Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2742

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (2):** 723-731 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Variability and Correlation Studies in Bottlegourd

K. Usha Rani* and E. Nagabhushana Reddy

Department of Horticulture, Sri Venkateswara Agricultural College, Acharya N.G. Ranga Agricultural University, Tirupati, 517 502, Andhra Pradesh, India

*Corresponding Author E-mail: ushahort77@gmail.com

Received: 23.03.2017 | Revised: 5.04.2017 | Accepted: 6.04.2017

ABSTRACT

*The investigation entitled "Genetic analysis of yield and its attributes in F3 generation of 5 X 5 half diallel set in bottlegourd (Lagenaria siceraria (Molina) standley)" was carried out with the objective to identify superior parents and F3 cross combinations and to propose a viable and effective breeding strategy for yield improvement in bottle gourd in a randomized block design with three replications during rabi at horticultural garden, S.V. Agricultural college, Tirupati. The experimental material consisted of five parents viz., Arka Bahar (AB), Pusa Summer Prolific Long (PSPL), Pratik, IC-92330 and Tirupati-local and their ten F3 crosses derived from 5X5 half diallel set. Number of seeds per fruit recorded the highest values for genotypic variance (3689.70) and phenotypic variance (3941.20). The characters like fruit length (99.70), days to first female flower opening (98.40), number of branches per vine (98.10) showed high heritability values. Vine length (60.42) and number of branches per vine (38.01) recorded highest values for genetic advance as per cent of mean offering greater scope for selection.Correlation analysis revealed that number of branches per vine (0.684**), number of fruits per vine(0.898**), fruit length(0.803**), fruit girth(0.588*), number of seeds per fruit(0.539*) showed strong positive correlation with yield and among themselves. Therefore these characters could be used as indices for selection of genotypes with high yielding potential.*

Key words: *Bottlegourd, Genetic analysis, Correlation, Fruits*

INTRODUCTION

Bottlegourd (*Lagenaria siceraria* (Molina) Standley) is an important vegetable crop grown extensively all over India. A programme of breeding for high yield requires information of the nature magnitude of variation in the available material, association of characters with yield among themselves, so that a rational choice of the characters in which selection is to exercised can be made. An attempt was therefore made in the present investigation to study the inter relationships and heritabilities of quantitative traits, contributing to yield, so as to assist the plant breeder in forming a basis for selection.

Cite this article: Rani, K.U. and Reddy, E.N., Variability and Correlation Studies in Bottlegourd, *Int. J. Pure App. Biosci.* **5(2):** 723-731 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2742

MATERIAL AND METHODS

The experimental material includes five parents *viz.,* Arka Bahar (AB)-P1, Pusa Summer Prolific Long (PSPL)-P2, Pratik-P3, IC-92330-P4, Tirupati local (TPT local)-P5 and their ten direct crosses. These were evaluated for yield and their attributing traits. The F3 seeds along with its respective parents were selected for study in a randomized block design with three replications during *rabi*. Twenty plants for each cross and ten plants for each parent were raised in each replication. Two healthy vigorous seedlings were maintained per pit. Interrow spacing 2.5m and intrarow spacing 1.1m was given. Standard horticultural operations were followed uniformly to all genotypes *viz.,* Arka Bahar (AB)-P1, Pusa Summer Prolific Long (PSPL)-P2, Pratik-P3, IC-92330-P4,Tirupatilocal (TPT local)-P5, Arka Bahar (AB)-P1 X Pusa Summer Prolific Long (PSPL)-P2, Arka Bahar (AB)-P1 X Pratik-P3, Arka Bahar (AB)-P1 X IC-92330-P4, Arka Bahar (AB)-P1 X Tirupati local(TPT local)-P5, Pusa Summer Prolific Long (PSPL)-P2 X Pratik-P3,Pusa Summer Prolific Long (PSPL)-P2 X IC-92330-P4, Pusa Summer Prolific Long (PSPL)-P2 X Tirupati local (TPT local)-P5, Pratik-P3 X IC-92330-P4, Pratik-P3 X Tirupati local (TPT local)-P5, IC-92330-P4 X Tirupati local (TPT local)-P5.

Data were recorded for 20 plants in each crosses and 10 plants in each of the parents in a replication for twelve quantitative characters *viz.,* vine length, number of branches per vine, node at which first female flower appeared, days to first female flower opening, sex ratio (female to male flowers), fruits per vine, fruit weight (Kg), fruit length (cm) , fruit girth (cm), yield per vine (Kg), seeds per fruit, hundred seed weight (g) and the mean values of the data computed were analysed statistically adopting the method suggested by Panse & Sukhatme[9]. Fruit weight, fruit length, fruit girth and yield of edible fruit was recorded. Fruits were considered edible when the skin or rind was soft enough to be easily punctured with a finger nail. Data on seeds have been recorded from the fruits left for seed. The estimates of heritability in broad sense and genetic advance expressed as percentage of mean at K=2.06were calculated according to Burton. The analysis of variance and covariance and the estimates of correlation were done according the methods given by Panse & Sukhatme[9].

RESULTS AND DISCUSSION

Genetic parameters: For higher production of any crop, genetic improvement is a prime need. The knowledge on the nature and magnitude of genetic variation in respect of quantitative characters like yield and its components is essential for effecting crop yield improvement. The estimates of mean serves as a basis for eliminating undesirable crosses whereas genetic variability, GCV and PCV helps to choose a potential cross. The magnitude of heritable variation in breeding material more particularly its genetic component has immense value in fixation of a particular trait and helps in identification of a genotype by its phenotypic expression. Genetic advance refers to the improvement in the mean genotypic value of a selected family over population, high genetic advance along with high heritability indicates that improvement could be made for such characters by simple selection on phenotypic performance. The genetic parameters may enable the breeder to plan proper breeding programme. The results on genotypic and phenotypic variance, genotypic and phenotypic coefficient of variation, heritability and genetic advance for twelve characters are presented in Table 1. GCV & PCV were considered low when it was less than 10 per cent, medium at 10-20 and high at more than 20 per cent[15]. Heritability was considered low when it was less than 20 per cent, medium at 20-50 per cent and high at more than 50 per cent[17]. Genetic advance as per cent of mean considered as low when it was less than 10 per cent, medium 10-20 per cent and high at more than20 per cent[5].

Variability: Most of the characters except sex ratio and hundred seed weight showed wide variability due to transgressive segregation in F3 generation. Number of seeds per fruit recorded the highest values for genotypic variance (3689.17) and phenotypic variance (3941.20) followed by fruit length (39.03 and 39.17) whereas days to first female flower opening showed moderate genotypic and phenotypic variance (14.87 and15.11), number

of branches per vine (8.46 and 8.63), vine length(3.68 and 4.64), node at which first female flower appeared(1.01 and 1.12), fruit girth(1.89 and 1.94),yield per vine (0.56 and 0.58), hundred seed weight (0.21 and 0.46), number of fruits per vine (0.81 and 0.19), fruit weight (0.09 and 0.10) and sex ratio (0.0020 and 0.0024) had lower values for genotypic and phenotypic variances. In general the phenotypic coefficient of variation was slightly higher than genotypic coefficient of variation. It means that the apparent variation is not only due to genotypes but also due to influence of environment on the expression of character. The genotypic and phenotypic coefficient of variation were highest for vine length (26.64and 29.93), whereas the number of branches per vine (18.65 and 18.83), fruit weight (15.53 and 15.85), fruit girth (14.91 and 15.07), yield per vine (13.12 and 13.52), node at which first female flower appeared(13.10 and 13.79), number of seeds per fruit (12.80 and 13.23),fruit length (11.30 and 11.32)showed moderate values. Sex ratio showed low genotypic values (9.32) and modern phenotypic values (10.32). Whereas days to first female flower opening (7.59 and 7.65) and hundred seed weight (2.34 and 3.42) exhibited lower values for genotypic and phenotypic coefficients of variation. In the present study wide range of variability was noticed in all the characters studied except hundred seed weight [4]. The estimates of phenotypic coefficient of variation for all the characters were higher than estimates of genotypic coefficients of variation, indicating the environmental influence on the expression of these characters. Among the parents and F3 progenies, genotypic and phenotypic coefficients of variation were higher for vine length indicating wide variation and offers good scope for improvement of this trait through selection[13, 11]. Low GCV and PCV were recorded for days to first female flower opening and hundred seed weight indicating no scope for improvement of these characters through selection[13]. The remaining characters recorded moderate GCV and PCV values, lending meagre scope for selection.

Heritability and Genetic advance: High heritability estimates in broad sense were recorded for all the characters except hundred seed weight. The highest being recorded for fruit length (99.70) followed by days to first female flower opening (98.40), number of branches per vine (98.10), vine length (98.00), fruit girth (97.90), yield per vine (94.10), fruit weight (93.60), number of seeds per fruit (93.60),node at which first female flower appeared(90.20) and sex ratio(81.60)indicating predominance of additive gene action in their inheritance. Moderate heritability was recorded by hundred seed weight (47.10).Seeds per fruit had very high genetic advance (121.08%), whereas fruit length recorded moderate genetic advance (12.85%). On the contrary the rest of the characters registered low values for genetic advance in the range of (0.08 to 7.88), indicating that these traits were under governance of non-additive genetic inheritance lending little scope for improvement through selection. Vine length recorded highest genetic advance as per cent of mean (60.42) followed by number of branches per vine (38.01), fruit weight(30.05), fruit girth(30.41),yield per vine(29.13), number of fruits per vine (26.17), node at which first female flower appeared (25.58), number of seeds per fruit (25.52), fruit length(23.34). Moderate genetic advance as per cent of mean was recorded for sex ratio (16.67), days to first female flower opening (15.51). Whereas low genetic advance as per cent of mean was registered for hundred seed weight (3.34). In the present investigation, high magnitudes of heritability and genetic advance as per cent of mean in respect of vine length, number of branches per vine, node at which first female flower appeared, number of fruits per vine, fruit weight, fruit length, fruit girth, yield per vine and number of seeds per fruit indicating that the additive gene effects are important in conditioning of these characters. These results are in agreement with the findings for fruit length and fruit girth[14], for vine length, node at which first female flower appeared, number of branches per vine, fruits per vine and average fruit weight[1,11], for yield per vine, vine length and number of seeds per fruit[18], for fruit yield per vine and fruit weight[10,16], for vine length, number of branches per vine, fruit length and yield per vine[19], for number of branches per vine and number of fruits per vine[3] in bottlegourd. High heritability and moderate genetic advance besides low to moderate GCV and PCV were

recorded for days to first female flower opening and sex ratio indicating the role of both additive and non-additive gene action in their inheritance. This suggested to follow recurrent selection or reciprocal recurrent selection to exploit both additive and non-additive genetic components selection in these traits may not be rewarding[18].

From the foregoing discussion, it is to conclude that the characters *viz.,* vine length, number of branches per vine, number of fruits per vine, fruit weight, fruit length, fruit girth, yield per vine and number of seeds per fruit showed high to moderate coefficient of variation coupled with high heritability and high genetic advance as per cent of mean indicating the variation in these characters due to additive gene effects. Hence simple selection may be effective to improve these traits. Whereas days to first female flower opening, node bearing the first female flower, sex ratio and hundred seed weight showed low to moderate GCV and PCV, high heritability, accompanied by moderate genetic advance indicating that these characters are influenced by environment and are controlled by polygenes. In such cases population breeding in the form of biparental mating between selected combinations followed by selection may be useful to release the locked up variability to isolate the superior segregants for these characters. Most of the characters except days to first female flower opening, sex ratio, and hundred seed weight recorded high genetic advance as per cent of mean offering greater scope for selection.

CHARACTERS ASSOCIATION

Yield being a complex polygenic character, direct selection is not effective. Hence, improvement in any crop rests on the understanding of the influence of different component characters on yield as well as among themselves. It has been generally accepted that the correlations between different characters represent a coordination of physiological processes which is often achieved through gene linkage[6]. Acknowledge of the strength and type of such association is an important prerequisite for the formulation of breeding procedures. Generally, if the phenotypic correlations were higher than the corresponding genotypic correlations indicating that strong inherent associations were somewhat masked at phenotypic level due to environmental effects. In order to assess the direction and magnitude of association existing between the fruit yield per plant and its eleven other component characters, phenotypic and genotypic correlation coefficients were computed and are furnished in Table 2 and 3 respectively. The results of character association in the F3 population both at phenotypic and genotypic levels are discussed to find out a common selection criterion.

PHENOTYPIC CORRELATION: yield per vine correlated highly and significantly with number of fruits per vine (r=0.862**), fruit length (r=0.786**) and number of branches per vine (r=0.062**) in positive direction, while fruit girth (r=0.572**) and number of seeds per fruit (r=0.534*) exhibited moderately significant positive association with yield per vine. The characters vine length, sex ratio, fruit weight, hundred seed weight correlated positively but non-significant with fruit yield. Node at which first female flower appeared and days to first female flower opening exhibited non-significant negative association with fruit yield indicating that early flowering genotypes would yield better than late flowering ones. As far as the hundred seed weight is concerned significant phenotypic correlation was not recorded for a single trait. The characters fruit girth(r=0.811*)and fruit weight(r=0.648**)had highly significant positive correlation with number of seeds per fruit while it had moderately significant positive association with vine length(r=0.633*), number of fruits per vine (r=0.566*) and fruit length(r=0.595*). Fruit recorded highly significant positive association with fruit weight (r=0.907**), vine length(r=0.794**) and fruit length(r=0.714**). It had moderately significant positive association with number of branches per vine (r=0.533*) and days to first female flower opening (r=0.515*). Fruit length exhibited highly significant positive association with number of branches per vine (r=0.789**), number of fruits per vine (0.726**) and fruit weight(r=0.643**). Fruit weight showed highly significant positive association with vine length (r=0.772**) while number of branches per vine (r=0.583*) recorded moderately significant and positive association

with fruit weight. Number of fruits per vine exhibited moderately significant positive association with number of branches per vine (r=0.569*). Sex ratio exhibited non-significant positive association with number of branches per vine. Days to first female flower opening showed highly significant positive association with node at which first female flower appeared (r=0.874**) and vine length(r=0.718**). Node at which first female flower appeared recorded moderately significant positive association with vine length(r=0.583*). Number of branches per vine exhibited non-significant positive association with vine length.

GENOTYPIC CORRELATION: Yield per vine had highly significant positive association with number of fruits per vine (r=0.898**), fruit length (r=0.803**) and number of branches per vine (r=0.684**) while fruit girth (r=0.588*), number of seeds per fruit (r=0.539*) and fruit weight (r=0.513*) recorded moderately significant positive association with yield. However, vine length, sex ratio and hundred seed weight showed positive but non-significant association with yield. Node at which first female flower appeared showed moderately significant negative association with yield. This indicate that the lower node bearing the first female flower at an early date as an index of early flowering would be desirable in a genotype for high yield potential. Hundred seed weight showed highly significant positive association with sex ratio (r=0.675**). Number of seeds per fruit exhibited highly significant positive association with fruit girth (r=0.842**), fruit weight(r=0.681**) and vine length (r=0.676**). It had moderately significant positive association with fruit length (r=0.609*) and number of fruits per vine (r=0.604*). Fruit girth recorded highly significant positive association with fruit weight (r=0.937**), vine length (r=0.813 **) and fruit length (r=0.724**). While moderately significant positive association with number of branches per vine (r=0.548*) and days to first female flower opening (r=0.516*). Fruit length had highly significant positive association with number of branches per vine (r=0.797**), number of fruits per vine (r=0.747**) and fruit weight (r=0.664**). Fruit weight showed highly significant positive association with vine length(r=0.814**) while moderately significant positive association with number of branches per vine (r=0.620**) days to first female flower opening (r=0.514*). Number of fruits per vine exhibited moderately significant positive association with number of branches per vine (r=0.597*). Sex ratio recorded moderately significant negative association with node at which first female flower appeared (r=-0.580*). Days to first female flower opening showed highly significant positive association with node at which first female flower appeared (r=0.921**) and vine length (r=0.733**). Node at which first female flower appeared exhibited moderately significant positive association with vine length (r=0.635*). The magnitude of correlation of number of branches per vine with vine length was low(r=0.408).

Yield per vine had positive and significant association with number of branches per vine, number of fruits per vine, fruit length, fruit girth, fruit weight and number of seeds per fruit. These findings are in conformity with the results for number of branches per vine, fruits per vine and fruit weight[8], for fruits per vine and fruit weight[11], for number of branches per vine and fruits per vine[2, 3], for fruit weight, fruit length and fruits per vine[7,10,16,18] in bottlegourd. Yield per vine showed positive but non- significant association with vine length, sex ratio, and hundred seed weight. Node at which first female flower appeared exhibited negative and significant association with yield[12]. Days to first female flower opening had negative and non-significant association with yield[2,10].

From the present investigation, it can be inferred that the characters *viz.*, number of branches per vine, number of fruits per vine, fruit weight, fruit length, fruit girth and number of seeds per fruit showed significant and positive association with yield. Therefore, these traits are considered to be the most important selection indices on which selection pressure can be exercised to improve the yield potential of bottlegourd. A simultaneous selection for these traits might bring a considerable improvement in yield.

Table 1: Variability and genetic parameters for twelve characters in F3 generation of 5 X 5 half diallel of bottlegourd

S.No.	Character	Mean	Range	Variance		Coefficient of variation		Heritability (broad sense) (%)	Genetic advance (GA)	Genetic advance as per cent of mean
				Genotypic	Phenotypic	Genotypic	phenotypic			
1.	Vine length (m)	7.20	4.97-13.97	3.68	4.64	26.64	29.93	98.00	4.35	60.42
2.	Number of branches per vine	15.60	10.27-20.50	8.46	8.63	18.65	18.83	98.10	5.93	38.01
3.	Number of node at which first female flower appeared	7.66	6.07-10.57	1.01	1.12	13.10	13.79	90.20	1.96	25.58
4.	Days to first female flower opening	50.81	47.07-63.47	14.87	15.11	7.59	7.65	98.40	7.88	15.51
5.	Sex ratio (Female to male)	0.48	0.42-0.59	0.0020	0.0024	9.32	10.32	81.60	0.08	16.67
6.	Number of fruits per vine	3.21	2.37-3.87	0.18	0.19	13.12	13.52	94.10	0.84	26.17
7.	Fruit weight (Kg)	2.00	1.55-2.73	0.09	0.10	15.33	15.85	93.60	0.61	30.5
8.	Fruit length (cm)	55.29	44.13-62.03	39.03	39.17	11.30	11.32	99.70	12.85	23.24
9.	Fruit girth (cm)	9.24	7.48-12.83	1.89	1.94	14.91	15.07	97.90	2.81	30.41
10.	Yield per vine (Kg)	5.15	4.01-6.51	0.56	0.58	14.47	14.81	95.40	1.50	29.13
11.	Number of seeds per fruit	474.52	362.07-605.90	3689.17	3941.20	12.80	13.23	93.60	121.08	25.52
12.	Hundred seed weight(g)	19.77	18.93-21.07	0.21	0.46	2.34	3.42	47.10	0.66	3.34

Table 2: Phenotypic correlation coefficient among fruit yield per vine and eleven yield components in F3 generation of bottlegourd

Character	Vine length	number of branches per vine	number of node at which first female flower appeared	Days to first female flower opening	Sex ratio	Number of fruits per vine	Fruit weight	Fruit length	Fruit girth	Number of seeds per fruit	Hundred seed weight	Yield per vine
Vine length	1.000	0.397	0.583*	0.718**	-0.125	0.099	0.772**	0.349	0.794**	0.633*	0.224	0.151
number of branches per vine		1.000	-0.238	-0.222	0.187	0.569*	0.583*	0.789**	0.533*	0.427	0.277	0.662**
number of node at which first female flower appeared			1.000	0.874**	-0.467	-0.505	0.377	-0.230	0.307	0.245	0.055	-0.481
Days to first female flower opening				1.000	-0.337	-0.333	0.505	-0.085	0.515*	0.475	0.041	-0.276
Sex ratio					1.000	0.316	-0.164	0.116	-0.106	-0.020	0.408	0.240
Number of fruits per vine						1.000	0.267	0.726**	0.451	0.566*	0.074	0.862**
Fruit weight							1.000	0.643**	0.907**	0.648**	0.172	0.471
Fruit length								1.000	0.714**	0.595*	0.231	0.786**
Fruit girth									1.000	0.811**	0.142	0.572*
Number of seeds per fruit										1.000	0.122	0.533*
Hundred seed weight											1.000	0.056

*=Significant at 5% level

**=Significant at 1% level

Table 3: Genotypic correlation coefficient among fruit yield per vine and eleven yield components in F3 generation of bottlegourd

Character	Vine length	number of branches per vine	number of node at which first female flower appeared	Days to first female flower opening	Sex ratio	Number of fruits per vine	Fruit weight	Fruit length	Fruit girth	Number of seeds per fruit	Hundred seed weight	Yield per vine
Vine length	1.000	0.408	0.635*	0.733**	-0.133	0.106	0.814**	0.355	0.813**	0.676**	0.356	0.164
number of branches per vine		1.000	-0.264	-0.227	0.202	0.597*	0.620*	0.797**	0.548*	0.438	0.389	0.684**
number of node at which first female flower appeared			1.000	0.921**	-0.580*	-0.538*	0.412	-0.245	0.326	0.262	0.038	-0.522*
Days to first female flower opening				1.000	-0.379	-0.340	0.514*	-0.085	0.516*	0.492	0.049	-0.296
Sex ratio					1.000	0.364	-0.170	0.142	-0.138	0.020	0.675**	0.322
Number of fruits per vine						1.000	0.282	0.747**	0.470	0.604*	0.166	0.898**
Fruit weight							1.000	0.664**	0.937**	0.681**	0.270	0.513*
Fruit length								1.000	0.724**	0.609*	0.329	0.803**
Fruit girth									1.000	0.842**	0.186	0.588*
Number of seeds per fruit										1.000	0.185	0.539*
Hundred seed weight											1.000	0.101

*=Significant at 5% level

**=Significant at 1% level

CONCLUSION

Higher phenotypic and genotypic coefficient of variation were observed for vine length. Abundant variability reflects possible chances for improving this trait by exercising selection. The characters *viz.,* the vine length, number of branches per vine, node at which first female flower appeared, number of fruits per vine, fruit weight, fruit length, fruit girth yield per vine and number of seeds per fruit recorded high variability coupled with genetic advance as per cent of mean in both parents and F3 progenies indicating the presence of additive gene effects for these traits and selection will be fruitful for improvement of these traits. Correlation analysis revealed that number of branches per vine, number of fruits per vine, fruit length, fruit girth, number of seeds per fruit showed strong positive correlation with yield and among themselves. Therefore these characters could be used as indices for selection of genotypes with high yielding potential.

Acknowledgement

Author wishes to express her sincere thanks to Dr. E. Nagabhushana Reddy, Professor, Department of Horticulture, S.V. Agricultural College, Tirupati for his support from the initiation of the work to the ship shaping of the manuscript.

REFERENCES

1. Sharma, A. and Sengupta, S.K., *The Bioscan*, **8(4):** 1461-1465 (2013).
2. Badade, D.S., Warade, S. D. and Gaikwad, S. K., *Journal of Maharashtra Agriculture University*, **26(1):**20-22 (2001).
3. Bawker, S.O., Bhalekar, M.N., Pawar, P.K. and Sonavane, P.N., *Trends in biosciences*, **8(8):** 2133-2135 (2015).
4. Chadha, M.L. and Tarsem Lal, Improvement of cucurbits. In K. L. Chadha and G. Kalloo (eds.) Advances in Horticulture Vol. 5 Vegetable Crops Part1 Malhotra Publishing House, New Delhi (1993) pp.137-180.
5. Johnson, H .W., Robinson,H. F. and Comstock, R. E., *Agronomy Journal*, **47:** 314-318 (1995).
6. Mather, K. and Jinks, J. L., Biometrical genetics, Chapman and Hall London (1971) pp. 382.
7. Pandit, M.K., Mahato,B. and Sarkar, A., *Acta Horticulturae*, **809(809):** 221-226 (2009).
8. Murali, B., Haribabu, K. and Reddy, P. V., *South Indian Hort*., **34:** 338-340 (1986).
9. Panse, V. G. and Sukhatme, P. V., Statistical methods for Agricultural Workers, ICAR New Delhi, (1967) pp.1-381.
10. Parvathi, L. (2002) Genetic analysis of yield and yield attributes in F2 generation of 5 X 5 diallelset in bottlegourd (*Lagenaria siceraria* (Mol.) Standl.). M.Sc. (Ag.) Thesis, Acharya N.G.Ranga Agricultural University, Hyderabad.
11. Prasad, M., Singh, M. and Srivastava, B. P., *Haryana Journal of Horticultural Sciences*, **22(3):** 222-227 (1993).
12. Kumar, S. and singh, S. P., *Vegetable Science*, **25(1):** 40-42 (1998).
13. Sharma, N. K. and Dhankar, B. S., *Haryana Journal of Horticultural Sciences*, **19(3-4):** 305-312 (1990).
14. Sirohi, P. S., Sivakamini, N. and Choudhary, B., *Indian Journal of Agricultural Sciences*, **56:** 623-625 (1986).
15. Sivasubramaniam, S. and Menon, P. M., *The Madras Agricultural Journal*, **60(9-12):** 1093-1096 (1973).
16. Sreevani, P. G., (2002) Heterosis and combining ability studies in 5 X 5 diallel of bottlegourd (*Lagenaria siceraria* (Mol.) Standl.), M. Sc. (Ag.) Thesis submitted to Acharya N. G. Ranga Agricultural University, Hyderabad.
17. Stansfield, W. D., Theory and Problems of Genetics, (1969) McGraw Hill New York.
18. Suchitra, V., (2000) Studies on genetic divergence, variability parameters and character association in bottle gourd (*Lagenaria siceraria*(Mol.) Standl.), M. Sc. (Ag.) Thesis submitted to Acharya N. G. Ranga Agricultural University, Hyderabad.
19. Yadav, Y.C. and Kumar, S., *Annals of Horticulture*, **5(1):** 80-89 (2012).