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Genetic variability, correlation and path analysis in ridge gourd [*Luffa acutangula* (Roxb.) L.]

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ABSTRACT

The present investigation was made to determine variability, heritability, genetic advance and correlation of fruit yield with 10 yield-contributing traits in ridge gourd. A wide variability was observed for days taken to first female-flower appearance, fruit length, fruit number/plant, fruit weight and fruit yield/ha. Phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the traits studied, indicating environmental influence on the expression of these traits. However, high heritability (broad-sense), along with high genetic advance, was recorded in node number at which first female-flower appeared, number of branches, fruit length, number of fruits/plant and fruit weight, indicating presence of additive gene effects. Fruit yield/ha was significantly and positively associated with peduncle length, fruit length, number of fruits/plant (at the phenotypic level), fruit weight and fruit yield/plant. Fruit weight had the highest direct effect (0.847) on fruit yield/ha, followed by fruit yield/plant (0.793), fruit number (0.344), peduncle length (0.237) and number of branches (0.216). Therefore, for yield improvement in ridge gourd, emphasis may be laid on indirect selection using fruit parameters like fruit weight, number of fruits/plant and fruit yield/plant.

Key words: Ridge gourd, *Luffa acutangula* (Roxb) L., genetic variability, heritability, correlation path analysis

INTRODUCTION

Ridge gourd [*Luffa acutangula* Roxb. (L.)] is one of the most important vegetables grown throughout the year in all the tropical regions of our country, and, in Asian and African countries. It is rich in Vitamin A, C and iron (Fe) (Yawalkar, 1985). Average productivity (kg/ha) in gourds (9.5t/ha) in India is lower than the world average (12.5t/ha), falling far below the productivity achieved by developed countries. The main reasons attributed for this is lack of availability of improved varieties/hybrids, quality seeds and improved production technologies. Yield is a complex trait influenced by genetic factors and their interaction with the environment. Success in any breeding programme depends upon the existing genetic variability in base-populations, and, on the efficiency of selection. For successful selection, it is necessary to study the nature of association of the trait of interest with other, relevant traits, as also the genetic variability available for these. Path coefficient analysis provides a better index for selection than mere correlation coefficient, thereby separating correlation coefficient of the yield and its components into direct and indirect effects. Therefore, the present study was undertaken to assess the nature and magnitude of variability, heritability, correlation coefficient and path analysis for various quantitative parameters in ridge gourd. Information generated on these aspects can greatly help formulate appropriate breeding strategies for genetic upgradation of this crop.

MATERIAL AND METHODS

The experiments were carried out at Vegetable Farm, ICAR-Indian Institute of Horticultural Research, Bengaluru, during the *rabi*-summer season of the years 2011-12, 2012-13 and 2013-14. The experiments were laid out in Randomized Block Design, with 51 germplasm lines in two replications, in all the three years. Ten plants per replication were raised. Two-week-old seedlings were planted at 150cm x 50cm spacing. Recommended agronomic practices were applied to the crop. Observations were recorded on five randomly-selected plants in each replication, on 10 quantitative traits (node number for first female-flower appearance, days taken to first female-flower appearance, vine length (m), number of branches, peduncle length (cm),

fruit length (cm), fruit girth (cm), number of fruits /plant, fruit weight (g), fruit yield/plant (kg) or fruit yield/ha (t).

Pooled data for the three years was analyzed as per Panse and Sukhatme (1984) for Analysis of Variance (ANOVA). Phenotypic and genotypic coefficient of variation (PCV and GCV, respectively), heritability in a broad sense, and genetic advance as per cent of mean, were calculated as per Burton and De Vane (1953) and Johnson *et al* (1955). Correlation co-efficient among all the possible character combinations at genotypic (rg) and phenotypic (rp) levels were estimated using the formula of Al-Jibouri *et al* (1958) and path coefficient analysis was done as per Dewey and Lu (1959). GENRES Statistical Software Package (GENRES, 1994) was employed for analysis of variance and estimation of correlation among traits.

RESULTS AND DISCUSSION

Mean, range and estimates for various genetic parameters of 10 traits in 51 germplasm lines of ridge gourd studied are presented in Table 1. Analysis of Variance revealed significant difference among germplasm lines for all the 10 traits studied. A wide range of variation was observed for most of the traits like days taken to first female-flower appearance (37.0-66.4), fruit length (10.5-41.3cm), number of fruits/plant (4.7-33.8), fruit weight (79.8-300.8g), and fruit yield/ha (8.5-37.9 t). High variability present for these parameters can form a basis for effective selection of superior lines in ridge gourd. Such wide variability has also been reported by Choudhary and Suresh Kumar (2011) in this crop. The degree of variability seen in various parameters can be judged by the magnitude of GCV and PCV. GCV, which indicates the extent of genetic variability present in a population, ranged from 11.0 (days taken to first female-flower appearance) to 39.8 (number of fruits / plant). Similar findings were reported by Varalakshmi *et al* (1995), Singh *et al* (2002) and Choudhary *et al* (2008) in ridge gourd. Table 1 shows that a considerable difference exists between PCV and GCV values for all the traits under study. This points to the presence of higher environmental influence on expression of all these parameters, and, selection may not be effective for improvement of ridge gourd. Further, GCV values were low in magnitude compared to PCV values for all the characters studied. This also indicates that direct selection may not be effective for these traits, and heterosis breeding may be resorted to for further improvement.

With help from GCV alone, it is not possible to determine the extent of variation heritable. Thus, estimates for heritability indicate the effectiveness with which selection can be expected for exploiting existing genetic variability. Broad-sense heritability was high (>60%) for node number for first female-flower appearance (74.3%), number of branches (80.8%), fruit length (78.6%), number of fruits/ plant (66.7%) and fruit weight (72.8%). Similar findings were reported by Varalakshmi *et al* (1995), Karuppaiah *et al* (2002) and Singh *et al* (2002) in ridge gourd. Moderate heritability (40-60%) was observed for days taken to first female-flower appearance (49.2%), vine length (58.2%), peduncle length (57.4%), fruit yield/plant (57.7%), and fruit yield/ha (56.8%) (Table 1). Johnson *et al* (1955) reported that heritability, along with genetic advance, was more useful than heritability alone in predicting the effect of selecting the best individual genotype, as, it suggests presence of additive gene effects. In the present study, high heritability,

Table 1. Mean, coefficient of variation, heritability and genetic advance for various traits in ridge gourd

Sl. No.	Trait	Mean	Range	Genotypic Variance (GV)	Phenotypic Variance (PV)	Genotypic Coefficient of Variation (GCV)	Phenotypic Coefficient of Variation (PCV)	Herita-bility (h^2)	Genetic Advance (GA)	GA as % Mean
1	NFF	9.8	5.3- 19.9	8.6	11.5	29.9	34.7	74.3	5.2	53.1
2	DFF	47.7	37.0- 66.4	27.6	56.1	11.0	15.7	49.2	7.6	15.9
3	Vine length (m)	3.9	2.2- 6.5	0.8	1.4	23.6	30.9	58.2	1.4	37.0
4	Number of branches	6.9	2.9- 13.3	7.3	9.0	39.0	43.4	80.8	5.0	72.3
5	Peduncle length (cm)	8.2	4.9- 12.7	3.1	5.3	21.3	28.1	57.4	2.7	33.3
6	Fruit length (cm)	22.5	10.5- 41.3	60.9	77.5	34.7	39.1	78.6	14.2	63.4
7	Fruit girth (cm)	11.8	8.1- 16.9	2.8	8.8	14.1	25.2	31.5	1.9	16.4
8	Number of fruits /plant	13.6	4.7- 33.8	29.2	43.8	39.8	48.8	66.7	9.1	67.0
9	Fruit weight (g)	169.8	79.8-300.8	2915.4	4004.1	31.8	37.3	72.8	94.9	55.9
10	Fruit yield/plant (kg)	1.8	0.6- 2.8	0.2	0.4	26.6	35.0	57.7	0.7	41.7
11	Fruit yield/ha (t)	23.3	8.5- 37.9	37.3	65.8	26.2	34.8	56.8	9.5	40.7

NFF: Node number for first female flower appearance; DFF: Days taken to first female flower appearance

Table 2. Genotypic (r_g) and phenotypic (r_p) correlation coefficient among various traits in ridge gourd

Trait		NFF	DFF	Vine length (m)	Number of branches	Peduncle length (cm)	Fruit length (cm)	Fruit girth (cm)	Number of fruits/ plant	Fruit weight (g)	Fruit yield/ plant (kg)	Fruit yield/ ha (t)
NFF	(r_g)	1.000	0.790**	0.674**	0.513**	0.461**	0.508**	-0.280*	-0.580**	0.646**	-0.135	-0.179
	(r_p)	1.000	0.522**	0.478**	0.396**	0.311*	0.439**	-0.145	-0.590**	0.470**	-0.136	-0.180
DFF	(r_g)		1.000	0.500**	0.465**	0.381**	0.372**	-0.296*	-0.600**	0.519**	-0.137	-0.181
	(r_p)		1.000	0.261	0.346*	0.257	0.265	-0.297*	-0.610**	0.348*	-0.138	-0.182
Vine	(r_g)			1.000	0.599**	0.717**	0.682**	-0.298*	-0.620**	0.780**	0.240	0.195
length(m)	(r_p)			1.000	0.471**	0.471**	0.505**	-0.299*	-0.600**	0.592**	0.203	0.213
Number of	(r_g)				1.000	0.450**	0.521**	-0.300*	-0.640**	0.573**	-0.028	0.019
branches	(r_p)				1.000	0.299*	0.399**	-0.301*	-0.650**	0.480**	0.043	0.078
Peduncle	(r_g)					1.000	0.902**	-0.302*	-0.660**	0.919**	0.529**	0.503**
length (cm)	(r_p)					1.000	0.755**	-0.303*	-0.670**	0.682**	0.377**	0.392**
Fruit length	(r_g)						1.000	-0.304*	-0.680**	0.961**	0.401**	0.391**
(cm)	(r_p)						1.000	-0.305*	-0.690**	0.823**	0.277*	0.279*
Fruit girth	(r_g)							1.000	-0.700**	-0.239	-0.085	-0.186
(cm)	(r_p)							1.000	0.174	-0.201	0.027	-0.187
Number of	(r_g)								1.000	-0.745**	0.143	0.223
fruits /plant	(r_p)								1.000	-0.551**	0.282*	0.328*
Fruit	(r_g)									1.000	0.292*	0.279*
weight (g)	(r_p)									1.000	0.276*	0.284*
Fruit yield/	(r_g)										1.000	0.948**
plant (kg)	(r_p)										1.000	0.903**
Fruit yield/	(r_g)											1.000
ha (t)	(r_p)											1.000

**Significant at *P=0.01*, *Significant at *P=0.05*

NFF- Node number for first female-flower appearance; DFF- Days taken to first female-flower appearance

along with a high genetic advance, was recorded in node number for first female-flower appearance, number of branches, fruit length, number of fruits/plant and fruit weight, indicating the presence of additive gene effects. Thus, selection can be employed for improvement in these parameters in ridge gourd. Fruit yield/plant and fruit yield/ ha recorded moderate levels of heritability and genetic advance. This suggests that environmental effects constitute a major factor for total phenotypic variation, and therefore, direct selection for these traits would be less effective. Similar findings were reported by Choudhary and Suresh Kumar (2011) in ridge gourd.

All possible correlation coefficients between fruit yield/ha and its component traits were estimated at the genotypic (G) and phenotypic (P) level (Table 2). From these associations, it appears that higher fruit yield/ ha was significantly and positively associated with peduncle length, fruit length, number of fruits/plant (at the phenotypic level only), fruit weight and fruit yield/plant. In the present investigation, interrelations among these parameters were also seen to be positive and significant. Fruit length exhibited a positive and significant association with fruit weight and fruit yield/plant, and, a negative association with fruit girth and number of fruits/plant. Number of fruits/plant had significant positive association with fruit yield/plant, and fruit weight/plant. This implies that indirect selection for all these traits can help improve fruit yield in ridge gourd. These results are in conformity with Varalakshmi *et al* (1995), Rao *et al* (2000), Chowdhury and Sharma (2002), Prasanna *et al* (2002), Choudhary *et al* (2008), Hanumegowda *et al* (2012) and Rabbani *et al* (2012) in ridge gourd.

Though correlation analysis can quantify the degree of association between any two characters, it does not provide the reasons for such an association. Simple linear correlation coefficient is designed to detect presence of linear association between two variables. This does not imply absence of any functional relationship between the two variables. Path coefficient analysis resolves this mystery by breaking the 'total correlation' into components of direct and indirect effects. Thus, path analysis was performed to assess direct and indirect effects of various characters on fruit yield/ha (Table 3). Fruit weight had the highest direct effect (0.847) on fruit yield/ha, followed by fruit yield/plant (0.793), number of fruits/plant (0.344), peduncle length (0.237) and number of branches (0.216) (Choudhary *et al*, 2008). Indirect effects of most other parameters through

Table 3. Direct and indirect effects of various traits on fruit yield/plant at the genotypic level in ridge gourd

Trait	NFF	DFF	Vine length (m)	Number of branches	Peduncle length (cm)	Fruit length (cm)	Fruit girth (cm)	Number of fruits/ plant	Fruit weight (g)	Fruit yield/ plant (kg)	Genotypic correlation
NFF	**-0.144**	-0.036	-0.211	0.111	0.110	-0.300	0.051	-0.200	0.547	-0.107	-0.179
DFF	-0.114	**-0.045**	-0.157	0.100	0.091	-0.220	0.053	-0.206	0.439	-0.272	-0.181
Vine length (m)	-0.097	-0.023	**-0.313**	0.129	0.170	-0.402	0.049	-0.170	0.661	0.190	0.195
Number of branches	-0.074	-0.021	-0.188	**0.216**	0.107	-0.307	-0.004	-0.172	0.485	-0.022	0.019
Peduncle length (cm)	-0.067	-0.017	-0.225	0.097	**0.237**	-0.532	0.021	-0.210	0.779	0.419	0.503**
Fruit length (cm)	-0.073	-0.017	-0.214	0.112	0.214	**-0.590**	0.048	-0.221	0.814	0.317	0.391**
Fruit girth (cm)	0.040	0.013	0.085	0.005	-0.028	0.156	**-0.181**	-0.008	-0.202	-0.067	-0.186
Number of fruits /plant	0.084	0.027	0.155	-0.108	-0.145	0.379	0.004	**0.344**	-0.631	0.114	0.223
Fruit weight (g)	-0.093	-0.023	-0.245	0.124	0.218	-0.567	0.043	-0.257	**0.847**	0.232	0.279*
Fruit yield/ plant (kg)	0.019	0.016	-0.075	-0.006	0.126	-0.236	0.015	0.049	0.248	**0.793**	0.948**

**Significant at *P=0.01*, *Significant at *P=0.05*

Figures on the diagonal in bold font indicate direct effect

NFF- Node number for first female-flower appearance; DFF- Days taken to first female-flower appearance

these stated parameters were also positive. Similarly, Rabbani *et al* (2012) from Bangladesh reported fruit weight and number of fruits as having the maximum direct effect on fruit yield in ridge gourd. Rest of the parameters such as node-number for first female-flower appearance, days taken to first-flower appearance, vine length, fruit length and fruit girth exhibited a negative direct effect on fruit yield/ha; indirect effects via these parameters were also negative for several of the traits. Positive direct and indirect effects of fruit weight, fruit yield/plant and fruit number lead to the significant and positive correlation with fruit yield/ha. This indicates that the positive selection for these parameters is going to contribute to higher fruit yields in ridge gourd.

Therefore, for yield improvement in ridge gourd, emphasis is to be laid on indirect selection using fruit parameters like fruit weight, fruit number and fruit yield/ plant.

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