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Generation Mean Analysis for Yield Related Traits in Bottlegourd [*Lagenaria siceraria* (MOL.) Standl.]

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ABSTRACT: Six generation mean analysis was carried out to investigate the inheritance of yield traits (Fruit length, fruit equatorial diameter, number of fruits per vine, average fruit weight, fruit yield per vine, number of seeds per fruit and hundred seed weight) using two crosses of bottle gourd *viz.*, IC342079 × IC4211962 and Arka Bahar × IC4211962, parents, F_1, F_2, B_1 and B_2 generation in the *kharif* season of 2023 at Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi district (Karnataka), India. Results indicated that dominance × dominance gene effect was predominant in cross IC342079 × IC4211962 for average fruit weight and fruit yield per vine. Whereas, additive, additive x dominance and dominance × dominance gene effect were predominant in cross Arka Bahar × IC4211962 for average fruit weight. For fruit yield per vine additive × dominance and dominance × dominance gene interactions in cross Arka Bahar × IC4211962 were found predominant.

Keywords: *Lagenaria siceraria*, Gene effects, Epistasis, Gene interactions, Generation Mean Analysis.

INTRODUCTION

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is an important gourd crop having wide range of users and is largely cultivated in the tropics and subtropics for its edible fruits. It is widely grown cucurbit of the world (Hidayatullah *et al*., 2012). The variation occurs in cultivated type existing among the genotypes is less and the availability of genetic material also makes it important. Since the crop is a traditional one, many possibilities of exploring, like the characterization of the plants at different geographical location by chemical markers can be a tool (Masuthi *et al.*, 2015a), physical characterization (Shridhar *et al*, 2019) and genetic diversity (Sulochana *et al.*, 2018). The only means of crop improvements is not only the breeding systems but may also be also by interference with seed endophytes by the different priming treatments for better crop and seed quality (Masuthi *et al.*, 2015b), also by preserving the seeds by storage studies to retain and make available the viable seed (Bhavya *et al.*, 2017), and by pelleting with micronutrients and botanicals on growth, seed yield and quality of vegetable cowpea (Masuthi *et al.*, 2009). Mutation breeding as a potent and beneficial tool in plant breeders to create variation, can be the other potential works on crop improvement that can be explored. The cultivated crops have drastic impact with respect to the environment. The plants will have to face pest and disease risk, which can be managed by the practices to tackle the diseases. The management of dieback at all stages of observation was to be done. Similarly, the per cent disease index recorded in other crops on die back of chilli revealed that significantly least per cent disease index (Kareem *et al.*, 2016a) for die back and chlorothalonil spray for fruit rot (Kareem *et al.*, 2016b). In recent years crops attacked by gall formers causing more economic loss (Chethan *et al.*, 2022). These are some of the challenges that now a days agriculture is facing.

In India Bottle gourd it is popular in Northern part of the country especially in Bihar and Uttar Pradesh. Though, there is a wide range of genetic variability available in India, not much attention has been given to the genetical studies and crop improvement. Estimation of genetic parameters is needed to understand the genetic architecture of yield and yield contributing components. Information about type of gene action of yield and yield contributing components would be of immense help for a plant breeder to decide about the proper breeding procedure to be adopted.

MATERIALS AND METHODS

The experiment comprising of two crosses *viz*., IC342079 × IC4211962 and Arka Bahar × IC4211962 of bottle gourd each having two parents, F_1, F_2 and two backcrosses were laid out in a randomized block design with two replications during kharif season of 2023 at Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi district (Karnataka), India. The different parents used were IC342079, IC4211962 and Arka Bahar. Seeds were sown in rows spaced 3m with spacing of 90cm between plants. In each replication five plants in each parent, 10 plants in each back cross and F_1 hybrid and 50 plants in each F_2 were taken for study. The normal recommended cultural practices were adopted during experimentation. The characters studied were fruit length, fruit equatorial diameter, number of fruits per vine, average fruit weight, fruit yield per vine, number of seeds per fruit and hundred seed weight. The estimates of six genetic parameters namely mean (*m*), additive (*d*), dominance (*h*), additive × additive (*i*), additive × dominance (*j*) and dominance × dominance (*l*) were worked out by analysing and partitioning the means of all the six generations by adopting the methods proposed by Jinks and Jones (1958) as well as Hayman (1958).

RESULTS AND DISCUSSION

The estimates of gene effects of different yield traits are presented in Table 1.

Fruit length. In cross IC342079 × IC4211962, dominance gene effects was significant for this trait, among non-allelic interactions only additive × additive (*i*) was found significant. Duplicate type of epistasis was found to be operating. Whereas, Ram *et al*. (1997) reported significance of *h* and *l* in bitter gourd. Hence, it is appropriate to follow reciprocal recurrent selection. In cross Arka Bahar × IC4211962, additive and dominance gene effects were non-significant for this trait, among non-allelic interactions additive × dominance (*j*) and dominance × dominance (*l*) were found significant, along with duplicate type of epistasis. Hence, recurrent selection would be appropriate breeding method in improving the trait using this cross.

Fruit equatorial diameter. In cross IC342079 × IC4211962, both additive and dominance gene effects were significant. Among the epistatic interactions, additive × additive (*i*) and dominance x dominance (*l*) showed significance for the trait. The same signs of *h* and *l* indicated complementary type of non-allelic interaction. Hence, heterosis breeding or recurrent selection can be suggested for improvement of this trait. In cross Arka Bahar × IC4211962, only dominance type of gene effect was significant. Among the epistatic interactions, additive × additive (*i*) and additive x dominance (*j*) showed significance, The opposite signs of *h* and *l* revealed the operation of duplicate type of epistasis. Earlier Dineshkumar (2001) also reported dominance gene action and additive x additive and additive × dominance epistatic interactions for the trait in cucumber. Therefore, reciprocal recurrent would be fruitful for the improvement of the trait.

Number of fruits per vine. Number of fruits per vine is the most important yield component, which ultimately determines the productivity of the crop. All types of gene effects (allelic and non-allelic) were found non-significant in cross IC342079 × IC4211962. Heterosis breeding can be followed to improve the character and it is also important to use other genetic stocks for improvement of fruit number per vine, in Cross-I. Both additive and dominance gene effects were significant. Among the epistatic interactions, only additive × additive (*i*) was significant in cross Arka Bahar × IC4211962. The same signs of *h* and *l* indicated complementary type of non-allelic interaction. Earlier, Singh *et al*. (1976) also reported *d, h* and *i* epistatic interactions for the trait in muskmelon. Because of the presence of both additive and dominance gene effects along with presence of epistasis. Hence, heterosis breeding or recurrent selection proves beneficial for enhancing this trait.

Average fruit weight. Fruit weight is one of the key yield components, which is positively associated with yield. Hence, giving importance to the fruit weight would be useful for achieving useful results. Among all allelic and non-allelic gene effects only dominance × dominance (non-allelic) gene effect was significant in cross IC342079 × IC4211962 with duplicate epistasis. Hence, heterosis breeding or recurrent selection would be useful in achieving lines with higher fruit weight. In Arka Bahar × IC4211962, additive gene effect, additive × dominance and dominance × dominance type of non-allelic interactions were found significant along with duplicate type of epistasis. Earlier Singh *et al*. (1976) also reported *d, i* and *j* gene effects for the trait in muskmelon. Therefore, recurrent selection would be fruitful for the improvement of the trait.

Fruit yield per vine. Both additive and dominance gene effects were not significant. Among the epistatic interactions, only dominance × dominance (*l*) showed significance for the trait along with the duplicate type of epistasis in cross IC342079 × IC4211962. Therefore, employing breeding approaches like heterosis breeding or recurrent selection is advisable for enhancing this trait. In cross Arka Bahar × IC4211962, only additive × dominance (*j*) and dominance × dominance (*l*) type of non-allelic gene interactions were found significant. Duplicate type of epistasis was found operating. Therefore, recurrent selection would be fruitful for the improvement of the trait.

Number of seeds per fruit. In cross IC342079 × IC4211962, additive and dominance gene effect and additive × additive type of non-allelic gene interactions were significant along with duplicate type of epistasis. Because of the presence of both additive and dominance gene effects along with presence of epistasis, heterosis breeding or recurrent selection proves to be a beneficial strategy for improving this trait. In cross Arka Bahar × IC4211962 both additive and dominance gene effects were non-significant. Among the non-allelic interactions, only dominance × dominance was found significant. Duplicate type of epistasis was found to be operating. Hence, heterosis breeding or recurrent selection can be adopted for the improvement of the trait.

Hundred seed weight. Dominance gene effect was found significant. Among the non-allelic interaction, only dominance × dominance was significant along with the complementary type of epistasis in cross IC342079 × IC4211962. Therefore, heterosis breeding or recurrent selection would be beneficial in the improvement of trait. In cross Arka Bahar × IC4211962, additive gene effect was significant. Among the non-allelic interactions only dominance × dominance showed significance for the trait along with duplicate type of non-allelic interaction. Therefore, recurrent selection can be suggested for the improvement of the trait.

Table 1: Estimation of gene effects for different yield traits in two crosses of bottle gourd.

Sr. No	Character	Crosses	*m*	SE	*d*	SE	*h*	SE	*i*	SE	*j*	SE	*l*	SE	Type of epistasis
1.	Fruit length (cm)	C-I	22.77**	0.53	0.83^{NS}	1.79	-3.61*	4.31	-12.80*	4.17	3.00^{NS}	3.61	23.63^{NS}	7.81	D
		C-II	22.68*	0.82	0.65^{NS}	1.33	9.38^{NS}	4.34	8.05^{NS}	4.21	-6.18*	3.06	-7.78*	6.57	D
2.	Fruit equatorial diameter (cm)	C-I	13.06**	0.19	0.57*	0.52	-3.29*	1.34	-2.32*	1.29	2.95^{NS}	1.15	-5.53*	2.35	C
		C-II	14.25**	0.37	0.00^{NS}	0.49	-4.41*	1.85	-4.68*	1.78	-0.07*	1.24	2.17^{NS}	2.66	D
3.	Number of fruits per vine	C-I	8.36**	0.09	-1.05^{NS}	0.27	-1.14^{NS}	0.74	-4.14^{NS}	0.66	-1.10^{NS}	0.72	1.24^{NS}	1.33	D
		C-II	8.21**	0.10	0.15*	0.23	0.86*	0.67	0.46*	0.62	-1.60^{NS}	0.62	1.24^{NS}	1.15	C
4.	Average fruit weight (g)	C-I	455.90^{NS}	13.42	30.00^{NS}	61.14	369.90^{NS}	138.12	328.40^{NS}	133.53	138.00^{NS}	136.87	-673.40**	260.13	D
		C-II	526.33^{NS}	18.45	-48.40**	59.96	131.88^{NS}	150.87	141.48^{NS}	140.81	-130.00**	133.53	-229.08**	273.33	D
5.	Fruit yield per vine (kg)	C-I	3.61**	0.09	-1.19^{NS}	0.19	-1.06^{NS}	0.59	-2.26^{NS}	555.91	-1.93^{NS}	0.45	0.67*	0.97	D
		C-II	3.33**	0.11	-0.43^{NS}	0.49	3.75^{NS}	1.17	3.74^{NS}	1.08	-2.84*	1.08	-2.15*	2.22	D
6.	Number of seeds per fruit	C-I	419.15^{NS}	13.53	-1.10*	36.76	-76.30**	99.19	-29.20**	91.29	45.70^{NS}	90.16	144.20^{NS}	174.82	D
		C-II	409.74^{NS}	14.02	37.15^{NS}	45.35	109.84^{NS}	113.65	85.94^{NS}	106.63	179.00^{NS}	102.71	-103.64**	205.52	D
7.	Hundred seed weight (g)	C-I	18.16**	0.29	-0.45^{NS}	0.79	-0.64*	2.07	0.06^{NS}	1.95	1.60^{NS}	1.87	-2.36*	3.6	C
		C-II	17.80**	0.28	0.55*	0.88	2.10^{NS}	2.24	1.50^{NS}	2.07	1.00^{NS}	2.17	-2.80*	4.05	D

*Significant at 5% level C-I = Cross-I (IC342079 × IC4211962); SE = Standard error; C = Complementary type of epistasis
**Significant at 1% level; C-II = Cross-II (Arka Bahar × IC4211962); NS = Non-significant; D = duplicate type of epistasis
m = mean, *d* = additive, *h* = dominance, *i* = additive × additive, *j* = additive × dominance, *l* = dominance × dominance

CONCLUSIONS

Generation mean analysis and heterobeltiosis in conjunction with negligible inbreeding depression, revealed presence of fixable gene action with interactions for yield suggesting simple selection or pedigree selection. Traits showing complex inheritance can be improved through reciprocal recurrent selection or by intermating with in the population.

FUTURE SCOPE

— The best selected traits can be utilized for development of inbred or varieties
— Screening for downy mildew and fruit fly can be undertaken on inbred lines
— Molecular studies can be taken up for further confirmation of results and improvement of characters

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Conflict of interest. None.

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