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Genetic variability among some miscellaneous legumes for yield-related traits

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ABSTRACT

Twenty-four (24) accessions of seven (7) legumes were planted to determine the relationship in their Agro-morphology and to estimate the heritability of plant character, using Randomize Complete Block Design (RCBD). The experiment was carried out at Teaching and Research Farms, Federal university of Agriculture, Abeokuta, Nigeria. Collection of data was carried out on plant height, stem girth, leaf length, leaf breadth, stem colour, flower colour, leaf shape, 100-seed weight, number of pod per plant, number of seed per pod and pod length. Data collected were subjected to Analysis of variance, inter-character association among the plant characters evaluated was determined using Pearson coefficient correlation analysis, while relatedness was done using dengrogram. Data analyses show significant effect among all the legumes indicating that there is possibility for selection. All plant characters evaluated show high heritability with genotypic variance higher than environmental effect. Number of pods per plant and number of seeds per pod were negatively correlated with all traits studied. Hundred seed weight was positively correlated with all traits studied except seedling emergence and number of pods per plant. The linkage clusters shows similarities at various percentage among the twenty-four accessions. All the accessions were distinct from each other at 0.0, while at a distance of 0.50 levels they formed four clusters. Legumes with high yield potential can be considered for selection, while characters with high heritability estimate can be used as criteria for selection during breeding programs. Accessions TVR-28, TVR-39 and TVR-86 with high number of seed per pod and TVA-1 and TVA-2 for pods per plant could be considered during selection and further breeding work.

Keywords: Legumes, diversity, relatedness, dendogram

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Introduction

Legumes are otherwise known as pulses. They are plants originating from the family of fabaceae or leguminosae. The leguminosae consist of about 750 genera and 19000 species of herbs, shrubs, trees and climbers. This large family is divided into four subfamilies –the Mimosoideae, Caesalpinodeae, Swartzoideae and Papilonoideae. Green gram (*Vigna radiate*), Kidney bean (*Phaseolus vulgaris*), Winged bean (*Psophocarpus tetragonolobus*), Jack bean (*Canavalia ensiformis*), Lablab bean (*Lablab purpureus*), Lima beans (*Phaseolus lunatu*), Rice bean (*Vigna umbellate*), are some of the examples found within this family. They are grown primarily for their food grain with the seed noted to be very rich in protein, minerals and vitamins, and has significance noted to be very rich in protein, minerals and vitamins, and has significance nutritious fiber as fodder rich in protein for livestock forage and silage. Legumes are notable species of plant for their symbiotic nitrogen fixing bacterial structures called root nodules and are used as soil enhancing green manure (Deacon, 2015).

Hence, the cultivation of these legumes can be considered important in contributing to food and nutritional security as well as their utilization on uncultivated marginal land and conserving biodiversity (Gautam et al., 2007) Legumes generally are affected by quite a number of serious diseases leading to reduction in yield and quality during production. Part of which are seed borne and they include bean common mosaic virus (BCMV) and bacterial blights. Soil borne, they include the seedling diseases (caused by Rhizoctonia and Pythium), Fusarium root or dry rot, white mold, and charcoal rot or ashy stem blight (Simmonds et al.,1989; Mureithi et al.,2003. Although, the area of cultivation and utilization of this important legume is marginal due to the lack of awareness on its nutritional, economic value and its narrow socio-traditional perceptions among most users which is observed to be the barriers to its large scale demand and production. An immediate attention for germplasm collection, conservation and utilization of these legumes is important to prevent their loss as multipurpose crops (Bajracharya et al., 2007). Efforts are therefore being devoted to conduct more research to extend both technical and practical knowledge about these legumes so that their full potential may be achieved. The reproductive structures, as well as some agro-morphological characters are some of the reliable parameters that could be used in the identification and classification into subfamilies which could be useful during crop improvement (FAO, 2012).

The objectives of this study were;

To determine the yield potentials and other related traits of some miscellaneous legumes, also to determine morphological variability and level of relativeness among some selected legumes.

Materials and Methods

The twenty-four accessions of legumes used for this study were obtained from International Institute of Tropical Agriculture (IITA), Ibadan. The research was carried out at the Directorate of University Teaching and Research Farm (DUFARMS) Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The twenty-four accessions of seven different kinds of legumes used for this study are listed in (Table 1). The experimental design used was the Randomized Complete Block Design (RBCD) with three replicates. The plot was 9m in length and 3m in width with spacing of 1m between each replicate. The spacing for planting was 50cm within rows and 60cm between rows with 2 seeds per hole. Each accession was planted on 24 rows of each replicate to give a total number of 168 stands in per replicate and a total plant population of 504. Cultural practices such as weeding and insects pest control were carried fortnightly.

Data collected are listed below;

Quantitative Traits

Seedling emergence: This was taken 2 weeks after planting using the formula;

Seedling emergence=

$$\frac{\text{Number of Observed plants}}{\text{Total Number of seeds planted}} \times 100$$

Number of branches per plant, Number of leaves per plant, Plant height (cm), Leaf length (cm) Leaf breadth (cm), Stem girth (mm), Pod length (cm), Seed yield per pod (g), Seed yield per plot (g), 100-seed weight (g). Data taken on qualitative traits included; Terminal leaf shape, Stem pigmentation, Flower colour, Seed colour and shape (using forage legumes descriptor-IBPGR, 1984). Scoring for pigmentation: Total pigmentation=3, Partial pigmentation= 2, No pigmentation= 1.

The data were subjected to Analysis of Variance (ANOVA) using SAS software Package (SAS, 2014). Means were separated using Duncan Multiple Range Test (DMRT) at probability level of 5% to determine the significant level of the means, while character association was done using correlation coefficient analysis. Dendogram was used to determine the relativeness among the legumes studied.

Table 1: List of Legume accessions used for the study.

S/N	ACCESSION NAME	CROP NAME	SEED COLOUR	S/N	ACCESSION NAME	CROP NAME	SEED COLOUR
1.	TPV-562	Kidney bean	Brown	15.	TPT-21	Winged bean	Brown
2.	TPV-667	Kidney bean	Black	16.	TLN-70	Lablab bean	Brown
3.	TPV-75	Kidney bean	White	17.	TLN-39	Lablab bean	Brown
4.	TPV-98	Kidney bean	White	18.	TLN-30	Lablab bean	Brown
5.	TPV-101	Kidney bean	Brown	19.	TVA-2	Rice bean	Brown
6.	TPV-131	Kidney bean	White	20.	TVA-1	Rice bean	Brown
7.	TPV-126	Kidney bean	Pink	21.	2006-007	Lima bean	Brown
8.	TPV-162	Kidney bean	Brown	22.	TCE-5	Jack bean	White
9.	16-NC	Kidney bean	Pink	23.	TCE-2	Jack bean	White
10.	TPV-515	Kidney bean	Black	24.	TCE-1	Jack bean	White
11.	TVR-39	Green gram	Brown				
12.	TVR-86	Green gram	Brown				
13.	TPT-28	Green gram	Green				
14.	TPT-22	Winged bean	Brown				

SOURCE: International Institute of Tropical Agriculture (IITA).

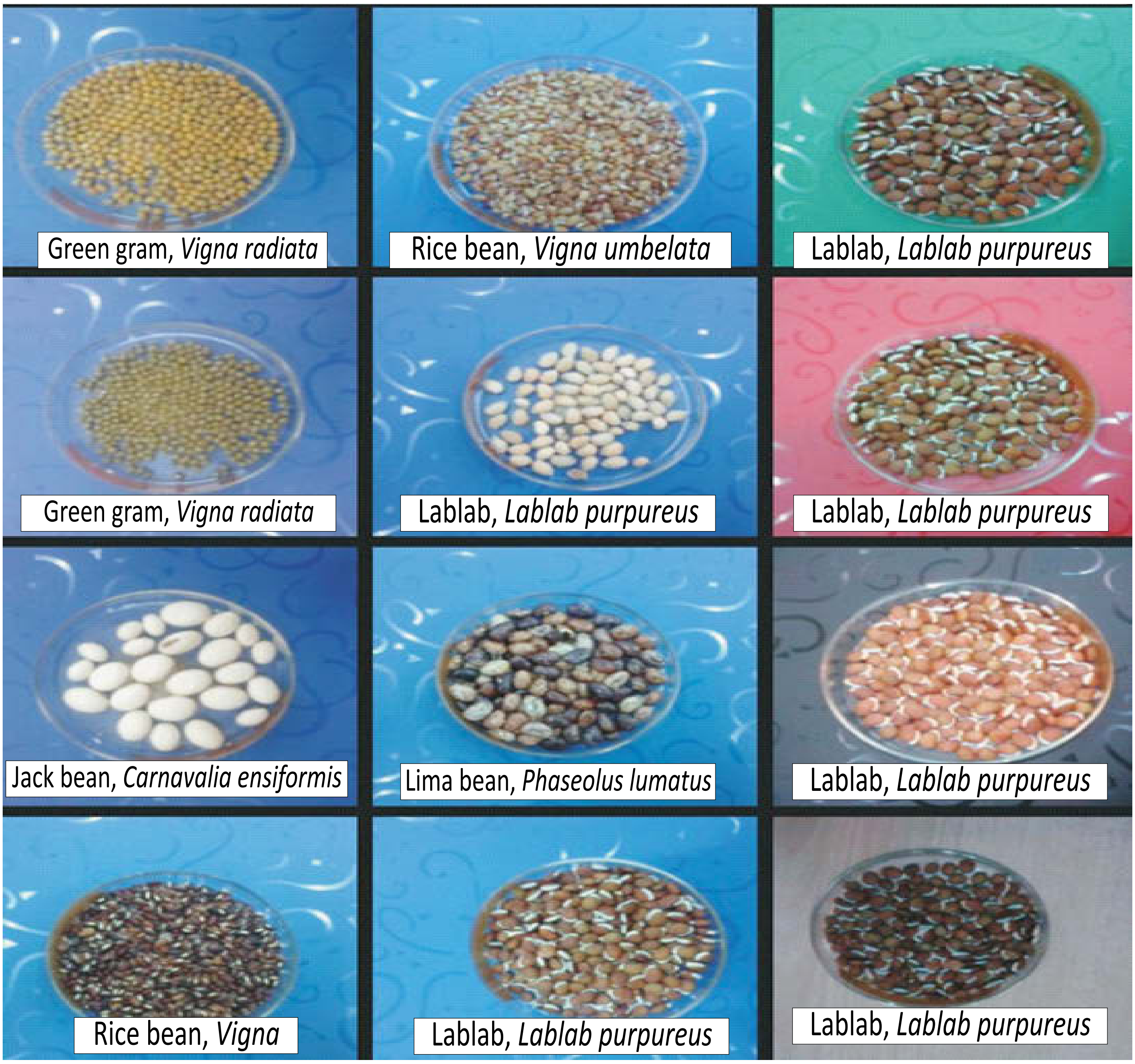

Plate 1: Variation in colour and seed size of some of the legumes studied.

Plate 2: Flower colour and morphology of [**A**] rice bean (Vigna umbelata) and [**B**] Lablab bean (Lablab purpureus).

Plate 3: Flower colour and morphology of [**C**] lima bean (Phaseolus lunatus) and [**D**] Jack bean (Canavalia ensiformis).

Results

The mean squares value for plant characters evaluated among twenty-four accessions of miscellaneous legumes is presented on Table 2. Analysis of variance revealed that there were significant differences among the accession for all plant characters evaluated except, seedling emergence, plant height at week four and stem girth at week two. The effect of blocking was significant only for number of leaves at week four and number of seeds per pod.

The inter-character association among the parameters studied shows that number of pods per plant and number of seeds per pod were negatively correlated with most of the traits studied. Hundred seed weight was however, positively correlated with all traits studied except seedling emergence (r= -0.20), stem girth at 4wks (r= -0.70*) and number of pods per plant (r= -0.27) Table 3.

Estimate of variances among 24 accessions of miscellaneous legumes for phenotypic, genotypic and environmental variance and heritability estimate of the plant characters studied (Table 4) revealed that, seedling emergence had the highest mean value of 83.73% while stem girth at week two had the lowest mean estimate of 2.54. The Phenotypic variance ranges from 3834.92 for 100-seed weight to 0.15 for stem girth at week four while values for Genotypic variance ranges from 3810.04 for 100-seed weight to 0.07 for stem girth at week two. Seedling emergence recorded the highest Environmental variance of 71.67 while stem girth at week four had the lowest value of 0.01. Number of seeds per pod recorded the highest heritability estimate of 99.60% while stem girth at week two had the lowest (22.22%). Genetic advance however, ranged from 3.31 to 270.19 for Plant height at 4 weeks to 100 seed weight respectively.

Dendogram drawn from single linkage cluster analysis to show the relativeness among the twenty-four accessions of miscellaneous legumes presented in Figure 1.0, revealed that at a minimum distance of 0.00 level of similarity,all twenty accessions were distinct from each other, while at a distance of 0.50 level, all had formed four single cluster indicating that the accessions had at least one neighbour. At a distance of 0.58 level of similarity 21 out of the accessions had formed a single cluster, but at a distance of 0.60 accession TPT-21, TPV-75, TCE-1 were distinguished from the rest of the population.

Table 2: Analysis of variance for twenty-four (24) accessions of some miscellaneous legumes

Df	Seedling Emergence %	Leave breadth@ 2wks (cm)	Leave breadth@ 4wks (cm)	Leave length@ 2wks (cm)	Leave length@ 4wks (cm)	No. of leaves@ 2wks	No. of leaves@ 4wks	Plant height@ 2wks (cm)	Plant height@ 4wks (cm)	Stem girth@ 2wks (mm)	Stem girth@ 4wks (mm)	No. of pods/plant	Pod length (cm)	No. of seeds/ pod	100-seed weight (g)
2	127.91	0.07	0.66	0.20	0.03	0.18	3.80*	0.24	1.77	0.90	0.06	1.40	2.85	7.53*	141.20
23	294.46	8.36**	4.23**	10.15**	5.72**	5.93**	55.83**	12.14**	2.79	0.90	0.46**	68.85**	105.96**	536.47**	11504.77**
46	215.01	0.22	0.28	0.32	0.16	0.35	0.74	0.42	1.81	0.70	0.02	1.73	2.04	2.17	74.64

**-Significance at 1% level of probability, *-significant at 5% level of prob
@= at, wks= Weeks.

Table 3: Inter-character association for some agronomic traits among twenty-four (24) accessions of some miscellaneous legumes

Characters	Leave breadth@ 2wks (cm)	Leave breadth@ 4wks (cm)	Leave length@ 2wks (cm)	Leave length@ 4wks (cm)	No. of leaves@ 2wks	No. of leaves@ 4wks	Plant height@ 2wks (cm)	Plant height@ 4wks (cm)	Stem girth@ 2wks (mm)	Stem girth@ 4wks (mm)	No. of pods/plant	Pod length (cm)	No. of seeds/pod
Seedling emergence (%)	0.07	0.22	-0.02	0.02	-0.02	0.01	-0.22	-0.17	-0.03	-0.16	0.17	-0.18	-0.05
Leave breadth @2wks (cm)		0.89**	0.78**	0.57**	0.86**	0.56**	0.11	0.02	0.17	0.67**	-0.46**	0.13	-0.52**
Leave breadth @4wks (cm)			0.64**	0.53**	0.74**	0.47**	-0.08	-0.02	-0.05	0.50**	-0.32	-0.03	-0.45**
Leave length @2wks (cm)				0.91**	0.65**	0.87**	0.59**	0.34	0.17	0.55**	-0.38*	0.43*	-0.80**
Leave length @4wks (cm)					0.43*	0.91**	0.70**	0.41*	0.05	0.37*	-0.26	0.51**	-0.86**
No. of leaves @2wks						0.52**	-0.01	-0.02	0.18	0.56**	-0.22	-0.16	-0.54**
No. of leaves @4wks							0.60**	0.32	0.13	0.35*	-0.17	0.38*	-0.92**
Plant height @2wks (cm)								0.50**	0.25	0.30	-0.25	0.69**	-0.51**
Plant height @4wks (cm)									0.34	0.22	-0.21	0.38*	-0.30
Stem girth @2wks (mm)										0.41*	-0.26	0.13	-0.06
Stem girth @4wks (mm)											-0.78**	0.45**	-0.17
No. of pods/plant												-0.68**	-0.10
Pod length (cm)													-0.12
No. of seeds/pod													

**-Significance at 1% level of probability, *-significant at 5% level of probability, @= at, wks= Weeks.

Table 4: Estimate of variances and heritability for growth parameter among twenty-four (24) accessions of some miscellaneous legumes.

Characters	Mean	Phenotypic variance	Genotypic Variance	Envr. Variance	PCV	GCV	Heritability (%)	Genetic Advance
Seedling emergence %	83.73	98.15	26.48	71.67	11.83	6.15	26.98	6.58
Leave breadth@2wks(cm)	6.03	2.79	2.71	0.07	27.71	27.34	97.37	55.57
Leave breadth@4wks(cm)	6.49	1.41	1.32	0.09	18.30	17.68	93.38	35.20
Leave length@2wks(cm)	8.57	3.38	3.28	0.11	21.46	21.12	96.85	42.81
Leave length@4wks(cm)	9.00	1.91	1.85	0.05	15.35	15.13	97.20	30.73
No. of leaves@2wks	6.43	1.98	1.86	0.12	21.87	21.21	94.10	42.39
No. of leaves@4wks	12.64	18.61	18.36	0.25	34.12	33.89	98.67	69.36
Plant height@2wks(cm)	14.79	4.05	3.91	0.14	13.60	13.36	96.54	27.05
Plant height@4wks(cm)	21.11	0.93	0.33	0.60	4.57	2.71	35.13	3.31
Stem girth@2wks(mm)	2.54	0.30	0.07	0.23	21.54	10.15	22.22	9.86
Stem girth@4wks(mm)	3.02	0.15	0.15	0.01	12.97	12.69	95.65	25.56
No. of pods/plant	7.98	22.95	22.37	0.58	60.00	59.24	97.49	120.49
Pod length (cm)	10.62	35.32	34.64	0.68	55.97	55.43	98.07	113.08
No. of seeds/pod	13.96	178.82	178.10	0.72	95.80	95.60	99.60	196.54
100-seed weight (g)	46.91	3834.92	3810.04	24.88	132.02	131.59	99.35	270.19

@= at, wks= Weeks, PCV= Phenotypic coefficients of variation, GCV= Genotypic coefficients of variation

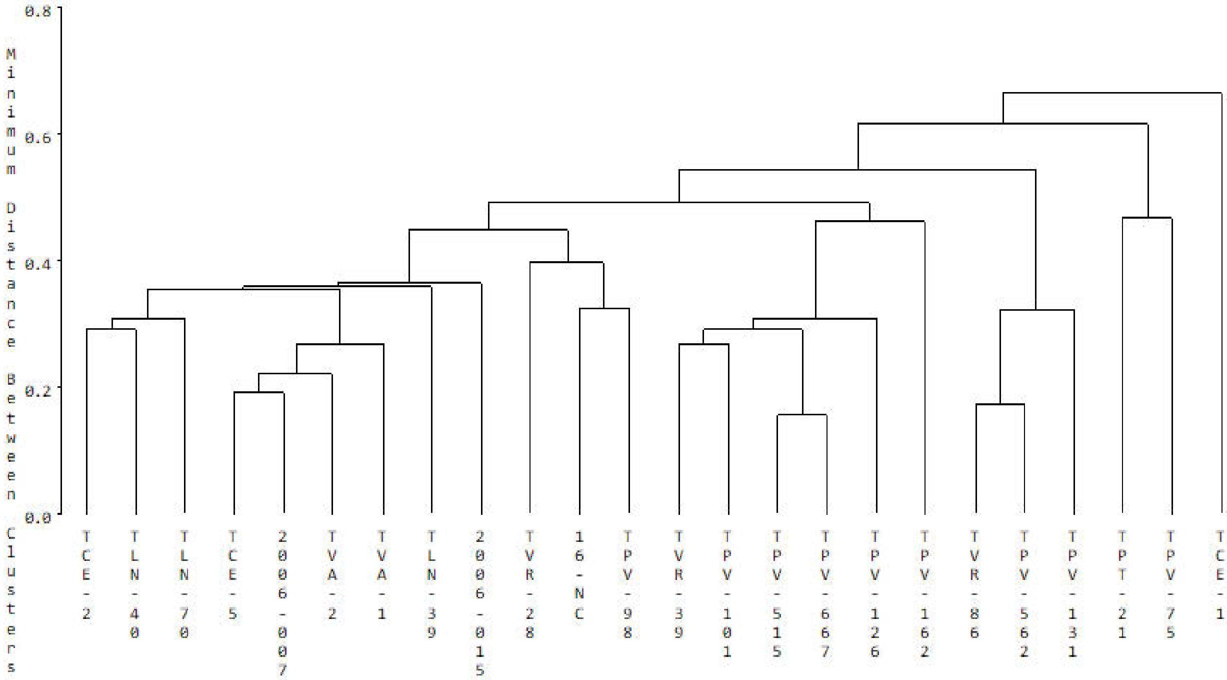

Figure 1.0: Dendogram resulting from single linkage cluster analysis of the twenty-four (24) accessions of miscellaneous legumes.

Discussion

The large variation observed among the twenty four miscellanous legumes studied for both morphological and agronomic traits suggest that variability exists in the agronomic trait of the accessions and also indicative of their ability to thrive under diverse environmental condition.

Lawn, (2007) reported a positive association between pod length and the number of seeds per pod in leguminous plant species. Selection based on seed weight however, had been reported to be more reliable and effective for yield related trait in soybean, due to its strong genetic association with seed yield (Adebisi, 1994). Contrary to earlier reports, number of seeds per pod was negatively correlated was all the traits studied, this could however be due to the differences in genetic constitutent of the various accessions studied. Characterization based on morphological traits also revealed that phenotypic variation was evident among the twenty four accessions. All the quantitative characters had relative importance to the determining of their variation, the high variability among these legume accessions is based on phenotypic characters as reported by (Aremu et al.,2007; Adewale et al.,2010).

Assessment of the qualitative traits showed wide variability for flower colour, seed colour and seed size and structure. Hence, phenotypic variance can now be seen as the summative of both the genotypic variance and environmental variance. Corroborating the report of Rogerio (2010), this study also reveals that variability among the twenty four accessions of legumes used for all quantitative traits measured, may be attributed to different genetic background of the various legumes used.

Correlation analysis of the agronomic characters revealed that the number of pod per plant had positive and significant correlation with yield related traits, suggesting that an increase in the number of pods per plant will lead to an increase in seed yield. This implies that these characters can be improved simultaneously as a selection criterion to enhance the performance of various legumes in plant population. The heritability estimated observed for all the characters evaluated indicated that seedling emergence and stem girth at week two have low heritability and were influenced by the environment while leave breadth, leave length, number of leaves, plant height, number of pods per plant and other characters shows high heritability and are more under the influence of genetic factors. Exploring and improving these characters for beneficial breeding purposes in various legumes is therefore possible.

High cluster existed between all the parameters measured hence high variability amog the accessions. The clustering among the accessions further emphasized their relative variability. The grouping of the accession however into each cluster base on the genotypic character, suggested that selection is possible among the accessions for hybridization programme.

From the study, was established that variability existed for all plant character studied, as indicated by analysis of variance. The study also reveals that the observed expression of these traits is more influenced by genetic factor than environment effect, which implies that there is high genetic diversity among them, the usefulness of this in plant breeding is that the observed trait can be transfer to subsequent generation through careful selection and more improvement for cultivation and edibility. Also, since there is great variability among the accessions, exploring for better hybrid vigour is possible among the accessions.

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