Inter-trait Relationship and Variability in Segregating Population of Muskmelon Derived from Intra-specific Cross for Total Soluble Solids and Yield

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Variability, character association, and path analysis were carried out in 599 individual plants of F_2 population derived from an intra-specific cross of *Cucumis melo* x *Cucumis melo* var. *Momordica*. The observations were recorded on nine horticultural traits *viz.* number of branches/plant, vine length (cm), number of fruits/plant, polar circumference and equatorial circumference of fruit (cm), flesh thickness (cm), fruit weight (kg), total soluble solid (%) and yield/plant (kg). The analysis of variance revealed remarkable variation within population for concerned characters. The maximum range of mean value was recorded in vine length and minimum in flesh thickness. Regression analysis revealed that number of fruits contribute maximum towards increase of fruit yield, followed by fruit weight and polar circumference of fruit. Yield has positive and significant association with all other characters except total soluble solids (TSS). Number of fruits had the highest direct effect on yield followed by fruit weight. Therefore, number of fruits and fruit weight should be considered during selection for yield. These populations will be converted into Recombinant Inbred Lines (RILs) by selfing following the Single Seed Decent (SSD) methods will be very useful to map the Quantitative Trait Loci (QTLs) for horticultural traits and TSS.

Key Words: Muskmelon, Phenotypic correlation, Regression analysis, TSS, Variability

Introduction

Muskmelon (*Cucumis melo* L.) is an important member of family Cucurbitaceae marketed and consumed as dessert all over the world. An intra-specific taxa *Cucumis melo* var. *momordica* Duthie & Fuller, commonly known as snapmelon or phoot consumed as vegetable and found only in Indian subcontinent. The morphological intra-specific variations were observed in genus *Cucumis* (Krikbride, 1993; Stepansky *et al*., 1999). The variation in morphological characters *i.e.*, growth habit, maturity, fruit shape flesh color and external skin texture of different botanical variety of *C. melo* in India as well as other part of world provide relatively broad phenotypic variation (Dhillon *et al*., 2007). In India, this group of melon has not been exploited in crop improvement programme as they have several desirable traits. Creation of variability in the cultivated melon by using the unexploited melon would be of great importance. Evaluation of variability is pre-requisite for planning the quality improvement programmes. Knowledge of the nature and magnitude of variation promotes a rational choice of the character in which selection can be exercised.

The regression analysis is useful for prediction of extent of contribution of other traits towards yield. The correlation and path analysis will establish the extent of association between yield and its contributing components and also bring out relative importance of their direct and indirect effects. The correlation of economic yield component with yield and the partitioning of the correlation coefficient into its component of direct and indirect effect have been extensively studied in individual crops. Highly significant associations of yield with contributing traits were studied by Chaudhary *et al.* (2003) in muskmelon and Pandey *et al.* (2003, 2005) in snapmelon and muskmelon. Therefore, an attempt was made to reveal direct and indirect influences of some important yield components on fruit yield in the segregating population through regression, correlation, path coefficient analysis and to know the extent of variability in F_2 population.

Materials and Methods

The study comprised of 599 F_2 population of melon generated from an intra-specific cross between cv. Kashi Madhu (*Cucumis melo*) and genotype B-159 (*Cucumis melo* var. *momordica*). Seeds of F_1 were selfed and advanced as F_2. Individual F_2 plants have been treated as an identical genotype (family). All F_2 lines have been planted at experimental block at Indian Institute of Vegetable Research (IIVR), maintaining a row to row and plant to plant spacing of 1.8 m × 0.8 m. Standard

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cultural practices were adopted to raise a healthy crop as recommendation of De *et al*. (2003).

The observation were recorded on individual plant for nine characters *viz*., number of branches/plant, vine length (cm), number of fruits/plant, polar circumference and equatorial circumference of fruit (cm), flesh thickness (cm), fruit weight (kg), total soluble solid (%) and yield/plant (kg). The data were analyzed for standard statistical procedure followed for estimating correlation and regression analysis and selection of best regression equation was done through backward elimination as per the procedure described by Mead *et al.* (1993). The analysis of descriptive statistics was done through statistical software SPSS 11 and regression, correlation and path through SPAR1.

Results and Discussion

Descriptive statistics of different characters under study were presented in Table 1. All characters were fitted on normal frequency distribution curve indicating that population was polymorphic for respective traits. An increase in yield and nutritional content of snakemelon has been obtained by utilizing intraspecific genetic variation of diverse melons (Pandey *et al*., 2010). The maximum range of variation was recorded in vine length followed by polar circumference and equatorial circumference of fruit and minimum range of variation was recorded in flesh thickness followed by fruit weight and TSS. On the basis of skewness and kurtosis was recorded maximum in yield plant followed by equatorial and polar circumference of fruit. It indicated that yield is complex traits and influenced by its contributed components. These results were in agreement to the findings of Pandey *et al*. (2005) and Singh (2008).

Regression analysis (Table 2) indicated increase in fruit yield due to increase in all the remaining eight characters. Average fruits weight was found to increase the yield to maximum level, followed by fruits number. The backward regression analysis was carried out to point out the contribution of independent variables to yield in linear fashion according to (Kempton and Fox, 1997).

Table 1. Descriptive statistics for yield and yield related traits of population

Variable	No. of branches /plant	Vine length (cm)	No. of fruits /plant	Polar circumference of fruit (cm)	Equatorial circumference of fruit (cm)	Flesh thickness (cm)	Fruit weight (kg)	TSS (%)	Yield/plant (kg)
Mean	4.100	270.785	2.425	56.399	33.059	2.414	1.420	2.870	3.366
Sum of square	10778	45754400.690	4795.000	2023171.640	678513.222	3651.380	1541.560	5072.420	11481.400
SD	1.088	55.360	1.457	14.036	6.314	0.514	0.746	0.480	2.801
Variance	1.183	3064.804	2.124	197.018	39.867	0.264	0.556	0.231	7.846
Minimum	2.000	123.000	1.00	24.000	15.000	1.000	0.200	2.000	0.200
Maximum	9.000	429.000	10.00	124.500	80.500	4.200	4.550	8.200	26.250
Skewnes	0.323	0.159	1.470	0.812	1.197	0.273	1.049	0.230	2.628
Kurtosis	3.450	3.029	5.785	4.445	8.336	3.066	4.403	2.746	14.530

Table 2. Regression analysis for yield related traits of muskmelon population

Variable	No. of branches /plant	Vine length (cm)	No. of fruits/ plant	Polar circumference of fruit (cm)	Equatorial circumference of fruit (cm)	Flesh thickness (cm)	Fruit weight (kg)	TSS (%)
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8
R^2	0.845	0.843	0.842	0.841	0.841	0.841	0.696	0.484
St. Error	18.191	18.95	22.235	23.747	25.650	36.278	40.438	47.792
F – value	266.989	287.353	395.909	447.716	523.162	1049.995	685.347	562.108
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Intercept	–1.681	–1.967	–2.066	–2.532	–2.572	–2.507	–5.340	0.1200
V_1	0.032	0.031	0.026	0.024	0.024	–	–	–
V_2	0.0003	0.0004	0.0004	0.0003	0.0003	–	–	–
V_3	1.387	1.392	1.395	1.402	1.402	1.409	1.442	1.338
V_4	–0.021	–0.019	–0.019	–0.020	–0.020	–0.021	0.092	–
V_5	–0.0109	–0.023	–0.023	–	–	–	–	–
V_6	0.0106	0.042	0.031	–0.024	–	–	–	–
V_7	2.709	2.654	2.649	2.574	2.566	2.561	–	–
V_8	–0.116	–0.113	–	–	–	–	–	–

Seven morphological and one quality traits *viz*., number of branches/plant, vine length, number of fruits/plant, polar circumference and equatorial circumference of fruit, flesh thickness, fruit weight, total soluble solid were able to explain variation up to nearly 85% in fruit yield (R^2 = 0.845). However, average fruit weight alone was able to explain 69% of total yield variation (R^2 = 0.696). The results indicated that above traits are important during selection.

The traits were significantly correlated with yield at the 1% level of significance (Table 3). Number of branches, vine length, polar and equatorial circumference of fruit, and number of fruits, flesh thickness and fruit weight showed higher correlation coefficient except TSS. Therefore, these characters should be considered while making selection for yield improvement. Most of the variables had positive significant association among themselves except number of fruits/plants had negative significant association with fruit weight and equatorial circumference of fruit. Kalloo *et al.* (1983), Pandey *et al.* (2005, 2009) observed similar results where yield was significantly and positively associated with the number of fruit, fruit weight, and number of branches and length of vine, which supports present findings.

The contribution of these characters was further analyzed by computing their direct and indirect effect on yield (Table 4). The findings revealed that fruits number had highest direct effect on yield followed by fruit weight. However, other yield contributing traits *i.e*., number of branches/plant, vine length, and flesh thickness provided a positive direct contribution to yield at low level. While highest negative direct effect on yield was exerted by polar and equatorial circumference of fruit and TSS. TSS showed negative direct effect on yield in spite of positive correlation with yield. Number of fruits/plant, fruit weight, and number of branches/plant, vine length, and flesh thickness contributed maximum positive indirect effect for all the characters, whereas, TSS, equatorial and polar circumference of fruit contributed negative indirect effects *via* all the characters to yield. These results were found in accordance to several other reports on melon and cucurbit crops Chaudhary *et al.* (2003), Kalloo *et al.* (1983) and Pandey *et al*. (2003, 2005, 2009).

Table 3. Inter-traits correlation coefficient for fruit yield and yield attributes in muskmelon

Characters	No. of branches / plants	Vine length (cm)	No. of fruits/ plant	Polar circumference of fruit (cm)	Equatorial circumference of fruit (cm)	Flesh thickness (cm)	Fruit weight (kg)	TSS (%)	Yield/plant (kg)
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9
V_1	–	0.1204**	0.230**	0.117**	0.074	0.072	0.110**	0.095*	0.240**
V_2	–	–	0.235**	0.170**	0.154**	0.143**	0.216**	0.059	0.308**
V_3	–	–	–	0.116**	–0.096*	–0.028	–0.072	–0.078	0.696**
V_4	–	–	–	–	0.547**	0.581**	0.830**	0.143**	0.376**
V_5	–	–	–	–	–	0.463**	0.594**	0.127**	0.246**
V_6	–	–	–	–	–	–	0.536**	0.189**	0.291**
V_7	–	–	–	–	–	–	–	0.162**	0.541**
V_8	–	–	–	–	–	–	–	–	0.021

*, **, Significant at 5% and 1% level of probability, respectively

Table 4. Direct (Diagonal) and indirect effects of independent traits on yield in muskmelon (phenotypic level)

Characters	No. of branches /plants	Vine length (cm)	No. of fruits/ plant	Polar-circumference of fruit (cm)	Equatorial circumference of fruit (cm)	Flesh thickness (cm)	Fruit weight (kg)	TSS (%)	Correlation with yield
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9
V_1	0.0123	0.0008	0.16663	–0.0124	–0.0018	0.0001	0.0795	–0.0019	0.240**
V_2	0.0015	0.0069	0.1701	–0.0180	–0.0038	0.0003	0.1560	–0.0012	0.308**
V_3	0.0028	0.0016	0.7219	0.0123	0.0024	–0.0001	–0.0523	0.0016	0.696**
V_4	0.0014	0.0012	–0.0842	–0.1055	–0.0135	0.0009	0.5595	–0.0029	0.376**
V_5	0.0009	0.0011	–0.0698	–0.0578	–0.0247	0.0009	0.4289	–0.0026	0.246**
V_6	0.0009	0.0010	–0.0208	–0.0509	–0.0114	0.0019	0.3875	–0.0038	0.291**
V_7	0.0014	0.0015	–0.0523	–0.0877	–0.0147	0.0010	0.7218	–0.0033	–0.541**
V_8	0.0012	0.0004	–0.0563	–0.0151	–0.0032	0.0004	0.1176	–0.0200	0.021

**, Significant at 5% level of probability; Residual effect: 0.1546

In the light of above finding it may be concluded that beside direct selection for fruit yield, other traits like the fruits number, polar circumference of fruit, fruit weight should also taken in consideration for improvement of yield in muskmelon. On the basis of regression analysis, number of fruits and fruit weight contribute maximum to increase the yield. The variation in TSS was very low in the population and had not contributed in yield. The results might be used to know the variation in the population, adopt the selection criteria in advance stage and increase the selection efficiency. These genomic resources may be further utilized for molecular mapping to detect the QTL for horticultural traits and TSS after regress phenotyping at different environment.

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