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Evaluation and correlation for growth, yield and quality traits of ridge gourd (*Luffa acutangula*) under arid conditions

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ABSTRACT

Landraces of ridge gourd [*Luffa acutangula* (Roxb.) L.] are spread over a wide range of environments in India and their fruits are consumed as vegetable. The dry fruits of six commonly grown genotypes were collected from different parts of Rajasthan. The collected materials were evaluated during summer season of 2011 and 2012 under hot arid conditions of western Rajasthan for growth traits, flowering, yield, yield components and quality traits. The evaluated genotypes showed significant variation for most of these traits, except pH of flesh. Average number of fruits per plant was the highest in AHRG 29 (21.75) and the lowest in AHRG 27 (17.30), which had the highest fruit length (27.26cm), fruit diameter (5.13cm), ovary length (8.06 cm) and fibre content (1.96 g/100g edible portion). The highest fruit hardness was also recorded in AHRG 27 (4.91 kg/cm^2), whereas the lowest in AHRG 29 (3.54 kg/cm^2). Significant correlation coefficients among growth, flowering, yield, yield traits and quality traits were found. The marketable yield/plant had positive and highly significant correlation with fruit weight (0.834) and number of marketable fruit/plant (0.624) at phenotypic level. The results of this study could be used in breeding programs for improving local landraces of ridge gourd grown in Rajasthan, India.

Key words: Correlation, Genotypes, Ridge gourd, Variability

Ridge gourd [*Luffa acutangula* (Roxb.) L.] is an important warm season cucurbitaceous vegetable crop grown in different parts of India and in the tropical countries of Asia and Africa. Its immature fruits are cooked as vegetable and also used in the preparation of chutneys and curries. The fruits are very nutritious and good source of calcium, phosphorus, ascorbic acid, iron and fibre content (Aykroyd 1963). Being a warm season crop, it has the ability to tolerate hotter conditions, which makes it suitable for widespread cultivation throughout the tropics. Due to monoecious sex form, ridge gourd is highly cross pollinated and had wide variation in growth and fruit characters (Chandra 1995). Thus, there is a need to identify stable and superior genotypes through screening of germplasm at large scale for commercial use. The success of any breeding programme depends upon selection of a proper plant. The efficiency of selection depends on the magnitude and nature of genetic variation in a specific population for effective breeding program (Debnath 1988). Yield is polygenic in nature and influenced by environmental factors, which complicate the selection process thus, the knowledge of correlation of the traits is necessary for effective selection process (Choudhary *et al.* 2008). Therefore before aiming an improvement in yield, it is necessary to have the knowledge of correlation with yield. The existence of wide genetic variation in ridge gourd in hot arid areas provides ample scope for screening the best genotypes for specific traits. Thus, the present investigation was carried out with the objectives to evaluate the performance and work out correlation coefficients of six local ridge gourd genotypes for growth, flowering, yield and quality traits.

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MATERIALS AND METHODS

The dried fruits of six locally grown ridge gourd genotypes were collected during 2010 from six different places of Rajasthan, India where they have been commonly grown for several decades (Table 1). Seeds were extracted, air-dried and kept at room temperature until the time of sowing.

The experiments were carried out at Research Farm of Central Institute for Arid Horticulture, Bikaner, Rajasthan

Table 1 Place of collection, fruit colour and shape of different ridge gourd genotypes

Genotype	Place of collection	Fruit colour	Fruit shape
AHRG 27	Salumber, Udaipur	Green 137B	Club
AHRG 29	Chomu, Jaipur	Green 143A	Cylindrical
AHRG 31	Husangsar, Bikaner	Green 137C	Spindle
AHRG 33	Merta, Nagaur	Green 138C	Cylindrical
AHRG 41	Jamwa Ramgarh, Jaipur	Green 137A	Cylindrical
AHRG 47	Shiv, Barmer	Green 137C	Club

(India) located at 28°N latitude, 73°18[1]E longitude at an altitude of 234.84m above sea level during summer season of 2011 and 2012 in randomized block design with three replications. The soil of experimental field was loamy sand with a pH of 8.7, EC 0.20 dS/m and organic carbon 0.07 per cent. The spacing maintained between rows was 2.5m and between plants 0.60m. Fertilization, drip irrigation, other cultural practices and need based plant protection measures were followed as recommended for commercial production. The temperature and relative humidity (RH) from sowing to last harvest of the crop (March-June) were also recorded. The mean monthly minimum temperature and RH of both the years varied from 18.6-27.9°C and 14.7-24.7%, respectively. The maximum temperature and RH was found to be ranged from 32.9-42.2°C and 45.6-56.5%, respectively.

The data were recorded on five randomly selected plants from each replication for 15 characteristics. Among growth traits, the observations on number of branches per plant, vine length (m) and internodal length (cm) were recorded. The flowering traits comprised days to first female flower, node at which first female flower appeared and ovary length (cm). Fruit length (cm), fruit diameter (cm), days to first fruit harvest, number of marketable fruits per plant, fruit weight (g) and marketable yield per plant (kg) were assessed among yield and its components. Diameter of fruits was measured with the help of Digital Vernier Caliper (MITU-TOYO, 300mm, 0.01mm reading capacity). Determination of pH of fresh fruit juice was carried out with pH Tester (EUTECH, $\pm$0.01pH resolution). The hardness of fruits was assessed at edible stage using fruit pressure tester (Model FT 327, 0-13kg/cm^2). The observation for skin colour of fruits was recorded with RHS Colour Chart, Royal Horticultural Society, London (England). Analysis of fibre content of fruits at edible stage was performed as per the procedure suggested by Maynard (1970). The recorded data were pooled and statistically analysed at the Agricultural Knowledge Management Unit of the Central Institute for Arid Horticulture, Bikaner, Rajasthan using the INDOSTAT statistical package (Indostat Services, Hyderabad).

RESULTS AND DISCUSSION

The analysis of variance showed highly significant differences among six genotypes of ridge gourd for growth, flowering, yield and quality components except flesh pH (Table 2). The range of variation was higher for ovary length (4.61-8.06cm) followed by marketable fruit yield/ plant (1.28-2.13 kg). The minimum range was recorded in flesh pH (5.23-5.78), which was found to be statistically non-significant among the six evaluated populations of ridge gourd.

The evaluated genotypes exhibited significant difference for all studied characters except flesh pH (Table 3). Maximum number of branches/ plant (5.40) and vine length at last harvest (4.13m) were observed in AHRG 47 and AHRG 41, respectively. The genotype AHRG 27 had the lowest internodal length at harvest (12.87cm) which was found to be statistically at par with AHRG 29 (14.09cm) genotype. AHRG 29 was found to be significantly earliest to produce first female flower among six genotypes which took 46.15 days for anthesis. The first female flowers were also appeared at lower node (13.95) in AHRG 29 which was significantly lower than all genotypes except AHRG 33 (14.75). The longest ovary (8.06cm) was produced by AHRG 27, which had significant difference over all genotypes. Earlier, Chowdhury and Sharma (2002), Karuppaiah *et al.* (2002), Singh *et al.* (2002) and Choudhary *et al.* (2008) also observed a wide variation in growth and flowering traits of ridge gourd.

Table 2 Analysis of variance (mean sum of squares) for growth, yield and quality traits of ridge gourd

Characters	Replication	Treatment	Error
d f	3	5	15
Number of branches/plant	0.14	1.94*	0.55
Vine length (m)	0.80	1.01*	0.30
Internodal length (cm)	7.94	9.05*	2.84
Days to 1st female flower	20.08	28.54*	7.95
Node at which 1st female flower appeared	10.07	24.37*	4.52
Ovary length (cm)	1.42	6.85**	0.53
Fruit length (cm)	5.37	26.62**	2.51
Fruit diameter (cm)	0.32	1.16*	0.26
Days to 1st fruit harvest	27.04	30.92*	10.43
Marketable fruits/plant	1.61	10.74*	2.84
Fruit weight (g)	5.48	560.09*	128.55
Flesh pH	0.68	0.20	0.34
Fruit hardness (kg/cm^2)	0.22	10.85*	0.17
Fibre content (g/100g edible portion)	0.08	0.29*	0.07
Marketable fruit yield/ plant (kg)	0.01	0.34**	0.07

*and ** indicate significant at 5 and 1 per cent probability level, respectively.

The average fruit length was observed maximum in AHRG 27 (27.26 cm), which had significant difference over all genotypes. This was probably attributed due to maximum ovary length (8.06 cm). AHRG 27 also exhibited the highest fruit diameter (5.13cm) but had non-significant difference to AHRG 31 (4.80 cm) and AHRG 33 (4.52 cm). The genotype AHRG 29 was the earliest in terms of harvesting which took 51.85 days for first fruit harvest from sowing and was found to be statistically at par with AHRG 31 (54.90) and AHRG 33 (56.20). The early harvesting in AHRG 29 was probably due to early production of female flowers at lower nodes. Average number of marketable fruits/plant was maximum in AHRG 29 (21.75) which was significantly higher than all genotypes except AHRG 41 (19.65) and AHRG 47 (19.45). Average fruit weight was the highest in AHRG 27 (109.46g) followed by AHRG 41(101.28g), AHRG 29 (98.06g), AHRG 47 (96.53g) and AHRG 33 (93.55g) genotypes but the difference among them was non-significant. AHRG 29 and AHRG 41 out

yielded other genotypes but statistically at par with AHRG 27, AHRG 33 and AHRG 47. The marketable fruit yield/ plant were the lowest in AHRG 31. Singh *et al.* (2002), Chowdhury and Sharma (2002) and Choudhary *et al.* (2008) reported significant variation among fruit traits in ridge gourd. Fruit quality measured as fruit hardness and fibre content varied significantly among genotypes whereas flesh pH resulted in non-significant difference. Fruits of AHRG 29 had the lowest hardness (3.54 kg/cm^2) which showed the tenderness of the genotype. AHRG 27 exhibited the highest fruit hardness (4.91 kg/cm^2) which might be due to the presence of high fibre content (1.96 g/100g edible portion).

The genotypic and phenotypic correlations were determined to obtain information on the relationship among 15 quantitative traits in ridge gourd (Table 4). The magnitude of genotypic correlation coefficients exhibited higher than the phenotypic ones for all the traits studied which established inherent relationships among the characters in ridge gourd (Prasanna *et al.* 2002). The marketable yield/ plant had positive and highly significant correlation with fruit weight (0.834) and number of marketable fruits/ plant (0.624) at phenotypic level. Results of this study indicated that for increasing fruit yield, selection might be directed towards plants having higher number of fruits with large fruit size. These results agree with the findings of Choudhary *et al.* (2008) and Hanumegowda *et al.* (2012) in ridge gourd. Days to first fruit harvest exhibited positive and highly significant association with days to appearance of first female flower (0.747) and fruit hardness (0.434). Fruit length was positively and significantly correlated with ovary length (0.702), fruit diameter (0.614) and fruit hardness (0.480). It is concluded that ovary length, fruit length and fruit diameter could be used as selection criteria in breeding ridge gourd for high yield. Days to first female flower had negative and significant correlation with marketable fruit yield/ plant (–0.483) and marketable fruits/ plant (–0.454) which is desirable thus, selection of genotypes producing early female flowers would increase yield of ridge gourd. Prasanna *et al.* (2002), Choudhary *et al.* (2008) and Hanumegowda *et al.* (2012) also noticed similar trend in ridge gourd. Fruit quality is also an important criterion in the production of ridge gourd. The high values of fibre content in AHRG 27 followed by AHRG 47 indicated their high quality attributes. Maintaining fruit quality, while at the same time increasing yield has been one of the primary goals of breeders. Singh *et al.* (2002) and Choudhary *et al.* (2011) reported that population improvement through selection could be performed to varying degrees, according to the degree of variation present in each population, selection intensity and heritability of traits.

The genotypes identified for different yield and quality components can be utilized to develop new genotypes with wider adaptability suitable for arid conditions. Fruit weight and number of marketable fruits per plant had positive and significant effect on yield/ plant thus these traits could be utilized in selection of high yielding genotypes of ridge gourd. The information obtained from the present study

Table 3 Growth, flowering, fruit and yield traits of ridge gourd genotypes

Genotypes	No. of branches/ plant	Vine length (m)	Internodal length (cm)	Days to 1st female flower	Node at which 1st female flower appeared	Ovary length (cm)	Fruit length (cm)	Fruit diameter (cm)	Days to 1st fruit harvest	Marketable fruits/ plant	Fruit weight (g)	Marketable fruit yield/ plant (kg)	Flesh pH	Fruit hardness (kg/cm^2)	Fibre content (g/100g edible portion)
AHRG 27	3.40	3.80	12.85	50.05	17.95	8.06	27.26	5.13	57.95	17.30	109.46	1.90	5.68	4.91	1.96
AHRG 29	4.90	3.15	14.09	46.15	13.95	5.94	22.31	4.13	51.85	21.75	98.06	2.13	5.35	3.54	1.45
AHRG 31	4.20	3.40	15.03	52.20	17.95	4.75	20.35	4.80	54.90	17.45	74.04	1.28	5.38	4.07	1.69
AHRG 33	4.65	2.91	15.27	48.30	14.75	4.78	23.38	4.52	56.20	18.95	93.55	1.77	5.78	4.39	1.46
AHRG 41	4.10	4.13	16.06	49.25	19.00	4.61	21.46	4.29	53.65	19.65	101.28	2.00	5.23	4.11	1.18
AHRG 47	5.40	2.88	17.17	53.55	20.30	5.40	20.48	3.58	59.40	19.45	96.53	1.87	5.29	3.75	1.72
SEm±	0.37	0.27	0.84	1.40	1.06	0.36	0.79	0.25	1.61	0.84	5.66	0.13	0.29	0.21	0.12
CD(P=0.05)	1.12	0.83	2.54	4.25	3.21	1.10	2.39	0.77	4.87	2.54	17.09	0.40	NS	0.62	0.39
CV (%)	16.77	16.36	11.56	5.65	12.28	13.04	7.03	11.55	5.80	8.82	11.87	14.42	10.73	10.38	16.41

NS, Non-significant

Table 4 Genotypic (G) and phenotypic (P) correlation coefficient among growth, flowering, yield and quality traits in ridge gourd genotypes

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1.	G	–	–0.962**	1.086**	0.048	0.038	–0.621**	–0.801**	–1.191**	–0.077	0.878**	–0.267	–0.041	–0.610**	–0.320	0.243
	P	–	–0.593**	0.271	0.166	–0.217	–0.287	–0.456*	–0.542**	0.175	0.336	–0.188	–0.202	–0.198	–0.169	0.038
2.	G		–	–0.439*	0.040	0.416*	0.257	0.303	0.630**	–0.258	–0.368	0.383	–0.030	0.122	–0.220	0.108
	P		–	–0.144	–0.240	0.204	0.125	0.255	0.296	–0.268	–0.144	0.243	–0.002	–0.050	–0.122	0.138
3.	G			–	0.756**	0.561**	–0.929**	–0.879**	–1.025**	0.628**	0.205	–0.558**	–0.100	–0.025	–0.644**	–0.307
	P			–	0.152	0.410*	–0.433*	–0.620**	–0.541**	–0.161	0.305	0.175	–0.352	–0.357	–0.178	0.319
4.	G				–	1.193**	–0.142	–0.490*	–0.195	0.708**	–0.697**	–0.376	–0.040	–0.194	0.643**	–0.644**
	P				–	0.392	–0.015	–0.106	–0.083	0.747**	–0.454*	–0.295	–0.236	0.073	0.283	–0.483*
5.	G					–	0.045	–0.296	–0.362	0.876**	–0.681**	0.104	–0.380	–0.226	0.397	–0.261
	P					–	–0.134	–0.148	0.055	0.238	–0.089	–0.077	0.077	–0.103	0.014	–0.123
6.	G						–	0.902**	0.506*	0.393	–0.255	0.662**	0.185	0.003	0.801**	0.323
	P						–	0.702**	0.317	0.224	–0.234	0.595**	–0.114	–0.054	0.588**	0.319
7.	G							–	0.680**	0.183	–0.369	0.878**	0.380	0.471*	0.559**	0.434*
	P							–	0.614**	0.309	–0.270	0.327	0.349	0.480*	0.318	0.085
8.	G								–	–0.173	–0.903**	0.093	0.058	0.589**	0.504*	–0.385
	P								–	0.098	–0.413	–0.184	0.308	0.525**	0.184	–0.378
9.	G									–	–0.726**	0.478	0.152	0.162	1.048**	–0.050
	P									–	–0.386	–0.164	0.144	0.434*	0.240	–0.371
10.	G										–	0.309	–0.235	–0.648**	–0.664**	0.757**
	P										–	0.094	0.061	–0.433*	–0.541**	0.624**
11.	G											–	1.701**	0.276	–0.096	0.857**
	P											–	–0.366	–0.276	0.249	0.834**
12.	G												–	0.047	0.043	0.010
	P												–	0.623**	–0.185	–0.291
13.	G													–	0.137	–0.123
	P													–	–0.096	–0.481*
14.	G														–	–0.457*
	P														–	–0.112
15.	G															–
	P															–

Critical 'r' value=0.515 at 1 per cent and 0.404 at 5 per cent.*and ** indicate significant at 5 and 1 per cent probability level, respectively. 1. Number of branches/plant, 2. Vine length (m), 3. Internodal length (cm), 4. Days to 1st female flower, 5. Node at which 1st female appeared, 6. Ovary length (cm),7. Fruit length (cm), 8. Fruit diameter (cm), 9. Days to 1st fruit harvest, 10. Marketable fruits/ plant, 11. Fruit weight (g),12. Flesh pH,13. Fruit hardness (kg/cm^2),14. Fibre content (g/100g edible portion),15. Marketable fruit yield/ plant (kg)

could be exploited in breeding programmes to develop horticultural superior genotypes under the scenario of climate change.

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