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Research Article

GENETIC ANALYSIS IN MUSKMELON (*Cucumis melo* L.) USING NORTH CAROLINA MATING DESIGN

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Abstract- Before starting any breeding programme, it is there is need to know the inheritance of important economic characters. By studying the genetics of economic traits and the precise estimation of components of genetic variation, the convenient breeding strategy can be formulated for their improvement. The sixteen BIPs of two crosses, IC-274014 × Punjab Sunheri (Cross-I) and IC-274014 × MM-28 (Cross-II) were evaluated. For node at which first pistillate flower opens, the BIPS of Cross-I and Cross-II exhibited significant additive genetic variance while dominance variance was non-significant and average degree of dominance was less than one. In Cross-I, polar diameter of fruit showed significance at both additive genetic variance and dominance variance but additive genetic variance was more than twice of dominance variance. While in Cross-II, additive genetic variance was highly significant and dominance was non-significant and average degree of dominance was less than one. For equatorial diameter, additive genetic variance was significant and dominance variance was highly significant in Cross-II while additive genetic variance was highly significant and dominance variance was non-significant in Cross-I and average degree of dominance was less than one. In the characters where dominance variance is more than additive genetic variance the heterosis breeding can be suitable option for muskmelon improvement. However, in other cases where additive genetic variance is more than dominance variance along with high heritability, it can be fixed in the inbred lines and inbred lines can be utilized for making new hybrids. Therefore, the present investigation was aimed at the mode of inheritance of important horticultural traits in muskmelon by evaluating bi-parental progenies (BIPs) which were developed and statistically analyzed by North Carolina Design-III.

Keywords- Additive Variance, Bi-parental Progenies, Dominance Variance, Muskmelon.

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Introduction

Muskmelon (*Cucumis melo* L.) belongs to *Cucumis* genus and is a diploid species with 2n=2x=24 chromosomes. The centre of origin is probably East Africa [1]. In the world, total production of muskmelon is 29.23 m ton and area 12.6 lakh ha with an average productivity of 23.15 t ha^{-1}[2]. The important muskmelon producing countries are China followed by Turkey, Iran, Spain and USA. In India, it is cultivated in an area of 31.5 thousand ha with production of 6.45 lakh tonnes and the productivity is 20.48 t ha^{-1} [3]. In India, the major cultivation of muskmelon is done on riverbeds of Yamuna, Ganga and Narmada in the North and Kaveri, Krishna and Godavari in the South. In Punjab state, area under this crop is 3007 ha and production is 58056 metric tonnes with an average productivity of 19.30 t ha^{-1} [4]. It is a good source of Carbohydrates, Vitamins A, B and C and is mainly consumed as a dessert fruit.

The economic importance of the crop has stimulated the breeding work, which is aimed at the improvement of qualitative and quantitative characters. In the past, the nature of the mode of inheritance of horticultural traits had been reported by applying different biometrical techniques but the accurate information was lacking. The information from different sources of literature indicated that there was lack of genetic information regarding important economic traits. However, before starting any breeding programme it is pertinent to know the inheritance of important economic characteristics. By studying the genetics of economic traits and the precise estimation of components of genetic variation, the convenient breeding strategy can be formulated for their improvement. Keeping this in view, the present studies on inheritance of economic characteristics was envisaged by involving bi-parental progenies. As bi-parental mating design, especially North Carolina Design-III serves two purposes. It tends to increase genetic variation within a population and provides most precise estimate of additive and dominance components of genetic variation.

Materials and Methods

The present investigation was undertaken at the Vegetable Research Farm, Punjab Agricultural University, Ludhiana during the spring-summer seasons of 2008 and 2009. The bi-parental progenies (BIPs) were developed in the year 2008 by backcrossing the randomly sampled F_2 plants with parents which were designated as P_1 and P_2. For crossing, the F_2 plants were used as males and parents as females. The bi-parental progenies (BIPs) of the crosses thus raised were assessed in spring-summer season of 2009. This trial was laid out in a randomized complete block design (RCBD).

The standard packages of practices were followed for raising the crop [4]. Seedlings of BIPs were raised in polythene bags during February, 2009 and transplanting was done in the first week of March, 2009. In this study, bi-parental progenies of two crosses, IC- 274014 × Punjab Sunehri and IC-274014 × MM-28 were produced. The data of individual plants of each progeny were noted for days taken to first pistillate flower opening, number of fruits per vine, fruit weight (kg), total fruit yield per vine (kg), rind thickness (mm), flesh thickness (cm) and total soluble solids content (%). The statistical analysis was done as suggested by [5]. Expected genetic advance (%) of full sib families was calculated to further elaborate the results.

Results and Discussion

The analysis of variance (ANOVA) for North Carolina Design –III is presented in [Table-1] for crosses IC-274014 × Punjab Sunehri and cross IC-274014 × MM-28, respectively.

Table-1 *Analysis of variance of North Carolina Design –III in crosses IC- 274014 × Punjab Sunehri and IC-274014 × MM-28*

Source of variation	Degree of freedom	Node at which first pistillate flower opens		Polar diameter of fruit		Equatorial diameter of fruit		Flesh thickness		Vine length	
		cross IC-274014 × Punjab Sunehri	IC-274014 × MM-28	cross IC-274014 × Punjab Sunehri	IC-274014 × MM-28	cross IC-274014 × Punjab Sunehri	IC-274014 × MM-28	cross IC-274014 × Punjab Sunehri	IC-274014 × MM-28	cross IC-274014 × Punjab Sunehri	IC-274014 × MM-28
Tester	1	13.23	5.01	717.65	6.99	9.27	7.22	0.52	0.40	5.09	0.68
F_2 (S) (Additive)	7	1.08**	0.30*	5.46*	1.11**	1.01**	1.06*	0.04*	0.07	0.33**	0.12*
T×S (Dominance)	7	0.44	0.15	5.40*	0.29	0.58	1.38**	0.03	0.17*	0.38**	0.12*
Within FS families	32	0.21	0.12	1.72	0.25	0.27	0.40	0.01	0.06	0.09	0.04
TSS	47										

* Significant at 5% level ** Significant at 1% level

In respect of the node at which first pistillate flower opens in case of cross IC-274014 × Punjab Sunehri, variance due to sums was highly significant (1.08) the variance due to differences was non-significant (0.44). Similarly, in cross IC-274014 × MM-28, analysis of variance indicated that variance due to sums was significant (0.30) but variance due to differences was non-significant (0.15). For polar diameter of fruit, analysis of variance for cross IC- 274014 × Punjab Sunehri, analysis indicated that both variances due to the sums and differences were significant. In respect of cross IC-274014 × MM-28, variance due to sums was highly significant (1.11) but variance due to differences was non-significant (0.29) for this character. Since the equatorial diameter of fruit, analysis of variance of cross IC-274014 × Punjab Sunehri, variance due to sums was highly significant (1.01) but variance due differences were non-significant (0.58). Contrastingly, in case of cross IC-274014 × MM-28, variance due to sums was significant (1.06) whereas the variance due to differences was highly significant (1.38). The analysis of variance revealed that, cross IC-274014 × Punjab Sunehri displayed variance due to sums was significant (0.04) but variance due to differences was non-significant (0.03). Again, opposite to the above, cross IC-274014 × MM-28 showed the variance due to sums was non-significant (0.07) but variance due to differences was significant (0.17) for flesh thickness. For the character of vine length, analysis of variance for cross IC- 274014 × Punjab Sunehri, both variances due to the sums (0.33) and differences (0.38) were highly significant whereas in cross IC-274014 × MM-28, variances due to the sums (0.12) and differences (0.12) were significant. In respect of node at which first pistillate flower opens, data of cross IC-274014 × Punjab Sunehri [Table-2] showed that additive genetic variance was highly significant. The average degree of dominance was less than one (0.51). Similarly, in cross IC-274014 × MM-28, additive genetic variance was significant. The average degree of dominance was less than one (0.42). Variance due to dominance was significant for both the crosses. In cross IC-274014 × Punjab Sunehri, both additive genetic variance and dominance variance were significant, but the value of additive genetic variance (2.489) was more than double to that of dominance variance (1.226). The average degree of dominance was nearly one (0.99). The data of cross IC-274014 × MM-28 showed that the additive genetic variance was highly significant, but dominance variance was non-significant. The average degree of dominance was less than one (0.21) for the polar diameter of the fruit. Since the equatorial diameter of the fruit, in case of cross IC-274014 × Punjab Sunehri where the additive genetic variance was highly significant but variance due to dominance was non-significant. The additive genetic variance (0.491) was more than four times of dominance variance (0.104). The average degree of dominance was less than one (0.65). However, in case of cross IC-274014 × MM-28, additive genetic variance was significant and dominance variance was highly significant, but the value of additive genetic variance (0.438) was more than the dominance variance (0.326). The average degree of dominance was more than one (1.22). Results of flesh thickness in cross IC-274014 × Punjab Sunehri indicated that additive genetic variance was significant, but dominance variance was non-significant. The average degree of dominance was less than one (0.70). Same findings are reported by [6,7] for this character. However, in cross IC-274014 × MM-28, dominance variance was found significant, but the additive genetic variance was non-significant. The average degree of dominance was very high (3.55). The results of [8,9] have been confirmed by this study. In cross IC-274014 × Punjab Sunehri, where value of additive genetic variance and dominance variance were highly significant but the value of additive genetic variance (0.159) was more than the dominance variance (0.097) for vine length. The average degree of dominance was more than one (1.10). Additive gene effects were more important in comparison to non-additive gene effects in most of the cases. In cross IC-274014 × MM-28 21, additive genetic variance and dominance variance were significant, but the value of additive genetic variance (0.051) was higher than the dominance variance (0.027). The average degree of dominance was equal to one (1.02).

Table-2 *Components of variance, average degree of dominance, heritability and genetic advance obtained from North Carolina Design-III of crossesIC- 274014 × Punjab Sunehriand IC-274014 × MM-28*

Character	Additive genetic variance (σ^2_A)		Dominance variance (σ^2_D)		Environmental variance (σ^2_E)		Average degree of dominance		Heritability (%)		Genetic advance (%)	
	IC-274014 × Punjab Sunehri	IC-274014 × MM-28	IC- 274014 × Punjab Sunehri	IC-274014 × MM-28	IC- 274014 × Punjab Sunehri	IC-274014 × MM-28	IC-274014 × Punjab Sunehri	IC-274014 × MM-28	IC-274014 × Punjab Sunehri	IC-274014 × MM-28	IC-274014 × Punjab Sunehri	IC-274014 × MM-28
Node at which first pistillate flower opens	0.578**	0.121*	0.075	0.011	0.028	0.085	0.51	0.42	84.74	55.62	0.72	0.27
Polar diameter of fruit	2.489*	0.572**	1.226*	0.013	0.489	0.102	0.99	0.21	59.20	83.29	1.25	0.71
Equatorial diameter of fruit	0.491**	0.438*	0.104	0.326**	0.098	0.129	0.65	1.22	70.87	49.09	0.61	0.48
Flesh thickness	0.019*	0.006	0.005	0.038*	0.009	0.037	0.70	3.55	58.84	7.39	0.11	0.02
Vine length	0.159**	0.051*	0.097**	0.027*	0.001	0.012	1.10	1.02	62.06	56.47	0.32	0.17

* Significant at 5% level ** Significant at 1% level

Results pertaining to heritability and genetic advance for different characters are presented in [Table-2]. In cross IC-274014 × MM-28, heritability was moderate (55.62 per cent), genetic advance was 0.27 and expected mean value was 2.82. Cross IC- 274014 × Punjab Sunehri showed the high heritability value of 84.74 %, genetic advance was 0.72 and expected mean value was 2.81. The results corroborated the findings of [10] for node at which first pistillate flower opens. For polar diameter of the fruit, in case of cross IC- 274014 × Punjab Sunehri, estimated heritability was 59.20%, genetic advance was 1.25 and expected mean value was 15.94. However, in cross IC-274014 × MM-28, heritability value was very high (83.29%), genetic advance was 0.71 and expected mean value was 10.36. In cross IC- 274014 × Punjab Sunehri, heritability value was high (70.87%), genetic advance was 0.61 and expected mean value was 9.86. In cross IC-274014 × MM-28, heritability estimates was moderate (49.09%), genetic advance was 0.48 and expected mean value was 10.97 for the equatorial diameter of fruit (cm). In case of cross IC-274014 × Punjab Sunehri, results indicated that heritability value was moderate (58.84%), genetic advance was 0.11 and expected mean value was 2.15 for flesh thickness. In cross IC-274014 × MM-28, very low heritability (7.39 per cent) was estimated, genetic advance was 0.02 and expected mean value was 2.18. In cross IC- 274014 × Punjab Sunehri, heritability value was 62.06%, genetic advance was 0.32 and expected mean value was 2.08. In cross IC-274014 × MM-28, heritability had moderate value (56.47%), genetic advance was 0.17 and expected mean value was 1.71 for vine length.

Conclusions

In the characters where dominance variance is more than an additive genetic variance and where a degree of dominance is more than one the heterosis breeding can be suitable option of breeding for genetic improvement of muskmelon in terms of both qualitative and quantitative characters. In the characters like node at which first female flower opens, Polar diameter of fruit and equatorial diameter of the fruit. However, in other cases where an additive genetic variance is more than a dominance variance along with high heritability, it can be fixed in the inbred lines and inbred lines can be utilized for making new hybrids. The bi-parental progenies should be evaluated at multi-locations to assess their performance properly by minimizing the genotypic-environment interaction. The population improvement programme should be carried out to improve the economically important quantitative characters in this crop. In population improvement, undesirable linkages are needed to be broken, releasing potential genetic variability and forming new recombinants, which can be used in breeding programme of muskmelon.

Conflict of Interest: None declared

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