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Genetic divergence in Yam bean Germplasm

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ABSTRACT

Altogether, 30 germplasm of Yam bean including two released varieties viz., Rajendra Misrikand-1(RM-1) and Rajendra Misrikand-2 (RM-2) were analyzed for genetic divergence among twelve studied characters. Analysis of variance revealed highly significant differences among the genotypes for all the twelve characters under study. The (PCV) was greater than the genotypic coefficient of variance (GCV) for all the characters and high magnitude of PCV and GCV were observed for traits like tuber weight followed by tuber yield indicating that these traits could be used for tuber yield improvement but wide difference between GCV and PCV were recorded for most of the traits except for the tuber yield and tuber weight. All the thirty genotypes were grouped into 6 clusters using D^2 statistics. Highest inter-cluster distance was observed between cluster I and III (107.53) followed by cluster III and VI (97.61) and cluster I and II (78.54) on the basis of their genetic distances. Tuber yield followed by tuber weight and seed yield were having a maximum contribution towards total divergence.

Keywords : Yam bean, Germplasm, Genetic divergence, D^2 statistics, clustering phenotypic coefficient of variance.

INTRODUCTION

The Yam bean (*Pachyrhizus spp.*) is one of the legume root crops. The name yam bean is used to designate the species within the genus *Pachyrhizus*, in particular, the three cultivated species; *P. erosus*, from the semiarid tropics of Central America; *P. tuberosus* from the tropical lowlands of both slopes of the Andean mountain range and *P. ahipa* from Andean highland (Sorensen *et al*., 1996). The plant is widely cultivated in most southern states of Mexico. Moreover, *P. erosus* is cultivated in many South East Asian countries. *P. erosus* was introduced into India during the period between 1880 and 1890. In India, it is most commonly grown in North Bihar including eastern Uttar Pradesh and in parts of West Bengal, Assam, Orissa and Andhra Pradesh. Due to its high tuber productivity and nutritional value, this crop is gaining importance in other parts of India also and cultivated as minor tuber crops.

The yam bean is mainly self-pollinating crop propagated by seed and needs to have the fertile shoots pruned repeatedly during the growing season in order to produce a higher tuber yield. Yam bean provides high tuber yields (Grüneberg, pers. comm.) and as a legume, it produces protein-rich food and improves sustainability in cropping systems. The starch is of good quality in regard to the digestibility and consists essentially of amylopectin (Bergthaller *et al*., 2001).

The mature seeds of the yam bean are not used due to the high rotenone content (about 0.5% to 1% seed weight), even so, the seeds are an interesting source of high palmitic acid oil (Santos *et al*., 1996). The species is found in the area with rainfall ranges from 250-500 mm to over 1500 mm. The optimal day/night temperature is 30/20°C with well-drained, sandy, alluvial soils are preferred in cultivation.

MATERIALS AND METHODS

An experiment was conducted to assess the genetic variability and divergence among 30 germplasm accessions of Yam bean having different geographical origin, obtained from germplasm collections maintained at Tirhut College of Agriculture, Dholi, including Rajendra Misrikand-1 (RM-1) and Rajendra Misrikand-2 (RM-2) released from All India Coordinated Research Project on Tuber Crops (AICRPTC), Dholi. The experiment was conducted in Randomized Block Design in three replications at T.C.A., Dholi Research Farm of Dr. R.P.C.A.U., Pusa, Samastipur, Bihar. Data were collected for twelve characters viz., Plant height (cm), No. of branches per plant, Days to 50% flowering, Pods per plant, Pod weight per plant (g), Pods per peduncle, Pod length (cm), No. of seeds per pod, Tuber weight (g), Dry matter (%), Tuber yield (kg/plot) and Seed yield (kg/plot). The soil of experimental site is sandy loam, basic in reaction (pH - 8.1) with available N (233.6 kg/ha.), available P (18.0 kg/ha.) and available K (142.5 kg/ha.).

Weather conditions during the cropping season were moderate with total rainfall received 870 mm, maximum and minimum temperature ranged from 30-38 ^{0}C and 22-26 ^{0}C, respectively and relative humidity was ranging from 50 to 98 %. The crop was supplied 80:60:80 kg of NPK ha^{-1} as per recommended doses. Standard cultural practices were applied during the crop period. Data for twelve quantitative characteristics were statistically analyzed for genetic variability parameters as per the standard methods. Genetic divergence analysis was performed as per Mahalanobis (1936) and clustering of genotypes was done by using Tocher's method (Rao, 1952).

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RESULTS AND DISCUSSION

Tuber and Seed yield are complex traits influenced by several interdependent quantitative traits, which are less influenced by environmental fluctuations (**Table 1**). The mean of different quantitative characters including tuber yield and seed yield as performed by available germplasm of yam bean suggested that selection of desirable germplasm based on these traits from evaluated materials can be effective.

Table 1: Mean performance of thirty genotypes of yam bean for twelve characters

Germplasm	Characters											
	PH (cm)	NBPP	DFF	PoPP	PoWPP (g)	PoPPe	PoL (cm)	NSPP	TW (g)	DM (%)	TY (kg/Plot)	SY (kg/Plot)
TCAYB -1	60.67	2.70	82.00	6.33	15.67	2.90	10.53	7.87	165.00	20.87	0.76	0.0613
TCAYB -2	66.13	3.50	82.00	18.27*	31.00	3.73	10.33	7.13	256.67	19.57	0.67	0.1090
TCAYB -3	65.40	3.30	84.33	15.20	30.67	2.90	11.10*	8.37	233.33	21.33	1.90	0.0950
TCAYB -4	46.13	3.00	82.67	5.60	21.67	3.50	9.67	4.60	125.00	19.23	1.07	0.0590
TCAYB -5	77.87*	3.60*	85.67	16.27	30.00	3.90*	10.47	7.97	166.67	20.97	1.00	0.0970
TCAYB -6	55.97	3.30	88.00	11.47	26.00	3.63	10.47	8.50*	135.00	17.60	0.89	0.0860
TCAYB -7	61.47	3.60*	89.67	15.80	15.67	3.43	10.47	8.07	170.00	18.10	0.89	0.0833
TCAYB -8	56.17	3.10	78.67	15.87	31.33	2.80	10.17	7.33	180.00	16.87	0.86	0.0810
TCAYB -9	59.97	3.83*	85.33	14.13	25.67	3.00	9.67	6.87	250.00	21.53	1.79	0.0733
TCAYB -10	38.27	3.50	84.33	14.80	33.67	2.90	9.80	8.23	260.00	20.73	1.54	0.1013
TCAYB -11	45.97	2.57	87.00	10.33	26.00	4.23*	10.57	8.50*	183.33	18.67	1.04	0.0853
TCAYB -12	69.07	2.90	84.00	11.33	25.67	3.00	10.17	8.07	200.00	20.80	1.14	0.0860
TCAYB -13	53.00	2.80	86.67	13.53	17.67	2.80	10.60	8.67*	266.67	21.03	1.44	0.0923
TCAYB -14	52.77	2.47	94.67	11.00	24.67	3.43	10.13	7.97	330.00	18.03	1.85	0.0673
TCAYB -15	52.03	3.10	85.67	12.40	21.00	3.67	10.27	7.03	268.33	18.27	1.04	0.0783
TCAYB -16	72.50*	3.73*	85.33	14.73	34.00	4.00*	11.17*	8.17	340.00	17.43	1.75	0.0883
TCAYB -17	60.30	3.63*	84.00	13.33	31.00	3.63	10.57	7.13	306.67	18.40	1.63	0.0873
TCAYB -18	63.20	3.10	86.33	11.60	30.00	2.40	9.37	7.33	386.67	19.47	1.85	0.0630
TCAYB -19	66.67	3.30	83.67	11.60	20.67	2.77	9.87	8.17	316.67	21.50	1.79	0.0520
TCAYB -20	75.80*	3.10	86.00	12.13	25.67	2.60	9.67	7.27	396.67	17.57	1.88	0.0437
TCAYB -21	75.97*	3.30	83.00	15.13	33.67	2.63	10.50	8.40	260.00	17.90	1.46	0.1177
TCAYB -22	55.63	2.70	85.67	15.53	26.00	2.63	10.33	7.77	180.00	18.70	0.94	0.0903
TCAYB -23	54.77	2.60	75.67*	15.07	38.00	2.63	10.17	7.73	171.67	16.70	0.65	0.1097
TCAYB -24	52.30	3.50	85.67	12.47	24.67	2.90	9.80	6.83	135.00	14.33	1.22	0.0877
TCAYB -25	42.07	3.63*	87.67	13.40	30.33	3.53	10.70	7.33	233.33	20.57	1.74	0.0723
TCAYB -26	52.70	2.70	81.33	14.27	20.67	3.37	10.63	7.23	153.33	21.00	1.22	0.1040
TCAYB -27	51.13	3.10	84.33	13.40	30.67	2.97	9.73	7.73	211.67	20.37	0.84	0.1333*
TCAYB -28	62.00	2.57	88.33	10.73	15.67	2.80	10.00	8.27	241.67	21.20	1.24	0.0517
RM-1	**59.57**	**2.80**	86.00	12.07	27.33	**3.07**	**10.47**	**7.33**	333.33	18.53	1.74	**0.1033**
RM-2	54.03	2.57	**83.67**	**13.47**	**31.00**	2.80	10.33	6.70	**375.00**	**21.70**	**1.88**	0.1017
Mean	**58.65**	**3.12**	**84.91**	**13.04**	**26.52**	**3.15**	**10.26**	**7.62**	**241.06**	**19.30**	**1.32**	**0.0854**
C.D.5%	11.38	0.73	5.69	2.86	7.18	0.77	0.59	1.08	39.12	2.46	0.12	0.0183
S.E.	3.95	0.25	1.98	0.99	2.49	0.27	0.20	0.37	13.58	0.85	0.04	0.0063

*superior over best check variety

PH=Plant height (cm), NBPP=No. Of branches per plant, DFF=Days to 50% flowering, PoPP=Pods per plant, PoWPP=Pod weight per plant (g), PoPPe=Pods per peduncle, PL=Pod length (cm), NSPP=No. of seeds per pod, TW=Tuber weight (g), DM=Dry matter (%), TY=Tuber yield (kg/plot) and SY=Seed yield (kg/plot).

The analysis of variance showed significant differences among all the thirty germplasm accessions of yam bean for all the twelve characters. This, in turn, indicated that there was a considerable extent of inherent differences among germplasm of yam bean, which could be utilized in the future breeding programme. Nwofia *et al.* (2013) also reported significant variability for different characters in yam bean. The range of differences was found comparatively wider for tuber weight, days to 50% flowering, plant height, pod weight per plant and dry matter showing a greater extent of variability among selected germplasm for these traits. The phenotypic variances for all the characters studied were higher than the genotypic variances. Nwofia *et al.* (2013) reported a similar finding in African yam bean. This may be due to non-genetic factors which played s ome important role in the manifestation of these characters. Wide ranges of variances (genotypic and phenotypic) were observed in the experimental material for all the characters under investigation. Prasad *et al.* (2018) reported similar finding in elephant foot yam. The maximum phenotypic and genotypic variance exhibited by the traits like tuber weight, plant height and pod weight per plant offering ample scope for selection of these traits in development of suitable variety.

In the present investigation, the phenotypic coefficient of variation (PCV) was found greater than the genotypic coefficient of variation (GCV) for most of the traits studied among thirty yam bean germplasm indicating the role of environment in the expression of these traits (Table 2). Both genotypic and phenotypic coefficient of variation was higher for tuber weight followed by tuber yield, seed yield and pod weight per plant. Singh *et al.* (2001) reported that seed yield exhibited a phenotypic coefficient of variation greater than that of the genotypic coefficient of variation. Tuber yield and tuber weight had small differences in PCV and GCV values in the present study suggesting a minimum role of environment on the expression of these traits. Therefore, such characters could be relied upon and simple selection can be practiced for further improvement. Days to 50% flowering had least GCV and PCV.

Table 2: Estimates of genetic parameters for twelve characters in yam bean

Characters	$\sigma^2 g$	$\sigma^2 p$	GCV	PCV	h^2 (Broad sense %)	Genetic advance as % of mean
Plant Height (cm)	79.97	128.48	15.25	19.33	62.00	24.78
Number of Branches Per Plant	0.10	0.30	10.13	17.61	33.00	12.01
Days to 50 % Flowering	7.32	19.46	3.19	5.20	38.00	4.03
Pods Per Plant	6.26	9.33	19.19	23.42	67.00	32.39
Pod Weight Per Plant (g)	28.43	47.75	20.10	26.05	59.00	31.96
Pods Per Peduncle	0.15	0.38	12.48	19.51	41.00	16.45
Pod Length (cm)	0.14	0.27	3.64	5.07	51.00	5.38
Number of Seeds Per Pod	0.49	0.93	9.22	12.65	53.00	13.86
Tuber Weight (g)	6027.55	6600.35	32.207	33.70	91.00	63.40
Dry Matter (%)	2.58	4.84	8.32	11.40	53.00	12.50
Tuber Yield (kg/Plot)	0.18	0.18	31 .71	32.23	97.00	64.27
Seed Yield (kg/Plot)	0.0004	0.0005	23.086	26.54	76.00	41.37

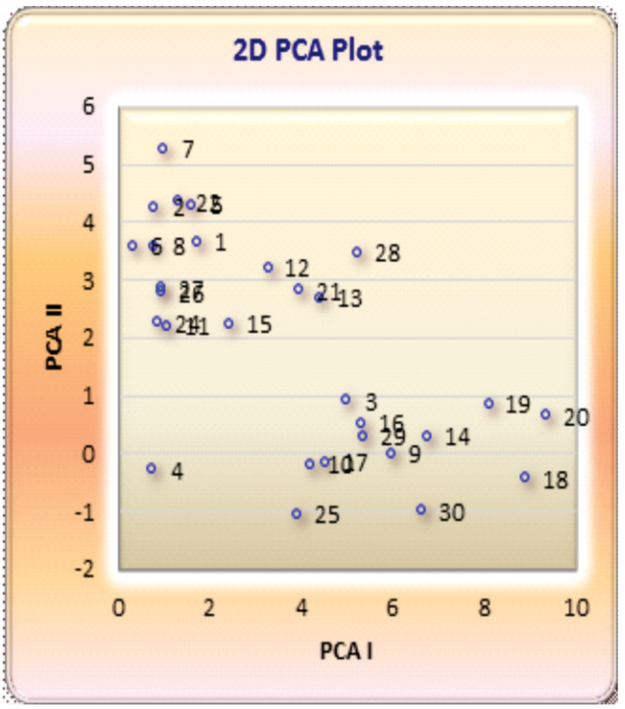
Where, ^{2}g = Genotypic variance, ^{2}p = Phenotypic variance, GCV = Genotypic Coefficient of Variation, PCV = Phenotypic Coefficient of Variation, h^2 = heritability

Heritability in a broad sense for the characters namely tuber yield, tuber weight, seed yield, pods per plant and plant height was found high. High heritability values for these traits indicated that variation observed was mainly under genetic control and having less influence of the environment. So, these traits can be used as selection criteria for tuber and seed yield in confirmation with the result of earlier workers viz. Nwofia *et al.* (2013), who has also recorded high heritability for pods per plant and seed yield in yam bean. In the present investigation, high heritability estimates coupled with high genetic advance as percent of the mean was recorded for tuber yield, tuber weight, seed yield, pods per plant and plant height indicating additive gene action and effectiveness of selection for these characters which may result in the development of adapted genotype. Similar findings were also reported by Singh *et al.* (2001) in yam bean.

The multivariate analysis presented in Table 3, revealed that the first two principal components (PC1 and PC2) gave Eigen value (Root) more than 1.0 and cumulatively accounted for 42.93% of the total variations present for twelve parameters. The association of considered tuber characteristics with specific principal component (PC) values presented in the table revealed that variation in PCA-1 was mainly associated with Tuber weight, Dry matter and Tuber yield. In PCA-2, variation was found mainly associated with Plant Height, Pods per plant and Number of Seeds per Pod. Distribution of 30 genotypes has been plotted in 2D PCA plot given in figure on the basis of PCA-1 and PCA-2 showing relative positions of these diverse genotypes.

Table 3: Multivariate analyses for twelve yam bean characters

	1 Vector	2 Vector	3 Vector
Eigene Value (Root)	3.176	1.976	1.539
% Var. Exp.	26.466	16.463	12.828
Cum. Var. Exp.	26.466	42.929	55.757
Plant Height (cm)	0.266	0.343	0.125
Branches Per Plant	-0.117	-0.290	0.067
Days to 50% Flowering	0.221	0.017	-0.168
Pods Per Plant	-0.109	0.276	0.565
Pod Weight Per Plant(g)	-0.064	-0.411	0.317
Pods Per Peduncle	-0.307	-0.360	-0.064
Pod Length (cm)	-0.265	0.187	0.425
No. of Seeds Per Pod	0.191	0.456	0.070
Tuber Weight(g)	0.447	-0.144	0.315
Dry Matter (%)	0.400	-0.230	0.178
Tuber Yield (kg/Plot)	0.340	-0.327	0.306
Seed Yield (kg/Plot)	-0.417	0.015	0.344



The thirty yam bean germplasm were taken for genetic divergence analysis differed significantly with regard to the characters studied and displayed marked divergence and grouped into six clusters following clustering method suggested by Tocher (Table 4). Cluster I had twelve numbers of genotypes *viz*., TCAYB-1, TCAYB-2, TCAYB-5, TCAYB-6, TCAYB-7, TCAYB-8, TCAYB-11, TCAYB-12, TCAYB-15, TCAYB-22, TCAYB-23 and TCAYB-27. Cluster II also had twelve genotypes *viz*., TCAYB-3, TCAYB-9, TCAYB-10, TCAYB-13, TCAYB-14, TCAYB-16, TCAYB-17, TCAYB-18, TCAYB-19, TCAYB-25, RM-1(Rajendra Misrikand -1) and RM-2 (Rajendra Misrikand -2).

Cluster VI had three genotypes *viz*., TCAYB-4, TCAYB-24 and TCAYB-26 while, Cluster III, IV and V were solitary, comprising single genotypes each, namely TCAYB-20, TCAYB-28 and TCAYB-21 respectively. Similar approach was adopted by Akande (2009) and Ojuederie *et al.* (2015) in African yam bean. Clustering pattern showed that genotypes of different geographical areas were accumulated in one group and also the genotypes belonging to same geographical area where grouped into the same cluster as well as in different cluster indicating that there was no formal relationship between geographical diversity and genetic diversity.

Table 4: Clustering patterns of 30 genotypes of yam bean on the basis of D^2 statistics

Cluster No.	No. of genotypes within the cluster	Genotypes in cluster
I	12	TCAYB -1, TCAYB -2, TCAYB -5, TCAYB -6, TCAYB -7, TCAYB -8, TCAYB -11, TCAYB -12, TCAYB -15, TCAYB -22, TCAYB -23, TCAYB -27
II	12	TCAYB -3, TCAYB -9, TCAYB -10,TCAYB -13, TCAYB -14, TCAYB -16, TCAYB -17, TCAYB -18, TCAYB -19, TCAYB -25, RM -1, RM -2
III	1	TCAYB -20
IV	1	TCAYB -28
V	1	TCAYB -21
VI	3	TCAYB -4, TCAYB -24, TCAYB -26

Cluster mean in respect of twelve quantitative characters of thirty genotypes were presented in Table 5. It was observed that cluster I had maximum cluster mean value for Pods per peduncle (3.29) and minimum cluster mean value for number of branches per plant (3.06) and tuber yield (0.90). Cluster III had maximum cluster mean value for tuber weight (396.67) and tuber yield (1.88) and minimum cluster mean value for pods per peduncle (2.60), pod length (9.67), dry matter percentage (17.57) and seed yield (0.04). Cluster III had the genotype with the highest mean value for tuber weight and tuber yield. It can be concluded that genotypes from this cluster can be selected as parents to be utilized in hybridization programme in order to improve tuber yield.

Cluster IV had maximum cluster mean value for days to fifty percent flowering (88.33) and dry matter percentage (21.20) and minimum cluster mean value for number of pods per plant (10.73) and pod weight per plant (15.67). Cluster V had maximum cluster mean value for plant height (75.97), number of branches per plant (3.30), number of pods per plant (15.13), pod weight per plant (33.67), pod length (10.50), number of seeds per pod (8.40) and seed yield (0.12) and minimum cluster mean value for days to fifty percent flowering (83.00).

Cluster VI had minimum cluster mean value for plant height (50.38), number of seeds per pod (6.22) and tuber weight (137.78). Cluster V had maximum mean value for characters like plant height, number of branches per plant, pods per plant, pod weight per plant, pod length, number of seeds per pod and seed yield and these characters are seed yield attributing characters except plant height. Thus, it can be suggested that genotypes grouped in cluster V can be used as parent in hybridization programme in other to improve seed yield in yam bean. A similar approach was adopted by Akande (2009) and Ojuederie *et al.* (2015) in African yam bean.

Table 5: Cluster mean values for twelve characters in yam bean

Cluster	PH	NBPP	DFF	PoPP	PoWPP	PoPPe	PoL	NSPP	TW	DM	TY	SY
Cluster I	58.91	3.06	84.03	13.51	26.42	3.29	10.31	7.81	190.69	18.96	0.90	0.09
Cluster II	57.31	3.22	86.00	13.24	28.06	3.10	10.31	7.69	302.64	20.02	1.74	0.08
Cluster III	75.80	3.10	86.00	12.13	25.67	2.60	9.67	7.27	396.67	17.57	1.88	0.04
Cluster IV	62.00	2.57	88.33	10.73	15.67	2.80	10.00	8.27	241.67	21.20	1.24	0.05
Cluster V	75.97	3.30	83.00	15.13	33.67	2.63	10.50	8.40	260.00	17.90	1.46	0.12
Cluster VI	50.38	3.07	83.22	10.78	22.33	3.26	10.03	6.22	137.78	18.19	1.17	0.08

PH=Plant height (cm), NBPP=No. Of branches per plant, DFF=Days to 50% flowering, PoPP=Pods per plant, PoWPP=Pod weight per plant (g), PoPPe=Pods per peduncle, PL=Pod length (cm), NSPP=No. of seeds per pod, TW=Tuber weight (g), DM=Dry matter (%), TY=Tuber yield (kg/plot) and SY=Seed yield (kg/plot).

From the perusal of Table 6, the average intra cluster distance ranged from 16.92 to 22.12. Maximum intra cluster distance was observed in cluster VI (22.12) followed by cluster II (17.76), while the lowest intra cluster distance was recorded from cluster I (16.92). The highest inter cluster distance was recorded between cluster I and cluster III (107.53), followed by cluster III and VI (97.61), cluster I and cluster II (78.54), cluster II and cluster VI (59.16), cluster III and cluster V (44.30), cluster III and cluster IV (42.82), cluster II and cluster IV (41.39), cluster IV and cluster VI (36.64), cluster I and cluster V (33.40), cluster V and cluster VI (32.49), cluster I and cluster VI (30.09), cluster II and cluster III (27.63), cluster I and cluster IV (27.47), cluster II and cluster V (25.63) and cluster IV and cluster V (21.04). The highest inter-cluster distance was observed between cluster I and III, indicating that genotypes belonging to these two clusters exhibited a high degree of genetic diversity and thus may be utilized under hybridization programme (transgressive breeding) for getting superior recombinants. A similar approach was adopted by Ojuederie et *al.* (2015) in African yam bean.

Table 6: Mean intra and inter-cluster distance (D^2) among six clusters in yam bean

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Cluster I	**16.92**	78.54	107.53	27.47	33.40	30.09
Cluster II		**17.76**	27.63	41.39	25.63	59.16
Cluster III			**0.00**	42.82	44.30	97.61
Cluster IV				**0.00**	21.04	36.64
Cluster V					**0.00**	32.49
Cluster VI						**22.12**

Intra-Cluster distance values are given in bold

The contribution percentages of traits studied towards total divergence are tabulated in Table 7. The highest contribution in the manifestation of genetic divergence was exhibited by tuber yield (59.54) followed by tuber weight (14.71), seed yield (7.13), dry matter percentage (4.37), pods per plant (2.76), pod weight per plant (2.76), plant height (2.30), pods per peduncle(1.84), pod length(1.84), number of seeds per pod (1.61), days to fifty percent flowering (0.92) and contribution of number of branches per plant towards genetic divergence was minimum (0.23). There is scope for improvement and diversity study may be taken by considering these traits.

Genotype TCAYB-21 exhibited superiority for Plant height, Number of branches per plant, Pods per plant, pod weight per plant, pod length, Number of seeds per pod and Seed yield with the highest cluster mean value and *per se* performance. Genotype, namely TCAYB-20 was selected from cluster III for tuber weight and tuber yield based on cluster mean (highest) and significantly superior *per se* performance.

Table 7: Contribution percentages of twelve characters towards genetic divergence in yam bean genotypes

Source	Contribution %	Times Ranked 1st
Plant Height (cm)	2.30	10.00
Number of Branches Per Plant	0.23	1.00
Days to 50% Flowering	0.92	4.00
Pods Per Plant	2.76	12.00
Pod Weight Per Plant (g)	2.76	12.00
Pods Per Peduncle	1.84	8.00
Pod Length (cm)	1.84	8.00
Number of Seeds Per Pod	1.61	7.00
Tuber Weight (g)	14.71	64.00
Dry Matter (%)	4.37	19.00
Tuber Yield (kg/Plot)	59.54	259.00
Seed Yield (kg/Plot)	7.13	31.00

REFERENCES

Akande SR. 2009. Germplasm Characterisation of African Yam Bean from South West Nigeria. *Acta Horticultare* **806**: 695-700.

Bergthaller W, Kersting HJ, Velasco L and Grüneberg WJ. 2001. Andean yam bean (*Pachyrhizus ahipa*) tubers, a new source of legume starch. Proceedings of the 4th European Conference on Grain Legumes, Cracow, Poland, 8-12 July 2001. European Association for Grain Legume Research (AEP), Paris. 204-205.

Mahalanobis PC. 1936. On the generalised distance in statistics. *Proceedings of National Institute of Science,* India. **2**: 49-55.

Nwofia GE, Awaraka RO and Agbo CU. 2013. Genetic Variability and Trait Association Studies in African Yam Bean (Sphenostylis sternocarpa) Hochst ex A. Rich. *American-Eurasian J. Agric. & Environ. Sci*. **13**(11): 1547-1553.

Ojuederie OB, Balogun MO, Akande SK, Korie S and Omodele T. 2015. Intraspecific Variability in Agro-Morphological Traits of African Yam Bean (*Sphenostylis stenocarpa* (Hochst ex. A. Rich) Harms). *J. Crop Sci. Biotech*. **18**(2): 53-62.

Prasad R, Singh PK and Singh VB. 2018. Genetic Evaluation of Genotypes for Variability in Elephant foot Yam. *International Journal of Current Microbiology and Applied Sciences* **7**: 4673-4679.

Rao CR. 1952. Advanced statistical methods in biometrical research. Ed. J. John Wiley and Sons, Inc. New York: 198-201.

Santos ACO, Cavalcanti MSM and Coello, LCBB.1996. Chemical composition and nutritional potential of yam bean seeds (*Pachyrhizus erosus* (L.) Urban). *Plant Food for Human Nutrition*. **49**: 36-41.

Singh HV, Gaur GS, Rajput CBS and Singh S. 2001. Variability, heritability, genetic advance and path analysis in yam bean (*Pachyrhizus erosus* L.). *Indian Journal of Horticulture* **58**(4): 366-370.

Sørensen M. 1996. Yam bean (*Pachyrhizus* DC.). Promoting the conservation and use of underutilized and neglected crops. 2. Institute of Plant Genetics and Crop plant Research, Gaterslebean/ International Plant Genetic Resources Institute, Rome.

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