (TABLE 2). There was no significant difference in the effect of raceme positions on germination percentage and index except in week 3 of germination index. The interaction (accession x raceme position)

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
AccessionA	6	21.312ns	330.407ns	84.767**	16.101ns	0.450ns	4.010ns	1.000**	0.044ns
Raceme R	2	7.635ns	141.444ns	33.444ns	20.905ns	0.369ns	1.249ns	0.536*	0.107ns
A* R	12	9.265ns	246.852ns	32.315ns	8.664ns	0.288ns	3.310ns	0.355*	0.020ns
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 $p < 0.01$

was also only significant on germination index at 3 weeks after planting (TABLE 2).

TABLE 3 showed the effect of accessions on germination percentage. At weeks 1 and 2, accession GTK had the highest germination percentage, followedby NKAN at week 2. NKAN had the highest total germination ability followed by GTK. On the other hand, AKN1 had 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	0.67	38.89	3.67	0.89	44.1
AKN2	2.22	49.33	11.11	2.67	65.3
GTK	4.44	56.00	2.67	2.44	65.6
GTTK	3.78	48.67	8.89	3.56	64.9
KTAN	1.56	49.00	9.33	1.67	61.6
NKAN	2.00	54.56	8.11	4.22	68.9
UWYK	0.22	42.67	7.33	4.56	54.8
Mean	2.13	48.45	7.30	2.86	60.74
LSD 5%	3.4	15.9	4.1	3.0	17.31

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.

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 (Figure 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.

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	2.81	45.57	5.86	2.62	56.9
Secondary raceme	1.67	50,62	8.19	3.95	64.4
Tertiary raceme	1.91	49.14	7.86	2.00	60.9
Mean	3.4	48.4	7.3	2.9	60.7
LSD 5%	2.3	10.4	2.7	1.9	11.33

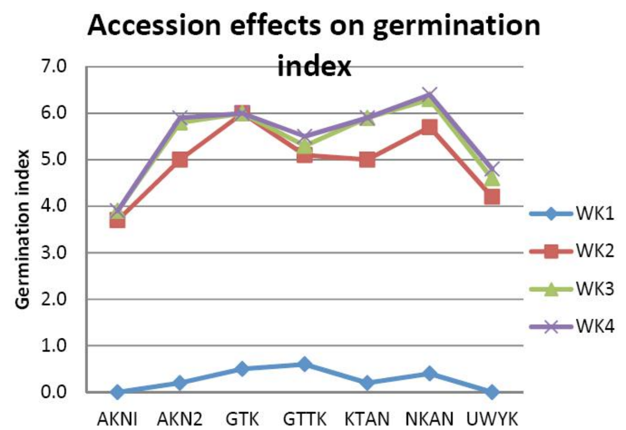

Figure 1 : Effect of accessions on germination rate index

Figure 2 showed effect of raceme position on germination rate index. At WK1, the primaryraceme (basal panicle) had the higher germination rate index followed bythe tertiary raceme. Middle and upperPanicles (raceme 2 and 3) had the higher germination rate index with equal mean of 5.1 at WK2. At WK3 and WK4, secondaryracemealso had higher germination rate index followed bytertiaryraceme while primaryraceme had the least germination rate index. This could probable be due to what Tekrony *et al.*,[9] and Dornbos Jr[4], 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[7] 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. On the other hand, germination ability and vigor of castor seed were significantly affected by genotype potentials of the accessions.

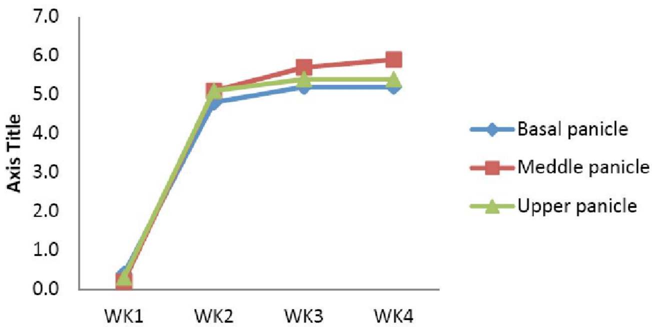

Figure 2 : Effect of raceme positions on germination rate index

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