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Estimation of genetic parameters in ash gourd

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ABSTRACT

Nine elite lines of ash gourd were crossed in full diallel mating system to generate 72 F_1 hybrids. These F_1 hybrids and nine parental lines were evaluated for thirteen growth and yield related traits and fourteen quality traits. A wide range of variability along with moderate phenotypic and genotypic coefficients of variation was observed for traits such as days to fruit maturity, number of seeds per fruit, seed weight per fruit, iron and zinc content. High estimates of broad sense heritability were recorded for all traits except rind thickness, TSS and crude fibre with heritability ranging from 44.22% for rind thickness to 99.12% for calcium. High heritability for these traits indicated less influence of environment in their expression. Yield per vine, number of fruits per vine, seed weight per fruit, number of seeds per fruit, vitamin C, iron and copper content showed greater estimates of genetic advance as percentage of mean coupled with high amount of heritability indicating that these traits are governed by additive genes and continued selection would be helpful in modifying the mean performance of the population.

Key words: Ash gourd, *Benincasa*, variability, GCV, heritability, quality, genetics.

INTRODUCTION

Ash gourd [*Benincasa hispida* (Thunb.) Cogn., syn. white gourd, wax gourd, white pumpkin] is an important vegetable mainly valued for its long storage life and having a good scope for value addition. The fruits are consumed as baked, fried, boiled, pickled or candied/preserved. In India, its fruits are used as vegetable both in immature and mature stage and fully mature fruits are used in preparing '*petha*' sweet (candy) and *murraba* (Sureja *et al.* 13, Verma *et al.* 15). Indo-China region being a centre of diversity is endowed with great variability in terms of morphological characters, especially, growth habit, maturity including shape, size and flesh thickness of fruits. As a result of continued selection, a large number of landraces and forms with restricted local distribution have been accumulated in different growing areas. There is substantial variation in ash gourd vegetative traits, especially, fruit characters. Assessment of variability and heritability of various quantitative and quality traits is important in this underutilized vegetable crop.

Genotypic and phenotypic coefficients of variation, heritability and genetic advance constitute the important genetic parameters frequently applied in vegetable breeding. Coefficient of variation allows a meaningful comparison of the variation of several traits of plants belonging to the same population, as well as a comparison of the variation for the same trait as expressed by different populations (of the same or different crops). Heritability is used to describe properties of the inheritance of quantitative traits. Vegetable breeders are interested in heritability because characters with higher values can be improved more rapidly with less intensive evaluation than those with lower heritabilities (Nyquist, 5). Heritability tells us about the additive genetic variance and phenotypic variance. The main purpose of estimating heritability and the genetic parameters that compose the heritability estimate is to compare the expected gains from selection based on alternative selection strategies (Holland *et al.* 1). Prediction of selection response is one of the important practical uses of heritability estimate in plant breeding. Heritability coupled with genetic advance is more reliable in predicting the selection response than either of the two parameters alone.

MATERIALS AND METHODS

Nine elite inbred lines of ash gourd were selected based on their superior agronomic performance and nutritional quality characteristics. These were crossed in a diallel mating system to generate 72 F_1 hybrids (including the reciprocals) during the *Kharif* season at the Research Farm of Division of Vegetable Science, Indian Agricultural Research Institute, New Delhi. The inbred lines utilized as parents in the diallel cross were

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selected from the germplasm purified and maintained at the Division of Vegetable Science, Indian Agricultural Research Institute, New Delhi. The nine parental lines used were Sel-12 (P_1), Sel-16 (P_2), Sel-8 (P_3), Sel-9-1 (P_4), Sel-6-1 (P_5), Sel-6 (P_6), Sel-O-1 (P_7), Sel-A-4 (P_8) and Sel-1 (P_9).

The F_1 hybrids, along with their parental inbreds, were grown for phenotypic evaluation under field condition in Randomized Complete Block Design (RCBD) with three replications in the *Kharif* season of 2000 at the Research Farm of Division of Vegetable Science. Seeds were sown in both sides of channels keeping 6.5 m between channels, 1.5 m between plants with 90 cm irrigation channels. Standard and uniform agronomic practices recommended under irrigated conditions were followed throughout the growing season to raise a healthy crop. For each F_1 hybrid and parent, five plants were selected, after discarding the border plants at both ends, and were examined for 13 growth and yield related traits: (1) vine length (m), (2) days to opening of first male flower, (3) days to opening of first female flower, (4) days to fruit maturity, (5) number of fruits per vine, (6) fruit weight (kg), (7) fruit length (cm), (8) fruit girth (cm), (9) flesh thickness (cm), (10) rind thickness (mm), (11) number of seeds per fruit, (12) seed weight (g) per fruit, (13) yield (kg) per vine, and 14 quality traits (1) nitrogen (%), (2) phosphorus (%), (3) potassium (%), (4) sulphur (%), (5) calcium (%), (6) magnesium (%), (7) iron content (ìg g^{-1}) (8) manganese (ìg g^{-1}), (9) copper (ìg g^{-1}), (10) zinc content (ìg g^{-1}), (11) crude protein (%), (12) TSS (^{o}Brix), (13) vitamin C (mg/100 g) and (14) crude fiber (%). Vitamin C and crude fiber content were estimated according to Ranganna (10) and Thimmaiah (14), respectively. Total nitrogen (on dry weight basis) was determined by Kjeltec-2300 auto analyser unit (Foss Tecator). Phosphorus, potassium and sulphur content were estimated by the vanado-molybdate colour reaction method, flame photometer, and turbidimetric method, respectively. Dried fruit samples were also used to analyse calcium, magnesium, iron, manganese, copper and zinc contents by atomic absorption spectrophotometer (GBC, Model-Avanta PM, Dandenong, VIC, Australia). Means across 3 replications were calculated for each trait and used for data analyses.

RESULTS AND DISCUSSION

Different genetic parameters like genotypic and phenotypic variance, genotypic and phenotypic coefficients of variation, broad sense heritability and genetic advance were estimated for growth and yield related traits and quality traits and the results are presented in Table 1 and 2, respectively.

The phenotypic variability expressed in terms of variance was high in all the traits than the corresponding genotypic variances (Table 1). The genotypic variances were comparatively less in rind thickness (0.08), flesh thickness (0.28), number of fruits per vine (0.55), vine length (0.58) and fruit weight (0.90).

Heritability was quite high for all the growth and yield related traits except rind thickness and it ranged from 44.22% to 93.60%. Highest heritability was noted for seed weight per fruit (93.60%), followed by number of seeds per fruit (92.70%), fruit length (89.11%), number of fruits per vine (87.25%), yield per vine (86.97%), fruit weight (84.84%) and fruit girth (84.30%). Vine length, days to opening of first male and female flower, days to fruit maturity, flesh thickness and rind thickness recorded less than 80% heritability estimates.

Table 1. Estimates of genetic parameters for growth and yield related traits.

Trait	V_g	V_p	$h^2_{(bs)}$ (%)	GCV (%)	PCV (%)	Genetic advance (GA)	Grand mean	GA as % of mean
Vine length (m)	0.58	0.77	76.33	9.56	10.94	1.38	8.00	17.20
Days to opening of first male flower	24.12	30.44	79.23	6.73	7.57	9.01	72.92	12.35
Days to opening of first female flower	20.56	28.26	72.75	5.25	6.16	7.97	86.30	9.23
Days to fruit maturity	52.23	66.89	78.09	5.64	6.38	13.16	128.19	10.26
Number of fruits per vine	0.55	0.63	87.25	34.90	37.36	1.42	2.12	67.16
Fruit weight (kg)	0.90	1.06	84.84	16.61	18.03	1.80	5.70	31.52
Fruit length (cm)	5.34	5.99	89.11	8.59	9.10	4.49	26.92	16.70
Fruit girth (cm)	37.18	44.11	84.30	9.57	10.42	11.53	63.75	18.09
Flesh thickness (cm)	0.28	0.37	76.71	10.25	11.70	0.96	5.19	18.49
Rind thickness (mm)	0.08	0.18	44.22	17.34	26.07	0.38	1.62	23.75
Number of seeds per fruit	25647.87	27667.94	92.70	31.25	32.46	317.64	512.49	61.98
Seed weight per fruit (g)	1170.61	1250.68	93.60	31.39	32.45	68.19	109.00	62.56
Yield per vine (kg)	23.76	27.32	86.97	39.95	42.84	9.37	12.20	76.75

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) ranged from 5.25% to 39.95% and 6.16% to 42.84%, respectively and were moderately high (31% to 43%) for yield per vine, number of fruits per vine, number of seeds per fruit and seed weight per fruit. For all other traits the estimates of GCV and PCV were low (5% to 26%).

The genetic advance as percentage of mean was maximum for yield per vine (76.75), followed by number of fruits per vine (67.16), seed weight per fruit (62.56) and number of seeds per fruit (61.98). The genetic advance as percentage of mean was least for days to opening of first female flower (9.23). Heritability estimates together with genetic advance as percentage of mean is more reliable than either of these two parameters alone in predicting the resultant effects of selecting the best individual. Yield per vine, number of fruits per vine, seed weight per fruit and number of seeds per fruits possessed greater estimates of genetic advance as percentage of mean coupled with high amount of heritability, GCV and PCV.

Results of the estimates of genetic parameters for quality traits (Table 2) indicated high phenotypic variance for most of the traits than the corresponding genotypic variances. Both genotypic and phenotypic variances were high for iron and zinc, moderate for copper and very low (less than 7.00) for other traits. Zero variance was observed for phosphorus, sulphur and magnesium.

All the quality traits (except TSS and crude fibre) had very high estimates of broad sense heritability (greater than 90%). Maximum heritability was noticed for calcium (99.12%), whereas minimum was observed for TSS (71.79%). Moderate estimate of genotypic and phenotypic coefficients of variation were recorded for vitamin C (49.10% and 49.42%), iron (36.18% and 36.80%) and copper (35.29% and 35.56%), respectively. For all other traits the estimates of GCV and PCV ranged from 16% to 29%. Maximum genetic advance as percentage of mean was noted for vitamin C (100.47), followed by iron (73.27), copper (72.17), manganese (58.55) and sulphur (53.58). All other quality traits possessed fairly good amount (29% to 49%) of genetic advance as percentage of mean. High broad sense heritability along with greater estimates of genetic advance as percentage of mean was observed in vitamin C, iron and copper.

A wide range of variation was observed for traits like days to fruit maturity, number of seeds per fruit, seed weight per fruit, iron and zinc. Wide ranges of variability for these traits except days to fruit maturity were also coupled with moderate phenotypic and genotypic coefficients of variation. In agreement with the present findings, low variability was reported by several workers for days to flower opening (Puri and Singh, 7) and days to fruit maturity (Raju *et al.* 8). High estimates of broad sense heritability were recorded for all traits except rind thickness, TSS and crude fibre with heritability ranging from 44.22% for rind thickness to 99.12% for calcium. High heritability for these traits indicated less influence of environment in their expression. High estimates of heritability were recorded for fruit diameter, flesh thickness, average fruit weight and total fruit yield in ash gourd (Singh *et al.* 12). High estimates of heritability were also reported by some workers for traits like vine length, number of fruits per vine, fruit weight, number of seeds per fruit, yield per vine and TSS (Kumaran *et al.* 3) and days to flower anthesis and flesh thickness (Mohanty and Mishra, 4) in pumpkin and fruit length at edible stage, node number bearing first male flower and

Table 2. Estimates of genetic parameters for quality traits.

Trait	V_g	V_p	$h^2_{(bs)}$ (%)	GCV (%)	PCV (%)	Genetic advance (GA)	Grand mean	GA as % of mean
Nitrogen (%)	0.14	0.16	90.91	16.83	17.65	0.75	2.26	33.05
Phosphorus (%)	0.00	0.00	95.84	20.99	21.44	0.12	0.29	42.33
Potassium (%)	0.31	0.33	93.88	17.81	18.38	1.11	3.13	35.55
Sulphur (%)	0.00	0.00	98.29	26.24	26.46	0.07	0.13	53.58
Calcium (%)	0.01	0.01	99.12	22.31	22.40	0.21	0.47	45.75
Magnesium (%)	0.00	0.00	97.39	20.50	20.77	0.08	0.18	41.67
Iron (ìg g^{-1})	2697.78	2790.99	96.66	36.18	36.80	105.19	143.58	73.27
Manganese (ìg g^{-1})	6.28	6.37	98.58	28.62	28.83	5.12	8.75	58.55
Copper (ìg g^{-1})	35.65	36.18	98.52	35.29	35.56	12.21	16.92	72.17
Zinc (ìg g^{-1})	47.68	48.36	98.60	23.64	23.80	14.13	29.21	48.35
Crude protein (%)	5.65	6.21	90.90	16.83	17.65	4.67	14.12	33.05
TSS (^{0}Brix)	0.14	0.20	71.79	16.15	19.06	0.66	2.35	28.19
Vitamin C (mg/100g)	2.06	2.09	98.68	49.10	49.42	2.94	2.92	100.47
Crude fiber (%)	0.02	0.02	75.27	18.41	21.22	0.24	0.74	32.90

fruit weight at edible stage in cucumber (Yadav *et al.* 16).

The heritability estimates together with expected genetic gain is usually more reliable than either of these two parameters alone in predicting the resultant effects of selecting the best individuals. From this point of view, yield per vine, number of fruits per vine, seed weight per fruit, number of seeds per fruit, vitamin C, iron and copper content possessed greater estimates of genetic advance as percentage of mean coupled with high amount of heritability indicating that these traits are governed by additive genes and continued selection would be helpful in modifying the mean performance of the population. Similar results were reported by Kumaran *et al*. (3) and Kumar *et al.* (2) for number of fruits per vine and yield per vine, Prasad *et al*. (6) for seed weight per fruit and Ramachandran and Gopalakrishnan (9) for vitamin C, TSS and iron. In agreement to the present findings, Puri and Singh (7) observed high heritability and expected genetic advance for yield per vine and moderately high heritability for vine length in ash gourd. In contrast to the present results, they reported low and moderate heritabilities for days to appearance of first female flower and fruit weight. Singh *et al*. (12) recorded high estimates of PCV and GCV for total fruit yield, average fruit weight and dry fruit weight and high genetic advance for fruit diameter, flesh thickness, seed cavity, dry fruit weight and total fruit yield in ash gourd. Sanwal *et al.* (11) observed high values of genotypic coefficient of variance along with high heritability and genetic advance for number of fruits/plant, fruit yield/plant, TSS, acidity and ascorbic acid in chow chow.

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