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Studies on genetic variability, heritability and genetic advance in F2 generation of ridge gourd

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Abstract
Variability studies were carried out for eighteen characters of ridge rourd in F2 generation of four crosses *viz.*, Swarna Manjari x VRG-16, Arka Prasan x VRG-16. VRG-24 x VRG-13 and Swarna Manjari x Arka Prasan during *summer*, 2020 at College of Horticulture, Venkataramannagudem. High PCV and GCV were recorded for average fruit weight, fruit yield per vine, rind thickness, number of seeds per fruit, fibre content and TSS in all the crosses disclosing the presence of high degree of genetic variability and could be improved through selection. High heritability accompanied by high genetic advance as per cent of mean was observed for fruit weight, rind thickness and number of seeds per fruit in all the crosses under study which significantly exhibited less influence of environmental factors and advancement of these traits through selection would be rewarded.

Keywords: Variability, heritability, ridge gourd, GCV, PCV

1. Introduction
The "*Luffa*" Genus consist of nine different species. India has abundant genetic diversity for ridge gourd which varies in plant habit and sex forms. Ridge gourd is a climber with 5- angled acute stem, tendrils and 5-7 angled leaves. It has racemose inflorescence as male, solitary flowers as females and club shaped fruit with persistent style (Hari, 2006) [4]. Fruit is demulcent, diuretic and nutritive. The pounded leaves are applied locally to splenitis, haemorrhoides and leprosy. Every 100 g of the edible portion of ridge gourd contains 0.5 g of fibre, 0.5 per cent of protein, 0.34 per cent of carbohydrate, 37 mg of carotene, 5.0 mg of vitamin C, 18 mg of calcium and 0.5 mg of iron (Hazra and Som, 2005) [5].
Ridge gourd being a monoecious and cross-pollinated crop, exhibits considerable heterozygosity resulting in natural variability in the population. Variability among the population forms the basis for selection in any crop improvement programme. Presence of genetic variability is a prerequisite for selection along with heritability accompanied by genetic advance for successful crop improvement in ridge gourd.

2. Material and Methods
The present study was conducted at Department of Vegetable Science, College of Horticulture, Venkatarammanagudem, Andhra Pradesh, during summer, 2020. The F2 population of four crosses *viz.*, Cross 1 (Swarna Manjari x VRG-16), Cross 2 (Arka Prasan x VRG-16), Cross 3 (VRG-24 x VRG-13) and Cross 4 (Swarna Manjari x Arka Prasan) were evaluated. In each F2 population 100 plants were maintained with a spacing of 1m x 1m. The observations were recorded on days to male flowering, days to female flowering, node to first male flower, node to first female flower, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit set (%), fruit weight (g), fruit length (cm), fruit girth (cm), rind thickness (mm), flesh thickness (mm), number of seeds per fruit, number of fruits per vine, fruit yield per vine (kg), fibre content (g 100g-1) and TSS (0Brix). The statistical analysis for genotypic and phenotypic coefficient of variation by Burton (1952) [2], heritability suggested by Lush (1943), genetic advance as per cent of mean by Comstock and Robinson (1952) [3] were used.

3. Results and Discussion
The estimates of PCV, GCV, heritability and genetic advance as per cent of mean are presented in tables 1,2,3 and 4

The estimates of PCV were higher than their corresponding GCV values indicated that there is an influence of environmental factors on expression of these characters. Similar results were reported by Alekar *et al.* (2019) [1] in F4 population of cross Phule Green Gold x Hirkani in bitter gourd and Suresh and Balamohan (2018) [13] in F2 population of ridge gourd

The characters namely fruit weight, fruit yield per vine, rind thickness, number of seeds per fruit, fibre content and TSS in all four crosses; sex ratio in cross 1,2 and 3; number of male flowers per vine in cross 1 and 2; fruit set percentage in cross 1 and 2; node of first male flower in cross 2 and 3; fruit girth and flesh thickness in cross 1; number of male flowers per vine in cross 2 and fruit length in cross 4 had high phenotypic and genotypic coefficient of variation indicating more variability and improvement of these characters through selection could be rewarded. This results are in confirmation with Suma *et al.* (2009) [12] in bitter gourd and Kanimozhi *et al.* (2015) [7] in wax gourd.

The higher estimates of PCV and moderate estimates of GCV were observed for the traits namely, node of first female flower in cross 1,3 and 4; fruit girth and flesh thickness in cross 2,3 and 4; node of first male flower, fruit length and number of fruits per vine in cross 1 and TSS in cross 3 indicating the presence of variability. These results are contradictory with the findings of Suresh and Balamohan (2018) [13] and Kannan and Rajamanickam (2019) [8, 9] in ridge gourd. The traits *viz.*, node of first female flower and fruit length in cross 2 were recorded high phenotypic and low genotypic coefficient of variation. These results are in contrast with the findings of Alekar *et al.* (2019) [1] in bitter gourd and Vaidhya *et al.* (2020) [14] in bottle gourd

Moderate PCV and GCV were exhibited by the traits namely number of female flowers per vine in cross 1,2,3 and 4; fruit set percentage, fruit length and number of fruits per vine in cross 3; days to male flowering, number of male flowers per vine, number of female flowers per vine and sex ratio in cross 4. Contradictory results were reported in earlier findings of Suma *et al.* (2019) [12] in bitter gourd. Moderate PCV and low GCV were observed for days to female flowering in cross 2 and 4; number of male flowers per vine in cross 3; fruit set percentage and number of fruits per vine in cross 4. These results are in contrary to Suresh and Balamohan (2018) [13], Kannan *et al.* (2019) [8, 9] in ridge gourd and Alekar *et al.* (2019) [1] in bitter gourd.

The traits *viz.*, days to male flowering (cross 1,2 and 3) and days to female flowering (cross 1 and 3) were reported low PCV and GCV indicating low variability for these characters where selection of these characters may not be rewarding. Similar results were observed by Rani *et al.* (2014) [11] in bitter gourd and Kannan and Rajamanickam (2019) [8, 9] in ridge gourd

Heritability along with genetic advance is more helpful in predicting the gains under selection than heritability estimates alone (Johnson *et al.* 1955) [6].

High heritability along with high genetic advance was observed for fruit weight, rind thickness and number of seeds per fruit in all four crosses; sex ratio and fruit set percentage (cross 1,2 and 3), number of male flowers per vine and TSS (cross 1,2 and 4), number of fruits per vine and fruit yield per vine (cross 1 and 2), node of first male flower, number of female flowers per vine and fruit length, (cross 3 and 4), fruit girth and flesh thickness (cross 1), node of first female flower (cross 3), days to male flowering, number of female flowers per vine and fibre content (cross 4) indicating heritability was mainly due to additive gene effect and hence selection was highly effective for these characters. Similar results were obtained by Suma *et al.* (2019) [12] in bitter gourd and Alekar *et al.* (2019) [1] in bitter gourd.

High heritability along with moderate genetic advance observed for days to male flowering (cross 1 and 3), days to female flowering (cross 2 and 4), number of female flowers per vine (cross 2), sex ratio and fruit set percentage (cross 4) indicated the presence of additive gene action and selection may be effective for this character. Similar results were obtained by Kannan *et al.* (2019) [8, 9] in ridge gourd.

Moderate heritability and high genetic advance were observed for node of first male flower (cross 2), fruit yield per vine and fibre content (cross 3), node of first female flower (cross 4) indicated that these characters are influenced by environmental factors. Contradictory results were reported by Vaidhya *et al.* (2020) [14] in bottle gourd and Vijaya *et al.* (2020) [15] in ridge gourd

Moderate heritability and moderate genetic advance was observed for number of female flowers per vine (cross 1), fruit girth and flesh thickness (cross 2 and 3) and number of fruits per vine (cross 3 and 4). These results are contradictory with the findings of Suma *et al.* (2019) [12] in bitter gourd.

In cross 1 (Swarna Manjari x VRG-16), the trait days to female flowering showed moderate heritability and low genetic advance indicated that, this character was influenced by environment and governed by non additive gene action. Similar results were reported by Kannan *et al.* (2019) [8, 9] in ridge gourd.

Low heritability and moderate genetic advance were observed for node of first male flower, node of first female flower, fruit length (cross 1), fibre content (cross 1 and 2), TSS (cross 3), fruit girth and flesh thickness (cross 4) which indicated the influence of environmental factors rather than genotype. These traits could be exploited through manifestation of dominance and epistatic components through heterosis breeding. Contradictory results were obtained by Rani *et al.* (2014) [11] in bitter gourd and Vaidhya *et al.* (2020) [14] in bottle gourd. Hence, selection would be ineffective.

The parameters days to male flowering, node of first female flower and fruit length in cross 2 whereas days to female flowering and number of male flowers per vine in cross 3 have recorded low heritability and genetic advance indicated selection may not be rewarding due to non-additive gene action. Contradictory results were reported by Kanimozhi *et al.* (2015) [7] in wax gourd and Suma *et al.* (2019) [12] in bitter gourd.

Table 1: Estimates of PCV, GCV, Heritability and Genetic advance as per cent of mean in F2 population of cross-1 (Swarna Manjari x VRG-16)

Parameters	General Mean	Coefficient of variation (%)		Heritability (%) (Broad Sense)	Genetic advance @ 5%	GAM @ 5%
		PCV	GCV			
Days to male flowering	26.25	8.97	7.45	68.09	3.34	12.74
Days to female flowering	34.48	10.00	6.82	46.56	3.30	9.59
Node of first male flower	2.75	32.32	12.68	15.40	0.28	10.25
Node of first female flower	9.36	28.89	14.69	25.88	1.44	15.40

Number of male flowers per vine	244.52	23.37	21.65	85.77	101.01	41.31
Number of female flowers per vine	24.34	15.70	11.88	57.27	4.50	18.52
Sex ratio	10.15	26.17	22.47	73.70	4.03	39.74
Fruit set (%)	52.90	30.12	29.24	94.25	30.94	58.49
Fruit length (cm)	17.67	27.65	11.87	18.42	1.85	10.49
Fruit girth (cm)	17.17	23.66	22.04	86.76	7.26	42.30
Average fruit weight (g)	270.63	43.66	42.01	92.57	225.34	83.26
Rind thickness (mm)	6.92	34.89	33.15	90.23	4.49	64.87
Flesh thickness (mm)	47.74	24.09	23.22	92.88	22.01	46.10
Number of seeds per fruit	118.13	37.04	30.14	66.20	59.68	50.53
Number of fruits per vine	12.52	23.43	19.74	71.00	4.29	34.27
Fruit yield per vine (kg)	3.38	48.94	46.75	91.23	3.11	91.99
Fibre content (g/100g)	0.97	89.31	28.99	10.53	0.18	19.38
TSS (0Brix)	2.50	45.02	36.61	66.12	1.53	61.32

Table 2: Estimates of PCV, GCV, Heritability and Genetic advance as per cent of mean in F2 population of cross-2 (Arka Prasan x VRG-16)

Parameters	General Mean	Coefficient of variation (%)		Heritability (%) (Broad Sense)	Genetic advance @ 5%	GAM @ 5%
		PCV	GCV			
Days to male flowering	25.14	9.59	5.03	27.51	1.36	5.43
Days to female flowering	33.42	11.00	8.78	63.72	4.83	14.45
Node of first male flower	3.08	33.88	24.50	52.29	1.12	36.50
Node of first female flower	11.15	25.95	6.70	6.67	0.39	3.57
Number of male flowers per vine	264.17	23.38	22.57	93.16	118.56	44.88
Number of female flowers per vine	23.76	15.41	12.05	61.14	4.61	19.42
Sex ratio	12.04	55.12	54.20	96.70	13.21	109.80
Fruit set (%)	52.90	22.98	22.03	91.88	23.01	43.50
Fruit length (cm)	25.39	21.43	6.01	7.87	0.88	3.47
Fruit girth (cm)	16.84	23.21	14.69	40.07	3.22	19.16
Average fruit weight (g)	336.97	45.51	42.16	85.84	271.20	80.48
Rind thickness (mm)	6.73	29.54	26.32	79.36	3.24	48.30
Flesh thickness (mm)	46.89	23.40	14.64	39.15	8.85	18.87
Number of seeds per fruit	158.71	36.31	33.19	83.52	99.18	62.49
Number of fruits per vine	12.44	23.09	20.08	75.64	4.47	35.98
Fruit yield per vine (kg)	4.11	46.81	40.15	73.55	2.91	70.94
Fibre contentm(g/100g)	1.04	82.63	28.00	11.48	0.20	19.55
TSS (0Brix)	2.64	38.80	38.27	97.28	2.05	77.77

Table 3: Estimates of PCV, GCV, Heritability and Genetic advance as per cent of mean in F2 population of cross-3 (VRG-24 x VRG-13)

Parameters	General Mean	Coefficient of variation (%)		Heritability (%) (Broad Sense)	Genetic advance @ 5%	GAM @ 5%
		PCV	GCV			
Days to male flowering	26.59	9.00	8.59	91.16	4.49	16.91
Days to female flowering	35.55	8.36	3.94	22.20	1.36	3.82
Node of first male flower	3.98	34.50	28.14	66.54	1.88	47.29
Node of first female flower	14.57	21.42	17.70	68.32	4.39	30.15
Number of male flowers per vine	222.14	12.52	6.28	25.16	14.41	6.49
Number of female flowers per vine	22.59	14.83	12.12	66.90	4.61	20.43
Sex ratio	9.92	25.54	23.03	81.30	4.24	42.79
Fruit set (%)	53.66	13.35	12.71	90.64	13.38	24.94
Fruit length (cm)	27.70	18.02	14.27	62.70	6.45	23.28
Fruit girth (cm)	15.24	22.25	14.57	42.91	2.99	19.67
Average fruit weight(g)	312.16	38.26	31.69	68.59	168.77	54.06
Rind thickness (mm)	7.73	42.63	39.18	84.48	5.73	74.20
Flesh thickness (mm)	40.80	23.35	13.54	33.63	6.60	16.18
Number of seeds per fruit	147.11	38.31	32.51	72.01	83.62	56.84
Number of fruits per vine	11.86	14.26	10.76	56.88	1.98	16.71
Fruit yield per vine (kg)	3.83	41.48	30.58	54.34	1.94	46.44
Fibre content (g/100g)	1.33	61.12	42.71	48.83	0.82	61.48
TSS (0Brix)	2.90	30.98	14.68	22.44	0.41	14.32

Table 4: Estimates of PCV, GCV, Heritability and Genetic advance as per cent of mean in F2 population of cross-4 (Swarna Manjari x Arka Prasan)

Parameters	General Mean	Coefficient of variation (%)		Heritability (%) (Broad Sense)	Genetic advance @ 5%	GAM @ 5%
		PCV	GCV			
Days to male flowering	28.51	14.76	12.80	75.23	6.52	22.87
Days to female flowering	36.28	10.80	9.01	69.72	5.62	15.51

Node of first male flower	3.69	39.56	34.39	75.55	2.27	61.58
Node of first female flower	12.69	23.81	17.79	55.84	3.47	27.39
Number of male flowers per vine	283.57	14.68	13.13	80.10	68.69	24.22
Number of female flowers per vine	26.04	15.68	14.81	89.20	7.50	28.81
Sex ratio	11.01	14.61	11.85	65.82	2.18	19.81
Fruit set (%)	53.48	11.43	9.78	73.30	9.22	17.25
Fruit length (cm)	28.70	23.12	20.50	78.62	10.75	37.46
Fruit girth (cm)	14.77	23.24	11.73	25.48	1.80	12.20
Average fruit weight (g)	329.48	33.41	27.72	68.86	156.17	47.40
Rind thickness (mm)	8.81	47.44	45.52	92.07	7.92	89.98
Flesh thickness (mm)	38.23	26.37	11.38	18.64	3.87	10.12
Number of seeds per fruit	145.28	41.50	35.22	72.05	89.50	61.60
Number of fruits per vine	13.99	10.88	7.50	47.58	1.49	10.67
Fruit yield per vine (kg)	4.55	34.10	26.99	62.64	2.00	44.01
Fibre content (g/100g)	0.98	77.95	69.45	79.37	1.24	127.46
TSS (0Brix)	1.57	76.95	64.67	70.62	1.76	111.96

4. Conclusion

The traits *viz.,* fruit weight, rind thickness, number of seeds per fruit, sex ratio, fruit set percentage, number of fruits per vine and fruit length were showed higher estimates of PCV,GCV, heritability and genetic advance. High heritability coupled with high genetic advance as per cent of mean indicating high degree of genetic variability, less environmental intervention and exhibiting additive gene effects for these traits. Considerable amount of variability was observed for all the characters under study and this proves that there is more scope for selection in the subsequent generations.

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