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Estimation of genetic components through biparental progenies in muskmelon (*Cucumis melo* L.)

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Abstract

Sixteen biparental progenies (BIPs) involving two crosses, IC- 274014 × Punjab Sunehri and IC-274014 × MM-28 developed by North Carolina Design III were evaluated in a Randomized Complete Block Design during 2009. The observations were recorded on days taken to first pistillate flower opening, total fruit yield per vine, number of fruits per vine, fruit weight, rind thickness, flesh thickness, and total soluble solids (TSS) content. Additive genetic variance was greater for days taken to first pistillate flower opening, total fruit yield per vine, number of fruits per vine and flesh thicknes in IC- 274014 × Punjab Sunehri and for number of fruits per vine, fruit weight, rind thickness and TSS content in IC-274014 × MM-28. Dominance variance was higher than additive genetic variance for total fruit yield per vine, fruit number per vine, fruit weight and rind thickness in cross IC-274014 × Punjab Sunehri, whereas dominance variance was higher for days to first female flower opening, total fruit yield per vine, fruit weight, rind thickness and flesh thicnkess in IC-274014 × MM-28. In cross IC- 274014 × Punjab Sunehri, for total fruit yield per vine, fruit weight, rind thickness and TSS content, degree of dominance was more than one along with low heritability and genetic advance. However, in the cross IC-274014 × MM-28, for days taken to first pistillate flower opening, total fruit yield per vine fruit weight, , rind thickness and TSS, degree of dominance was more than one along with low heritability and genetic advance.

Key words: *Biparental progenies, gene action, genetic advance, heritability, muskmelon*

Introduction

Muskmelon (*Cucumis melo* L.) is an important cucurbitaceous crop relished for its sweet taste and mainly consumed as a dessert fruit. In the world, total production of muskmelon is 31.25 million tonnes from an area of 12.90 lakh ha. The leading muskmelon producing countries are China, Iran, Turkey, Egypt, India, U.S.A and Spain. In India, it is cultivated on an area of about 39.72 thousand ha with a production of 8.13 lakh tonnes. In India, muskmelon is widely cultivated in Rajasthan, Punjab, West Bengal, Uttar Pradesh, Madhya Pradesh and Maharashtra (Anon 2011). However, in Punjab, area under this crop is 4.83 thousand ha and production 83.90 thousand tonnes with an average productivity of 17.37 tonnes ha^{-1} (Anon 2013).

The economic importance of the crop has stimulated the breeding work which is aimed at the improvement of qualitative and quantitative characteristics. In the past, nature and the mode of inheritance of horticultural traits had been studied by applying different biometrical techniques such as line × tester analysis (Dhaliwal and Lal 1996), diallel analysis (Choudhary 2006) and generation means analysis Zalapa *et al.* (2006) but the accurate information was lacking. Biparental mating design is one of the simplest random mating design available to effect forced recombination and breaking down undesirable linkages as pointed out by Comstock and Robinson (1952). Before starting any breeding programme it is right 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 appropriate breeding strategy can be formulated for their improvement. It is, therefore, important in choosing an appropriate breeding programme for improving yield in any crop.

Heritability provides an idea to the extent of genetic control for expression of a particular trait and the reliability of phenotype in predicting its breeding value (Tazeen *et al*, 2009). High heritability indicates less environmental influence in the observed variation (Songsri *et al*, 2008). It also gives an estimate of genetic advance a breeder can expect from selection applied to a population and help in deciding on what breeding method to choose (Hamdi *et al*, 2003). Genetic advance which estimates the degree of gain in a trait obtained under a given selection pressure is another important parameter that guides the breeder in choosing a selection programme (Shukla *et al*, 2004). High heritability and high genetic advance for a given trait

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indicates that it is governed by additive gene action and, therefore, provides the most effective condition for selection (Tazeen *et al*, 2009). The objectives of this study were to investigate components of genetic variation such as additive genetic variance and dominance variance which help in estimation of degree of dominance and heritability and genetic advance of different characteristics which is pre-requisite for suggesting an appropriate breeding strategy in this crop.

Material and Methods

The present investigation was undertaken at Vegetable Research Farm, Punjab Agricultural University, Ludhiana during the spring-summer seasons of 2008 and 2009. The biparental progenies (BIPs) were developed in year 2008 by backcrossing the randomly sampled F_2 plants with parents which were designated as P_1 and P_2 (Parents). For crossing, the F_2 plants were used as males and parents as females. The biparental progenies (BIPs) of the crosses thus raised were evaluated in spring-summer season of 2009. The experiment was laid out in a Randomized Complete Block Design (RBD). The standard packages of practices were followed for raising the crop (Anonymous, 2009). Seedlings of BIPs were raised in polythene bags during February, 2009 and transplanting was done in first week of March, 2009. In this study, biparental progenies of two crosses, IC-274014 × Punjab Sunehri and IC-274014 × MM-28 were produced. The data of individual plants of each progeny were recorded 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 Kearsey and Pooni (1996). Expected genetic advance (%) of full sib families was calculated to further elaborate the results.

Results and Discussion

Analysis of variance (ANOVA) for North Carolina Design III is presented in Table 1 for crosses IC- 274014 × Punjab Sunehri and IC-274014 × MM-28, respectively. For days taken to first pistillate flower opening, analysis of variance for cross IC-274014 × Punjab Sunehri indicated that variance due to sums (additive) was highly significant whereas variance due to differences (difference) was non-significant. However, in case of cross IC-274014 × MM-28 variance due to sums was non-significant while variance due to differences was significant. For the character number of fruits per vine in cross IC- 274014 × Punjab Sunehri analysis of variance showed that variances due to sums and differences were highly significant for this character. Contrary to the above, with respect to cross IC-274014 × MM-28 analysis of variance due to sums was significant but variance due to differences was non-significant. For fruit weight, analysis of variance in cross IC-274014 × Punjab Sunehri, variance due to sums was non-significant but variance due to differences was highly significant. However, in case of cross IC-274014 × MM-28, variance due to sums was highly significant and variance due to differences was significant for this character. For the character total fruit yield per vine, analysis of variance for cross IC-274014 × Punjab Sunehri analysis of variance indicated that both variances due to sums and differences were highly significant. Analysis of variance in cross IC-274014 × MM-28 revealed that variance due to sums was non-significant whereas variance due to differences was significant. For under rind thickness, analysis of variance for cross IC-274014 × Punjab Sunehri showed that variance of sums was non-significant but variance due to differences was significant. However, analysis of variance of cross IC-274014 × MM-28, indicated that variance due to sums was significant and variance due to differences was highly significant for rind thickness. In case of flesh thickness, the analysis of variance revealed that biparental progenies (BIP_S) of cross IC-274014 × Punjab Sunehri were significant for variance due to sums but non-significant for variance due to differences. Again, opposite to the above, BIP_S of cross IC-274014 × MM-28 showed that variance due to sums was non-significant but variance due to differences was significant. For TSS content in cross IC- 274014 × Punjab Sunehri, recorded non-significant variance due to sums but variance due to differences was highly significant. However in the cross IC-274014 × MM-28, both variances due to sums and differences were significant.

The genetic variation generated by Biparental progenies helps to estimate additive and non- additive components (Table 2). Regarding estimates of additive and dominance values, days taken to first pistillate flower opening which is an indication of earliness, the results of cross IC-274014 × Punjab Sunehri revealed that additive genetic variance was highly significant but dominance variance was non-significant. The average degree of dominance was less than one (0.40), heritability was high (87%) and genetic advance was 1.29 %. For same cross, inbred lines may be developed by selecting early types. Contrary to above, in case of cross IC-274014 × MM-28, dominance variance was found significant but additive genetic variance was non-significant. The average degree of dominance was more than one (1.81). The heritability (24.01%) and genetic advance was 0.54%. In this case, heterosis is present due to non-additive gene effects. These findings are in agreement with findings of Moon *et al*. 2004.

Cross IC- 274014 × Punjab Sunehri displayed that both additive genetic variance and dominance variance were highly significant but the value of additive genetic variance (0.103) was higher than the dominance variance (0.072) for the character total fruit yield per vine. The average degree of dominance was more than one (1.18). The heritability and genetic advance were 56.73% and 16.33%, respectively. In case of cross IC-274014 × MM-28, variance due to non-additive effects was found significant but variance due to additive effects was non-significant. The average degree of dominance was more than one (1.61). The heritability and genetic advance were 29.47% and 9.23%, respectively. In earlier studies, Singh *et al.* (1976) reported the evidence of dominance variance for this character in cross Hara Madhu × Early Gold. The results also corroborated the findings of Munshi and Verma (1998) and Moon *et al.* (2004). The component s of genetic variance in both crosses indicated presence of over dominance which exhibited the scope of heterosis breeding for increasing total fruit yield in muskmelon.

In case number of fruits per vine with respect to cross IC-274014 × Punjab Sunehri, both additive genetic variance and dominance variance were highly significant but the value of additive genetic variance was higher (0.251) than the value of dominance variance (0.080). The average degree of dominance was less than one (0.80). The heritability and genetic advance were 68.30%and 14.67%, respectively. However, in case of cross IC-274014 × MM-28, additive genetic variance was significant but dominance variance was non-significant. The average degree of dominance was less than one (0.25). The heritability and genetic advance were 67.22% and 16.60 %, respectively. Singh *et al.* (1976) and Zalapa *et al.* (2006) reported that additive component of variance was higher than dominance variance for number of fruits per vine.

In cross IC-274014 × Punjab Sunehri, dominance variance was found highly significant but additive genetic variance was non-significant for fruit weight. The average degree of dominance was more than one (1.73). The heritability and genetic advance were 29.95% and 6.45 %, respectively. In respect of cross IC-274014 × MM-28, additive genetic variance was highly significant while dominance variance was significant. The average degree of dominance was less than one (0.94). The heritability and genetic advance were 61.43% and 11.67%, respectively.

In respect of rind thickness, information obtained from BIPs of cross IC- 274014 × Punjab Sunehri revealed that dominance variance was found significant but additive genetic variance was non-significant. The average degree of dominance was more than one (2.63). The heritability (10.93 %) and genetic advance (2.02%) were very small. 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 (0.171) was more than the dominance variance (0.149). The average degree of dominance was more than one (1.32). The heritability and genetic advance were 45.29% and 10.36%, respectively. Over-dominance has been reported for this character in the past studies (Singh *et al.* 1990). Many studies in the past emphasised the heterosis breeding in muskmelon by exploiting non-additive genetic variance.

With respect to the flesh thickness in case of cross IC-274014 × Punjab Sunehri, it was revealed that additive genetic variance was significant but dominance variance was non-significant. The average degree of dominance was less than one (0.70). The heritability and genetic advance were 58.84% and 5.39%, respectively. Similar findings were reported by Chadha *et al.* (1972), and Munshi and Verma (1998) for this character. However in case of cross IC-274014 × MM-28, dominance variance was found significant but additive genetic variance was non-significant. The average degree of dominance was high (3.55). The heritability (7.39%) and genetic advance (0.93%) were very small. These results are in agreement with Singh *et al.* (1990) and Moon *et al.* (2004).

In case of total soluble solids (TSS) content, genetic variation obtained from biparental progenies of cross IC-274014 × Punjab Sunehri, it was inferred that dominance variance was highly significant but additive genetic variance was non-significant. The average degree of dominance was more than one (1.92). The heritability and genetic advance were 34.83% and 4.05%, respectively. Contrasting to above results, both additive genetic and dominance variance were significant in case of cross IC-274014 × MM-28 but the value of additive genetic variance (1.527) was more than twice to the value of dominance variance (0.640). The heritability and genetic advance were 64.66% and 12.06 %, respectively. The average degree of dominance was near to one (0.92). In the earlier studies, Singh *et al.* (1976) found that additive component of variance was high for TSS in cross Hara Madhu × Early Gold, whereas Chadha *et al*. (1972) and Munshi and Verma (1998) reported partial dominance for this character.

The predominance of dominance variance and average degree of dominance being more than one suggests the possibility of high yielding and superior F_1 hybrids. Therefore, the heterosis breeding remains suitable option of breeding for the characters such as number of fruits per vine, fruit weight, total fruit yield per vine, rind thickness and total soluble solids (TSS) content where F_1 hybrids are expected to give better performance than inbred lines. In this crop, both types

Table 1. Analyses of Variance of North Carolina Design-III in cross IC- 274014 x Punjab Sunehri and IC-274014 x MM-28

Source of variation	Degree of freedom	Days taken to first pistillate flower opening		Number of fruits per vine		Fruit weight		Total fruit yield per vine		Rind thickness		Flesh Thickness		TSS content	
		IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28
Tester	1	0.48	5.27	7.05	0.72	0.23	0.17	8.92	0.37	124.16	2.61	0.52	0.4	34.04	80.55
F_2 (S) (Additive)	7	3.35**	2.08	0.52**	0.50*	0.02	0.03**	0.22**	0.15	0.19	0.43*	0.04*	0.07	0.9	3.19*
(Dominance)	7	1.09	3.82*	0.38**	0.18	0.03*	0.02*	0.29**	0.25*	0.39*	0.62**	0.03	0.17*	2.27**	2.81*
Within FS families	32	0.65	1.32	0.14	0.16	0.01	0.01	0.07	0.08	0.15	0.17	0.01	0.06	0.4	0.89
TSS	47														

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

Table 2. Additive genetic variance, dominance variance, degree of dominance, heritability and genetic advance (%) of different characters in cross IC-274014 x Punjab Sunehri and IC-274014 x MM-28

Characters	Additive genetic variance (ó2A)		Dominance variance (ó2 D)		Environmental variance ($ó^2$E)		Average Degree of dominance		Heritability (%)		Genetic Advance (%)	
	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28	IC-274014 x Punjab Sunehri	IC-274014 x MM-28
Days taken to first female flower opening	1.805**	0.508	0.146	0.833*	0.123	0.774	0.4	1.81	87	24.01	1.29	0.54
Total fruit yield / vine (kg)	0.103**	0.043	0.072**	0.055*	0.006	0.047	1.18	1.61	56.73	29.47	16.33	9.23
Number of fruits / vine	0.251**	0.224*	0.080**	0.007	0.036	0.102	0.8	0.25	68.3	67.22	14.67	16.6
Fruit weight (kg)	0.004	0.007**	0.007**	0.003*	0.004	0.001	1.73	0.94	29.95	61.43	6.45	11.67
Rind thickness (mm)	0.023	0.171*	0.079*	0.149**	0.108	0.057	2.63	1.32	10.93	45.29	2.02	10.36
Flesh thickness (cm)	0.019*	0.006	0.005	0.038*	0.009	0.037	0.7	3.55	58.84	7.39	5.39	0.93
TSS content (%)	0.336	1.527*	0.621**	0.640*	0.006	0.194	1.92	0.92	34.83	64.66	4.05	12.06

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

of genetic variances were recorded in different magnitudes among different cross combinations. By adopting population improvement methods, superior inbred line can be developed after accumulating additive gene effects for different characters and high yielding possess high total soluble solids (TSS) inbred lines can be utilized to develop superior hybrids (Chahal and Gosal, 2002).

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