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Gene action involved in expression of growth, yield and its contributing traits in bottle gourd [*Lagenaria siceraria* (Mol.) Standl]

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Abstract
The present investigation was carried out in rainy seasons (*Kharif*) with aim to find out the gene action for inheritance of morphological, yield and its component traits in bottle gourd. The present study was comprised of seven diverse parents/ inbreds and 42 F_1s (including reciprocals) was sown in Randomized Block Design with four replications during September at Students Instructional Farm, N.D.U.A.&T., Kumarganj, Faizabad. The data were recorded on five randomly selected plants in each F_1, reciprocal and parents and in each replication for 14 characters *viz.*, days to anthesis of first male flower, days to anthesis of first female flower, node number of first male flower, fruit yield per plant (kg), node number for first female flower, days to first fruit harvest, fruit length (cm), fruit diameter (cm), fruit weight (kg), number of fruits per plant, number of branches per plant, number of nodes per plant, internodal distance (cm), vine length (m).The present study revealed that highly significant values for additive (D) and dominance ($\hat{H}1$ and $\hat{H}2$) effects of components were observed for most of the fourteen traits except the values of D for fruit yield per plant, number of nodes per plant and the values of $\hat{H}_1$ for node number of first female flower, days to first fruit harvest, fruit weight, number of branches per plant, number of nodes per plant and the values of $\hat{H}_2$ for days to first fruit harvest, fruit weight, number of branches per plant and number of nodes per plant. The proportion of $\hat{h}^2./\hat{H}_2$ suggested that the characters under study were mainly governed by at least one major gene.

Keywords: Bottle gourd, gene action, fruit yield attributes and diallel mating.

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl., 2n =2x= 22] is an important cultivated annual cucurbitaceous vegetable crop grown throughout the country. Being warm season vegetable crop it thrives well in warm and humid climate but at present it's off season cultivation has progressively stretched throughout the year in northern Indian plains. According to De Candolle (1882), bottle gourd has been found in wild form in South Africa and India. However, Cutler and Whitaker (1961) [2] are of the view that probably it is indigenous to tropical Africa on the basis of variability in seeds and fruits. The tender fruits of bottle gourd can be used as a vegetable or for making sweets (e.g. *Halva*, *kheer*, *petha* and *burfi* etc.), *kofta* and pickles. The fruit is rich in pectin also, which showed good prospects for jelly preparation. A decoction made from the leaf is a very good medicine for jaundice. The fruit has cooling effect, it is a cardiotonic and diuretic, good for people suffering from biliousness, indigestion and convalescences *i.e.*, regain health after illness. The pulp is good for overcoming constipation, cough, and night blindness and as an antidote against certain poisons. The plant extract is used as a cathartic and seeds are used in dropsy. In addition, the seeds and seed oil are edible. The fruits contain 96.3 per cent moisture, 2.9 per cent carbohydrate, 0.2 per cent protein, 0.1 per cent fat, 0.5 per cent mineral matter and 11 mg of vitamin C (Ascorbic acid) per 100 g fresh weight (Thamburaj and Singh, 2005) [11]. The existence of significant amount of non-additive gene action is a pre-requisite for exploitation of heterosis. The specific combining ability variance is largely the measure of dominance variance. If heterosis is high for specific cross and observations made are true for economic trait like fruit yield, it is possible to utilize the cross as a commercial hybrid provided that the pollination system of the crop permits commercial seed production of hybrids or there exists a male sterility, fertility restoration system.

Materials and Methods

The experimental materials consisted of seven diverse parental lines/ inbreds of bottle gourd and their F_1progenies. The selected parental lines *i.e.* Pusa Naveen, NDBG-129-B, NDBG-140, NDBG-202 LF, NDBG-208, L-22 and L-27.were crossed in the all possible combinations, including reciprocals. These experimental materials were grown under Randomized Block Design (RBD) with four replications at Student Instructional Farm, College of Agriculture, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) India. The treatments were sown in rows spaced 3.0 meters apart with a plant to plant spacing of 0.50 meter. The experiments were laid out during the *Kharif* (off season) for the study of gene action. All the recommended agronomic package of practices and crop protection measures were followed to raise a good crop. Fertilizers and manures were applied as per recommended dose.

The data were recorded on five randomly selected plants of each treatment F_1, reciprocal and parents in each replication for 14 characters *viz*., days to anthesis of first male flower, days to anthesis of first female flower, node number of first male flower, fruit yield per plant (kg), node number for first female flower, days to first fruit harvest, fruit length (cm), fruit diameter (cm), fruit weight (kg), number of fruits per plant, number of branches per plant, number of nodes per plant, internodal distance (cm) and vine length (m). Genetic components of variation were calculated for the analysis of numerical approach followed the method given by Jinks and Hayman (1953) [5], Hayman (1954a) [3] and Askel and Johnson (1963) [1].

Results and Discussion

The estimates of components of variation provide detailed accounts of additive and dominance components and allied statistics. The genetic progress in a population largely depends upon the relative values of these components. The diallel cross analysis through analytical method is based on a number of assumptions regarding applicability of this method as advocated by Hayman (1954 a) [3] *viz*., homozygous parents, diploid segregation, no reciprocal differences, no multiple allelism, absence of linkage, absence of epistatic and random mating. The validity of specific assumptions of diploid segregation, lack of reciprocal differences and multiple allelism were presumed. Bottle gourd being cross pollinated crop it is tedious to get complete homozygous parents for all the characters. However, if some traits exhibit the partial non-fulfillment of assumption, the estimates of population parameters are still possible (Hayman, 1954) [3]. However, the results in such cases are less reliable than would have been if all the assumptions are completed.The estimates of the components of variation and their related statistics for different traits of bottle gourd have been presented in Table-1.

Highly significant values for additive (D) and dominance ($\hat{H}1$and $\hat{H}2$) effects of components were observed for most of the fourteen traits except the values of D for fruit yield per plant, number of nodes per plant, the values of $\hat{H}_1$ for node number of first female flower, days to first harvest, fruit weight, number of branches per plant, number of nodes per plant and the values of $\hat{H}_2$ for days to first fruit harvest, fruit weight, number of branches per plant and number of nodes per plant. The significant values of D, $\hat{H}_1$and $\hat{H}_2$ indicated the importance of both additive and dominance gene action in the expression of these traits, which is in consonance with the findings of Hayward (1979) [4], Reys *et al*. (1993), Sit and Sirohi (2000) [9].

Components of variation showed that both additive and dominance gene action played an important role in the inheritance for days to anthesis of first male flower, days to anthesis of first female flower. fruit length, fruit diameter, number of fruits per plant, internodal distance and vine length. Similar, findings were reported by Sirohi *et al.* (1986) [8] for days to first male flower and days to first female flower anthesis, fruit length and fruit girth.The average degree of dominance $\hat{H}_1/D)^{½}$ revealed the presence of over dominance for all the traits studied. This suggested that heterosis breeding might be advantageous and more rewarding for improvement of yield and its attributing traits in bottle gourd. The findings are in agreement with Sirohi *et al*. (1986) [8], Sit and Sirohi (2000) [9] and Sharma *et al*. (2010) [7]. Ratio of ($\hat{H}_2/4\hat{H}_1$) which estimates the frequency of alleles with positive and negative effects in the parents were less than 0.25for all the traits which showed asymmetrical distribution of loci showing dominance for all the traits (Table-1). The ratio of $(4D\hat{H}_1)^{1/2} + F/(4D\hat{H}_1)^{1/2-}$ F indicated that the dominant alleles were more frequent than recessive alleles for all the traits studied.

The proportion of $h^2/\hat{H}_2$, which provides information about groups of gene exhibiting little or no dominance. The less than one $h^2/\hat{H}_2$ratio suggested that at least one gene group mainly governed the characters under study for most of traits.

The negative correlation suggesting the preponderance of dominant genes while positive values suggested preponderance of recessive genes. The results of present investigation suggested preponderance of dominant genes in the expression of most of the traits studied.Therefore, heterosis breeding approach could be more advantageous and rewarding rather than selection to produce superior hybrids for high fruit yield in bottle gourd. The above findings are in agreement with that of Singh *et al*. (2005) [11].

The non-significant values of 't^2' indicates the validity of assumptions pertaining to diallel (full) cross analysis, while significant values of 't^2'showed failure of hypothesis or null hypothesis for diallel cross analysis (Table-1).

The result of present study suggested preponderance of dominance genes in the expression of most of the fruit yield component traits studied. Therefore, heterosis breeding approach might be advantageous and more rewarding than selection to develop superior hybrids for high fruit yield in bottle gourd.

Estimates of D, F, $\hat{H}_1$, $\hat{H}_2$, $\hat{h}^2$, E, and other related statistics for 14 characters in a 7x7 diallel crosses (including reciprocals) of bottle gourd

Characters	D	F	$\hat{H}_1$	$\hat{H}_2$	h^2	E	$\hat{H}_1/D^{0.5}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$h^2/\hat{H}_2$	r	t^2
1. Days to anthesis of first male flower	1.98** ± 0.44	1.87 ± 1.04	2.18* ± 1.05	1.37 ± 0.92	-0.07 ± 0.62	0.17** ± 0.15	1.05	0.16	2.64	0.0510	0.555	3.427
2. Days to anthesis of first female flower	5.34** ± 1.81	7.82 ± 4.33	10.19* ± 4.35	4.91 ± 3.83	-1.27 ± 2.57	3.13** ± 3.64	1.38	0.12	3.26	0.2586	-0.591	0.323
3. Node number of Ist male flower	1.34** ± 0.24	1.17* ± 0.57	1.74* ± 0.57	1.40** ± 0.50	-0.15 ± 0.34	0.40** ± 0.08	1.14	0.20	2.24	0.1071	0.624	0.934
4. Fruit yield per plant (kg.)	0.16 ± 009	0.15 ± 0.21	0.59** ± 0.21	0.46* ± 0.19	0.39** ± 0.12	0.08** ± 0.03	1.93	0.19	1.62	0.84478	0.250	0.083
5. Node number of first female flower	3.36** ± 0.57	2.53 ± 1.38	1.33 ± 1.38	0.43 ± 1.22	-0.37 ± 0.8	1.79** ± 0.30	0.63	0.08	3.98	0.7604	-0.1240	4.7068

6.Days to first fruit harvest	10.52** ± 2.16	12.64* ± 5.17	7.19 ± 5.19	1.84 ± 4.57	-1.06 ± 3.07	5.43** ± 0.76	0.83	0.06	6.31	0.5760	-01240	6.1849
7. Fruit length (cm)	24.91** ± 3.8	21.78 ± 9.29	19.21* ± 9.32	14.68* ± 8.21	22.70** ± 5.52	5.97** ± 1.37	0.88	0.19	2.98	1.54	-0.9234**	0.0669
8.Fruit diameter (cm)	0.30** ± 0.04	0.32** ± 0.09	0.23** ± 0.09	0.15* ± 0.08	0.09 ± 0.05	0.07** ± 0.01	0.89	0.15	4.22	0.600	0.9605**	0.1709
9. Fruit weight (kg)	0.001 ± 0.00	0.004 ± 0.00	0.001 ± 0.00	0.0009 ± 0.0	0.0004 0.00	0.0001 0.00	2.00	0.22	1.97	0.450	-0.9145*	0.3923
10. Number of fruits per plant	0.30* ± 0.14	0.24 ± 0.34	0.73* ± 0.34	0.55* ± 0.30	0.02 ± 0.20	0.17** ± 0.05	1.56	0.19	1.71	0.036	0.6596	0.1566
11. Number of branches per plant	6.52** ± 1.09	7.60** ± 2.61	3.10 ± 2.62	1.01 ± 2.31	0.49 ± 1.55	2.42** ± 0.38	0.69	0.08	11.95	0.4871	0.7797*	1.6398
12. Number of nodes per plant	4.62 ± 3.29	8.54 ± 7.89	11.99 ± 7.92	7.85 ± 6.98	6.00 ± 4.69	4.45** ± 1.16	1.61	0.16	3.69	0.7643	-0.7334	0.1807
13. Internodal distance (cm)	1.24** ± 0.27	1.37** ± 0.65	1.22* ± 0.65	0.52 ± 0.57	-0.21 ± 0.39	0.84** ± 0.10	0.99	0.11	3.52	0.4038	0.2853	5.6095
14. Vine length (m)	0.57** ± 0.10	0.61* ± 0.23	0.52* ± 0.24	0.26 ± 0.21	0.13 ± 0.14	0.21** ± 0.03	0.96	0.13	3.5	0.5000	0.5111	3.5607

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