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Divyaraj S
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

VM Prasad
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Samir Eb Topno
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Mohd Shabi
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Vadapalli Madhukar
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Correspondence
Divyaraj S
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Study on genetic variability, heritability, character association and genetic divergence in ridge gourd *(Luffa acuntangula* (L.) Roxb.)

Divyaraj S, VM Prasad, Samir Eb Topno, Mohd Shabi and Vadapalli Madhukar

Abstract
An experiment was conducted on Genetic variability, heritability and genetic gain in the Fifteen genotypes of Ridge Gourd during 2018-19 at the Research Field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The observations were recorded on various yield and yield contributing characters. The results from the present investigation revealed that On the basis of mean performance of seventeen genotypes of Ridge Gourd, genotype, Nidhi (215.82) and Chitrada (134.99) was found superior in terms of Fruit yield/ha (q). On the basis of Analysis of variance significant difference was recorded for all the quantitative and qualitative traits indicating presence of large amount of variability in the genotypes. The study on genotypic and phenotypic coefficient of variation revealed that the magnitude of GCV and PCV highest for Fruit yield/ha (q) (43.37 & 41.78). The heritability estimate were found to be high (>60) for almost all the characters, On the other hand cluster II comprised 3 genotype, cluster III and IV cluster comprised 1 genotype. The inter cluster distance was maximum between cluster II and III (81170.76) followed by cluster II and Cluster IV (18636.9), Cluster I and cluster II (11325.81), cluster I and IV (5254.03), Cluster III and IV (4083.57). In the present investigation the highest contribution in manifestation of genetic divergence was exhibited by Fruit yield per plant (kg) (45.71), Average fruit weight (g) (38.1), Node to first male flower (5.71), Flesh thickness (cm) (4.76) and Fruit yield/ha (q) (3.81).

Keywords: Ridge gourd, genotypes, genetic variability, heritability

Introduction
Ridge gourd [*Luffa acutangula* (L.) Roxb.], popularly known as Kalitori and also called as angled gourd, angled loofah, Chinese okra, silky gourd and ribbed gourd, belongs to genus Luffa of "Cucurbitaceae" family and has chromosome number 2n = 26.

India has the credibility of producing 169.478 million tonnes of vegetables covering an area of 9.542 million hectares in 2014-15 (NHB, 2014-15) securing the second status among the vegetable producing countries of the world but the per capita availability of vegetables in India is as low as 160 gm as against the recommended 300 g per day by FAO.

Fruit contain moisture 92.5g, protein 0.5g, fat 0.5g, carbohydrate 3.4g, energy 17 k cal, calcium 18mg, vitamin C 5mg, riboflavin 0.01mg, phosphorous 26mg, iron 0.5mg and carotene 33µg per 100 g of edible portion (Sheshadri and Parthasarthy, 1980). Besides their use as vegetables, it is also used for various purposes. The fiber obtained from the mature dry fruit is used in industry for filters of various sorts, good pot holders, table mats, bath room mats, slipper and shoe soles. The fiber is also proved to be a good insulator for various purposes. Sometimes the dry fruits which gave good storability are used for ornamental purposes also. It is emetic and traditionally used for the treatment of stomach ailment and fever (Chakravarthy, 1959).

The success of any crop improvement programme largely depends upon the nature and magnitude of genetic variability existing in the breeding material. This study on genetic variability and divergence elucidates information on genetic parameters. Further, path-coefficient technique provides the information on the direct and indirect contribution of individual characters towards yield. Based on these studies, the importance of individual character is marked to facilitate the selection programme for larger gains. Generally, diverse germplasm are expected to give high hybrid vigour.

Hence, it necessitates studying the genetic divergence among the existing genotypes for identification of parents for hybridization programme.

Materials and Method

The present research work entitled, "Study on Genetic variability, Heritability, Character association and Genetic divergence in Ridge Gourd *(Luffa Acuntangula* (L.) Roxb.)" Was undertaken to study the variability, heritability, genetic advance, and correlation and their effect on yield and yield contributing traits. On 15 genotypes of Ridge Gourd collected from different institutes, research stations and private seed companies.

Experimental site

The study was conducted in the Research Field of Department of Horticulture, Naini Agriculture Institute, SHUATS, Prayagraj, located between 25. 87° North latitude 81.15° Eastlatitude. The altitude is 78 meters above the mean sea level.

Soil type

The soil type of experimental field was sandy loam with average fertility level and pH in the range of 7.0 to 8.0.

Climate

Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj, falls under the humid subtropical zone. Maximum rainfall received during the period between July to the end of September. However, occasional showers are also very common in the month of June, December and January. The winter month will usually cool and dry. The summer is hot and dry western hot winds start from April and end at onset of monsoon.

Table 1: List of genotypes were used in the present investigation

Sl. No.	Genotype Symbol	Name of genotypes
1	G_1	Anjanli Long
2	G_2	Mysuru local
3	G_3	Co - 1
4	G_4	KRCCH - 1
5	G_5	Rekha
6	G_6	Annihalli Local - 2
7	G_7	Mangala giri
8	G_8	ERG - 4
9	G_9	ERG - 1
10	G_{10}	Chitrada
11	G_{11}	Jaipuri long (SPC)
12	G_{12}	Nidhi
13	G_{13}	Jaipuri
14	G_{14}	SPL/80
15	G_{15}	Arka Prasanna

Result and Discussion

Analysis of variance showed significant differences among the genotypes for the seventeen characters studied. Analysis of variance showed significant difference among the genotypes for the different characters at 0.1% and 5% significance.

Similar finding for variance have also been reported by Ramakant *et al.,* (2008), Parameshwarappa *et al.,* (2008), Kumar *et al*., (2012), Reddy *et al*., (2013), Rani and Kumar (2013) [8] and Narayanan and Murugan (2013), Singh *et al.*, 2015 and Paul *et al.,* 2015 reported significant mean sum of square for various quantitative and quality traits in cow pea.

The genotypes Nidhi was recorded highest mean performance for Fruit yield/ha (q) with (215.82) followed by Chitrada (134.99) while lowest value observed for the Fruit yield/ha (q) SPL/80 (53.08).

The study on genotypic and phenotypic coefficient of variation revealed that the magnitude of GCV and PCV highest for Fruit yield/ha (q) (43.37 & 41.78) indicating the presence of high amount of variation and role of environment on the expression of these traits. The present findings are in accordance with the findings of Nath *et al.* (2009) [10].

The heritability estimate were found to be high (>60) for almost all the characters *viz* high for Vine Length (cm) at 90 DAS, Days to first female flower, Days to first male Flower, Node to first male flower, Node to first female flower, Days to 50% flowering, Days to first harvest, Days to last harvest, Sex ratio (Male: female), Fruit length (cm), Fruit diameter (mm), Rind thickness (mm), Flesh thickness (cm), Number of fruits per plant, Average fruit weight (g), Fruit yield per plant (kg) and Fruit yield/ha (q)

The estimation of genetic advance for all the characters are presented in Genetic advance as percent mean was categorized as low (0-10%), moderate (10-20% and (≥20%) as given by Johnson *et al.* (1955) and Falconer and Mackay (1996). Genetic advance as per cent of mean was highest for Fruit yield/ha (q), Average fruit weight (g) and Vine Length (cm) at 90 DAS

Genotypic and phenotypic correlation coefficient analysis revealed that fruit yield per plant (kg) showed positive significant association with Vine Length (cm) at 90 DAS, Fruit diameter (mm), Rind thickness (mm), Flesh thickness (cm), Number of fruits. While as negative significant association was observed with Days to first female flower, Days to first male Flower, Node to first male flower, Node to first female flower, Days to 50% flowering, Days to first harvest, Days to last harvest, Sex ratio (Male: female) and Fruit length (cm)

The highest direct positive effect on Fruit yield/ha (q) was exhibited by Days to first female flower, Node to first male flower, Node to first female flower, Days to 50% flowering, Fruit diameter (mm), Flesh thickness (cm), Number of fruits per plant, Average fruit weight (g) and Fruit yield per plant (kg). The character Vine Length (cm) at 90 DAS, Days to first male Flower, Days to first harvest, Days to last harvest, Sex ratio (Male: female), Fruit length (cm) and Rind thickness (mm) showed direct negative effect at genotypic levels.

The highest direct positive effect on Fruit yield/ha (q) was exhibited by Node to first male flower, Days to 50% flowering, Sex ratio (Male: female), Rind thickness (mm), Number of fruits per plant, Average fruit weight (g) and Fruit yield per plant (kg). The character Vine Length (cm) at 90 DAS, Days to first female flower, Days to first male Flower, Node to first female flower, Days to first harvest, Days to last harvest, Fruit length (cm), Fruit diameter (mm) and Flesh thickness (cm) showed direct negative effect at phenotypic level.

Clustering pattern of seventeen genotype of ridged gourd were grouped into clusters following Mohalanobis D^2 analysis, Clustering pattern indicated that cluster I is largest cluster comprising 10 out of seventeen genotype. On the other hand cluster II comprised 3 genotype, cluster III and IV cluster comprised 1 genotype.

The inter cluster distance was maximum between cluster II and III (81170.76) followed by cluster II and Cluster IV (18636.9), Cluster I and cluster II (11325.81), cluster I and IV (5254.03), Cluster III and IV (4083.57).

In the present investigation the highest contribution in manifestation of genetic divergence was exhibited by Fruit yield per plant (kg) (45.71), Average fruit weight (g) (38.1), Node to first male flower (5.71), Flesh thickness (cm) (4.76) and Fruit yield/ha (q) (3.81) In other words, selection for these characters may be rewarding.

Table 2: Analysis of variance for 17 characters in 15 genotypes of ridge gourd.

Sl. No.	Character	Mean sum of square		
		Replications (df = 2)	Treatments (df = 17)	Error (df = 34)
1	Vine Length (cm) at 90 DAS	61.35	8428.20**	37.43
2	Days to first female flower	0.24	34.82**	2.73
3	Days to first male Flower	0.89	35.70**	2.49
4	Node to first male flower	0.0007	1.66**	0.001
5	Node to first female flower	0.254	33.72**	0.71
6	Days to 50% flowering	1.70	38.26**	3.06
7	Days to first harvest	0.25	35.99**	2.75
8	Days to last harvest	0.24	56.80**	0.95
9	Sex ratio (male: female)	0.94	53.38**	0.135
10	Fruit length (cm)	0.36	99.58**	0.32
11	Fruit diameter (mm)	0.24	141.90**	0.39
12	Rind thickness (mm)	0.004	1.51**	0.002
13	Flesh thickness (cm)	0.030	1.55**	0.025
14	Number of fruits per plant	0.84	12.41**	0.17
15	Average fruit weight (g)	1.42	3449.11**	0.885
16	Fruit yield per plant (kg)	0.02	0.69**	0.002
17	Fruit yield/ha (q)	13.08	5073.24**	128.11

*and** indicate significant at 5 % and 1% level, respectively.

Table 3: Estimation of genetic variability, GCV, PCV, heritability, genetic advance and genetic advance as per cent of mean for 17 characters in ridge gourd genotypes

Sl. No.	Character	Phenotypic variance	Genotypic variance	Phenotypic coefficient of variation	Genotypic coefficient of variation	Heritability in broad sense (h^2b)	Genetic Advance	Genetic Advance as % of mean
1	Vine Length (cm) at 90 DAS	2834.35	2796.92	13.32	13.23	98.70	108.22	27.08
2	Days to first female flower	13.42	10.69	7.60	6.78	79.70	6.01	12.47
3	Days to first male Flower	13.56	11.06	8.43	7.61	81.60	6.19	14.17
4	Node to first male flower	0.55	0.55	17.11	17.08	99.70	1.53	35.15
5	Node to first female flower	11.71	11.05	21.03	20.38	93.90	6.62	40.70
6	Days to 50% flowering	14.79	11.73	7.46	6.64	79.30	6.28	12.19
7	Days to first harvest	13.83	11.07	6.27	5.61	80.10	6.13	10.35
8	Days to last harvest	19.57	18.61	4.80	4.68	95.10	8.66	9.42
9	Sex ratio (male:female	17.88	17.75	28.66	28.55	99.20	8.64	58.59
10	Fruit length (cm)	33.41	33.08	24.35	24.23	99.00	11.79	49.68
11	Fruit diameter (mm)	47.56	47.17	17.52	17.44	99.20	14.08	35.79
12	Rind thickness (mm)	0.50	0.50	18.09	18.04	99.50	1.45	37.07
13	Flesh thickness (cm)	0.53	0.50	18.52	18.08	95.30	1.43	36.36
14	Number of fruits per plant	4.25	4.07	21.77	21.32	95.90	4.07	43.02
15	Average fruit weight (g)	1150.29	1149.41	27.04	27.03	99.90	69.81	55.67
16	Fruit yield per plant (kg)	0.23	0.231	40.82	40.57	98.80	0.98	83.07
17	Fruit yield/ha (q)	1776.49	16.48.37	43.37	41.78	92.80	80.56	82.90

Table 4: Cluster mean values for seventeen growth and yield characters of Ridge Gourd

Characters	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Vine Length (cm) at 90 DAS	413.15	393.96	418.81	262.09
Days to first female flower	47.52	48.10	50.13	53.48
Days to first male Flower	43.03	43.59	45.23	48.90
Node to first male flower	4.28	3.92	5.17	5.72
Node to first female flower	15.96	14.58	18.87	21.82
Days to 50% flowering	50.91	51.34	53.33	56.85
Days to first harvest	58.49	59.48	60.56	64.83
Days to last harvest	91.05	92.19	94.37	98.89
Sex ratio (Male: female	15.74	10.09	12.77	20.93
Fruit length (cm)	24.76	19.48	31.90	18.05
Fruit diameter (mm)	35.82	51.10	40.91	38.06
Rind thickness (mm)	3.56	5.10	4.38	3.75
Flesh thickness (cm)	3.589	5.10	4.27	3.82

Number of fruits per plant	9.63	10.56	7.50	6.55
Average fruit weight (g)	108.91	184.40	141.08	97.54
Fruit yield per plant (kg)	1.04	1.90	1.04	0.64
Fruit yield/ha (q)	84.21	158.60	86.65	53.08

Table 5: Intra and inter cluster distance (D^2) of Ridge Gourd

	Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**
Cluster 1	2388.70	11325.81	3354.84	5254.03
Cluster 2		2490.16	81170.76	18636.9
Cluster 3			0.00	4083.57
Cluster 4				0.00

Conclusion

On the basis of mean performance of seventeen genotypes of Ridge Gourd, genotype, Nidhi (215.82) and Chitrada (134.99) was found superior in terms of Fruit yield/ha (q). On the basis of Analysis of variance significant difference was recorded for all the quantitative and qualitative traits indicating presence of large amount of variability in the genotypes.

Hence it can be concluded that Ridge Gourd Genotype Nidhi having highest yield can be utilized further for crop improvement programs.

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