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HETEROSIS, POTANCE RATIO AND CORRELATIONS OF FLOWERING, VEGETATIVE AND FRUIT CHARACTERS IN EGYPTIAN MUSKMELON (*CUCUMIS MELO VAR. MELON* L.)

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Abstract

This study was carried out during the period from 2017 to 2020 . Four local inbred lines of muskmelon (*Cucumis melo* var. melon), 3MML9 (D/M Salam), 86E2143 (IPGR), Angar (Flemran co. French) and 3MML2 (D/M Salam) were used in this study. These cultivars were crossed in a half diallel fashion excluding reciprocals to produce the 6 first-generation hybrid seeds in the summer season of 2019. The seeds from the Four parents and Six F1 hybrids were evaluated in a field trial during the growing Spring season of 2020 at Kaha, Vegetable Research Farm, Qalubia governorate and the Station experimental farm of the Ismailia Research, Ismailia governorate, Egypt to determine their mean performance. The 6 hybrids were evaluated along with their parents to determine heterosis, potance ratio and correlation of flower characteristics (number of days from cultivation of open male, female flower and sex ratio), vegetative characteristics (stem length, number of branches/plant and number of Leafs/plant) and fruits crop (fruit weight, Fruit width, fruit length, fruit shape, flesh thickness, total soluble solids (TSS) and number of fruits/plant). The genotype results showed highly significant mean squares for most of the studied traits. Some crosses revealed highly significant and significant mid-parent and better-parent heterosis for many of the traits. The genetic study showed that correlation was positive between number of branches/plant with number of leaves/plant, sex ratio, number of fruits per plant, stem length after 80 days, TSS% and fruit weight. Also correlation was found between number of days from first male flower with number of days from first female flower. flesh thickness has highly correlation with fruit length and fruit weight. Correlation between sex ratio and most traits were highly significant. 3MML9 and Angarand its hybrid were the best value of most studied characters table 8, these results refer that these lines available to used at new breeding program to produce marketable hybrid.

Key Words: Melon, Heterosis, potance ratio and correlation.

Introduction

According to the International Code of Nomenclature for Cultivated Plants, *C. melo* divided into sixteen groups within two subspecies: *C. melo* ssp. *melo* and *C. melo* ssp. *Agrestis*, Sweet melons are put in in the groups of Cantalupensis, Reticulatus, and Inodorus that are in the sub species of *C. melo* ssp. *melo,* also the group of Makuwa that is in the subspecies of *C. melo* ssp. *Agrestis* (Burger *et al.,* 2010). Also, Munger and Robinson (1991) showed that yield and its components and flowering traits are of the important aims to vegetable breeders. Melon (*Cucumis melo*) is a cross-pollinated plant and an economically important crop species of the Curcubitaceae family which is divided into six cultivar groups: Cantalupensis, Inodorous, Flexuosus, Conomon, Chito-Dudaim and Momordica.

Mallick and Masui, (1986) reported that In Iran, some researchers of botany consider as the most important center of secondary diversity and localization of this plant. Melon world harvested area is about one million hectares and its production is about 25 million tons (FAO 2013).

Melon flower biology and sexual expression are important traits for breeding programs. Most of melon commercial cultivars belong to the andromonoecious sex type flowers and male, or staminate flowers, in the same plant and partly to the monoecious sex type (Wang *et al.,* 2007, Abdelmohsin and Pitrat 2008).

Uniform fruit shape size and excellent and high yield, quality are impotent characters for the release of superior melon varieties. Lippert and Hall (1982), Kultur *et al.,* (2001), Abdalla and Aboul-Nasr (2002), Taha *et al.,*

(2003) and Zalapa *et al.,* (2006-2008) reported that Yield is correlated with several characters such as, days to anthesis, fruit number, primary branch number and weight per plant and average weight per fruit. It is highly revel because of its flavor, refreshing and sweet taste effect. It is a good source of dietary fiber, vitamins and minerals. However, little work has carried out on improvement of the muskmelon crop. For any crop improvement program aimed at achieving a detailed knowledge of genetic variability and diversity of various quantitative characters, maximum productivity and their contribution to yield, is essential. Rukam *et al.,* (2008) showed that correlation studies help to find the degree of interrelationship among various traits and to evolve selection criteria for improvement.

Selim (2019) evaluated 36 hybrids with their parents for yield components, leaf area index, average fruit weight, fruit shape index, netting percentage, seed cavity diameter, flesh thickness and total soluble solids, The genotype results showed highly significant mean squares for most of the studied characters. Sherpa (2014) reported that heterosis provides a chance for achieving unique improvement in yield and its attributing traits in single generation that would be more difficult and time consuming with other conventional breeding approaches.

Heterosis for yield and its associated components has been reported in melon (Bohn and Davis 1957; Dhaliwal 1995; Lippert and Hall 1982; Lippert and Legg 1972). Phenomenon of heterosis has been utilized in many crops to exploit dominance variance through the production of hybrids (Cramer and Wehner, 1999). 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).

The present investigation represent an attempt to study the genetic behavior Potance ratio, Heterosis and correlation between some yield and quality traits in a set of four parents mated by half diallel crossing manner.

Materials and Methods

Plant Materials

The genetic materials used in the present investigation included four deferent genotypes of muskmelon (*Cucumis melo* L.) *viz*, 3MML9 (D/M Salam), 86E2143 (IPGR), Angar (Flemran co. French) and 3MML2 (D/M Salam) were used in this study. These genotypes were chosen because they have sufficient genetic diversity in their flowering, yield and fruit quality traits.

Individual plants from each genotype were selfed for four successive generations during summer and fall seasons of 2017 and 2018 to obtain inbred lines. These cultivars were crossed in a half diallel fashion excluding reciprocals to produce the 6 first-generation hybrid seeds in the summer season of 2019. The seeds from the Four parents andSix F1 hybrids were evaluated in a field trial during the growing Spring season of 2020 at Kaha, Vegetable Research Farm, Qalubia governorate and the Station experimental farm of the Ismailia Research, Ismailia governorate, Egypt.

Randomized complete block design with Three replicates were used in this study. The seeds of Four parents and Six hybrids were directly seeded, plants were spaced 75 cm apart in rows 3 m long and 1.5 m width. All the recommended package of practices was followed to get complete expression of traits under study. The observation were recorded on individual plants basis for flower characteristics (number of days from cultivation of open male, female flower and sex ratio), vegetative characteristics (stem length, number of branches/plant and number of Leafs/plant) and fruits crop (fruit weight, Fruit width, fruit length, fruit shape, flesh thickness, total soluble solid % and number of fruits/plant).

Statistical analysis

All obtained data from the two seasons were subjected to the statistical analysis according to Steel and Torrie (1960). The Least Significant Differences (LSD) was computed at the 5% level to compare the determined averages.

Genetic analysis

Potence ratio (P)

The relative potency of gene set (P) was used to determine the direction of dominance according to the formula:-

$$P = \frac{F1 - MP}{\frac{1}{2}(P2 - P1)} \text{ (Smith 1952)}$$

Where:-

F1= First generation mean.

P1 = Mean of the smaller parent.

P2 = Mean of the larger parent.

MP = Mid-parent value = 1/2 (P1 + P2)

The absence of dominance was assumed when the difference between the parents was significant and F1–MP was not significant. Complete dominance was assumed when potence ratio equaled to or did not differ from ± 1.0. Meanwhile, partial dominance was considered when potence ratio was between +1.0 and - 1.0, but was not equal to zero. Overdominance (heterosis) was assumed when potence ratio exceeded ± 1.0.

Heterosis

Heterosis based on the mid and high parent value was estimated according to the following equation:

Mid parent heterosis = $\frac{F1-MP}{MP}$ × 100 (Sinha and Khanna, 1975)

Where:-

MP = mean of the mid - parent.

F1= mean of the first hybrid generation

High parent heterosis = $\frac{F1-MP}{HP}$ × 100

Where:

HP: - Mean of the higher or better - parent.

Estimation of correlations

Correlation coefficients were worked out to determine the degree of association among the characters as well as yield. This was done according to the formula given by Al-Jibouri *et al*., (1958).

r (xy) = $\frac{Cov(xy)}{\sqrt{Var\,x \times Var\,y}}$

Where,

r (xy) = Correlation coefficient between characters x and y

Cov (xy) = Covariance of characters x and y

Var x = Variance of character x

Var y = Variance of character y

Test of significance of correlation was done by comparing the computed values against table 'r' values given by Fisher and Yates (1963).

Results and Discussion

Evaluation of melon genotypes for some horticultural characteristics

This study was conducted in a open field in two location at spring season of 2020. Ten melon genotypes 4 parents and 6 hybrids) were used in this study.

Stem length(cm)

Data obtained on the stem length (cm) of 4 melon inbred Lines, and 6 produced hybrids in two location at spring season of 2020 are presented in table 1. The results indicated that parent L3 was the highest of stem length in the two seasons (168.3 and 178.9 cm) respectively.

Table 1: Vegetative characteristics of melon genotypes in two locations at spring season of 2020.

Vegetative characteristics						
	Number of branches/plant 80		stem length (cm)80		Number of leaves/plant 80	
L1	4.1	4.7	129.1	139.8	91.2	93.9
L2	2.1	1.4	196.6	176.6	62.2	56.2
L3	4.3	4.3	168.3	178.9	92.8	98.8
L4	3.9	3.2	96.2	89.1	78.1	88.3
L1× L2	4.1	3.4	91.5	95.8	80.3	85.3
L1× L3	5.8	6.4	214.2	204.1	111.4	101.4
L1× L4	4.1	3.3	95.9	92.7	74	64.3
L2× L3	3.4	3	82.5	88.4	83.5	80
L2× L4	3.6	3.1	89.6	81.6	66.8	73.8
L3× L4	3.3	2.8	127.2	107.5	82.2	85.6
LSD	0.9	0.7	10.1	11.8	5.6	6.8

On the other hand, the results recorded that parent L4 was the lowest of stem length in the two seasons. The results revealed also that the hybrids (L1) × (L3) gave significantly highest of stem length compared with the other hybrids studied in both seasons (214.2 and 204.1 cm).

Number of branches (cm)

Data obtained on the number of branches of 10 melon genotypes. In two location at spring season of 2020 are presented in table 1. The results indicated that the parents L1 and L3 were significantly the highest of number of branches compared with the other parents in both seasons. hybrid (L1) × (L3) was significantly the highest in number of branches in both seasons (5.8 and 6.4) respectively. Zalapa *et al*., (2006-2008) reported that measure the primary branch number for any crop improvement program aimed at achieving maximum productivity.

Number of leaves/plant (cm^3)

Data obtained on the number of leaves/plant of 10melon genotypesin two location at spring season of 2020 are presented in table 1. The results revealed that the parents L1 and L3 were significantly the highest of number of leaves/plant compared with the other parents in both seasons. The results indicated also that the hybrids L1 × L3was significant differences between other hybrids of number of leaves/plant in both seasons (111.4 and 101.4 cm^3).

Sex ratio

Data obtained on the sex ratio of 4 melon inbred lines, 6 produced hybrids in two location at spring season of 2020 are presented in table 2. The results obtained cleared that the parent L3 gave the best sex ratio as

Table 2: Flowering characteristics of melon genotypes in in two location at spring season of 2020.

Flowering characteristics						
	sex ratio		number of days from first male flower		number of days from first female flower	
L1	6.6	4.3	48.3	41.9	56.6	59.5
L2	4.3	4.4	44	46.3	55.9	56.3
L3	3.4	3.1	34.6	33.6	48.3	42.3
L4	4.6	5.2	47.5	44.5	57.3	54.3
L1× L2	5.7	7.0	44.9	47.9	53.4	56.6
L1× L3	3.4	3.6	36.3	39.5	43.9	46.1
L1× L4	4.9	3.6	43.4	47.8	54.4	59.6
L2× L3	6.3	5.6	42.5	43.4	54.1	49.3
L2× L4	6.2	5.2	46.2	49.3	56.3	53.1
L3× L4	6.9	9.0	42.2	44.7	52.5	55.6
LSD	1.1	1.3	2.1	2.4	2.3	2.1

Number of days for first flower

compared with the other used parents in both seasons (2, 4 and 3.1) respectively. The results refer also that the hybrids (L1) × (L3) was significantly greater in sex ratio (from 3.4 and 3.6) respectively, as compared with the other hybrids in both seasons of study. Similar results were obtained by Wang *et al*., (2007), Abdelmohsin and Pitrat (2008) who refer that Most of melon commercial cultivars belong to the and romonoecious sex type flowers and male, or staminate flowers, in the same plant and partly to the monoecious sex type.

Data obtained on the number of days for first flower (male and female) of 10 melon genotypes (4 inbred lines and 6 produced hybrids) in two location at spring season of 2020 are presented in table 2. The results obtained cleared that the parent L3 gave the best results in both seasons for appear first male (34.6 and 33.6 days) and female (48.3 and 42.3 days) flower respectively. The results refer also that the hybrids (L1) × (L3) was significantly greater in number of days for first flower male (36.3 and 39.5 days) and female (43.9 and 43.1 days) flower respectively, as compared with the other hybrids in both seasons of study. Similar results were obtained by Dandan *et al*., (2019) which reported that Sex determination is a research hotspot associated with yield and quality, and the genes involved are highly orthologous and conserved in cucurbits.

Fruit length (cm)

Data obtained on the fruit length are presented in table 3. The results obtained in two location at spring season of 2020 showed that the L1 gave the highest significant fruit length in both seasons (39.3 and 37.2cm, respectively) with significant difference between the other inbred lines at two seasons. On the contrast, L2 and L3 was the shortest in fruit length on both season. The data showed also that hybrid L1×L4 (which combine between higher two parents) have the lengthiest fruit length in both seasons (35.1 and 38.2 cm, respectively).

Fruit width

Data obtained on the fruit width of 10 melon genotypes in table 3. Data showed that only lines L1 and L2h values above 12 cm of width with values (13.2 and 14.2 cm) and (12.1 and 13.4 cm) respectively, without significant differences between them at in two location. The data showed also that hybrid L1×L3 have the high width fruit in both seasons (14.5 and 13.2 cm, respectively).

Fruit shape index

Data obtained on fruit shape index are presented in table 3. The results showed that all genotypes had the long of shape index, they values were over 2.5. Only L2

Table 3: Fruit characteristics of melon genotypes in in two location at spring season of 2020.

Fruit characteristics														
	Fruit shape index		Fruit length (cm)		Flesh thickness(cm)		TSS		Fruit width (cm)		Fruit weight (g)		Number of fruits/plant	
L1	3.0	2.6	39.3	37.2	2.9	2.6	2.2	2.7	13.2	14.2	1234.3	1315.3	2.2	2.8
L2	1.4	1.3	18.3	16.2	2.5	2.7	1.5	1.9	13.4	12.1	1241.8	1151.8	1.5	2.1
L3	1.5	1.5	18	15.9	2.9	3.4	4.3	4.9	11.7	10.9	1062.6	1076	4.3	3.9
L4	2.5	2.5	28.3	25.2	2.7	2.5	1.8	2.8	11.3	9.9	1011	1231.3	1.8	2.3
L1× L2	3.1	2.6	27.4	24.9	2.9	2.5	4.3	5.3	8.9	9.6	1438.2	1334.1	4.3	5.3
L1× L3	2.0	2.1	28.4	27.3	2.9	3.5	6.5	6.9	14.5	13.2	1657	1467.5	6.7	5.9
L1× L4	3.7	3.4	35.1	38.2	3.3	3.7	2	2.9	9.4	11.4	1235.2	1367.7	2	2.5
L2× L3	2.7	2.2	25.2	23.1	2.8	3.1	2.3	2.6	9.3	10.7	1159.4	1239.2	2.3	2.7
L2× L4	2.6	2.0	21	18.9	2.7	2.9	1.8	2.8	8.1	9.3	1124.3	1030.4	1.8	2.4
L3× L4	3.3	3.4	28.7	26.6	2.9	2.6	2.9	3.9	8.7	7.8	1558.4	1437.4	2.9	2.2
lsd	0.5	0.4	2.4	2.4	0.7	0.8	0.5	0.7	2.8	2.3	128.1	198.7	0.5	0.4

had round shape, this referred that the genetic of this shape is no dominance of this shape.

Arak (2011) Showed that the melon fruit shape is key important quantitative trait closely related to the fruit quality.

Fruit weight (g)

Data obtained on fruit weight are presented in table 3. It is clear that the values of all genotypes of fruit weight were over 1000 gm.

TSS %

Data obtained on the number of branches of 10 melon genotypes. In two location at spring season of 2020 are presented in table 3. The results indicated that the parent L3 was significantly the highest of TSS % compared with the other parents in both seasons. hybrid (L1) × (L3) was significantly the highest in TSS% in both seasons (5.8 and 6.4) respectively.

Number of fruits/plant

Data obtained on number of fruits/plant of 10 melon genotypes in table 3. Data showed that only line L3 the highest of number of fruits/plant with values (4.3 and 3.9) respectively, with significant differences between them at in two location. The data showed also that hybrid L1×L3 have the high number of fruits/plant in both seasons (6.7 and 5.9, respectively).

Genetic studies

Number of branches/plant

The results indicated that the potence ratio at 4 produced hybrids were negative (two were over and two were partial) this refer to dominance at this character towards the low parents, 2 of hybrids were positive refer to partial dominance toward the higher parents. The best hybrid (L1×L2 and L2×L3) were the higher than the other hybrids in the best parent heterosis value (15% and 48%). The hybrids (L1×L2 and L2×L3) were the higher mid parent hetrosis (33% and 43%) respectively. These results agreement with Abd Rabou (2008) which found the positive potence ratio was (0.65) which indicated partial dominance of fruit weight character towards the heavy fruit parent. Also, Ragab (1984) and Li-Jian *et al.,* (1995) reported in their studies that the partial dominance case was noticed for the heavy fruit over light. Mid-parent heterosis had positive value (11.9%) but high-parent heterosis had negative value (-5.63%).

Number of fruits/plant

The results indicated that the potence ratio at L1×L4 and L2×L3 were higher than 1, referring to over dominance at this character towards the high parent on the other hand, the value of potance ratio of L1×L2 refer to over dominance towards the high parent. The mid parent heterosis values of most hybrids were positive and ranged from (2 and 32 %), on the other hand, the high parent heterosis values of hybrids which contain L4 were negative.

Stem length

The results also indicated that the potence ratio at 5 of produced hybrids refer to dominance (over and partial) at this character towards the lower parent, only L2×L3 refer to over dominance towards the higher parent. Also the best and mid parent heterosis values of these hybrids were negative. only L2×L3 was the positive value.

Number of leaves/plant

The results indicated that the potence ratio at L2×L4 was higher than 1, referring to over dominance at this character towards the high parent on the other hand, the value of potance ratio of L1×L3 and L2×L4 were lower than (-1) refer to over dominance towards the low parents. The mid parent heterosis values of most hybrids were positive from (2 and 32 %), on the other hand, the high parent heterosis values of hybrids which contain L4 were negative.

Sex ratio

The results indicated that the potence ratio at all

Table 4: Mid parent and better parent Heterosis and potence ratio for some vegetative characteristics in F1 melon crosses.

Geno-types	Number of branches/plant 80			Number of fruits/plant			stem length (cm) 80			Number of leaves/plant 80		
	BPH	MPH	P	BPH	MPH	P	BPH	MPH	P	BPH	MPH	P
L1× L2	0.15	0.33	-0.88	0.17	0.08	-1.01	-0.16	-0.12	-3.00	0.19	-0.08	0.34
L1× L3	-0.36	-0.26	-1.80	0.33	-0.04	-0.10	-0.40	-0.20	-0.59	-0.13	-0.09	-1.53
L1× L4	-0.26	0.13	0.24	-0.96	0.32	7.25	-0.31	-0.19	-1.04	-0.09	0.14	0.55
L2× L3	0.48	0.43	-11.60	0.54	0.05	3.15	0.14	0.28	2.29	0.13	0.16	6.18
L2× L4	-0.29	-0.15	-0.85	-0.08	0.02	0.20	-0.34	-0.19	-0.86	-0.21	-0.19	-6.16
L3× L4	-0.31	0.04	0.08	-0.46	-0.20	-0.41	-0.51	-0.36	-1.20	-0.19	0.03	0.12

MPH= Mid parent heterosis, BPH=Better parent heterosis and P = Potence ratio.

Table 5: Mid parent and better parent Heterosis and potence ratio for some flower characteristics in F1 melon crosses.

Geno-types	Number of days from first male flower			Number of days from first female flower			Sex ratio		
	BPH	MPH	P	BPH	MPH	P	BPH	MPH	P
L1× L2	-0.03	-0.09	-1.41	0.00	-0.01	0.73	-0.49	-0.39	-1.98
L1× L3	0.08	-0.02	-0.21	0.09	-0.01	0.08	-0.63	-0.45	-0.93
L1× L4	0.15	-0.03	-0.21	-0.04	-0.05	7.80	-0.66	-0.57	-2.06
L2× L3	-0.06	-0.07	-7.55	-0.09	-0.16	2.07	-0.17	-0.13	-2.79
L2× L4	0.13	0.01	0.14	-0.03	-0.04	5.83	-0.63	-0.47	-1.06
L3× L4	0.07	-0.09	-0.60	0.12	0.04	-0.54	-0.60	-0.48	-1.50

MPH = Mid parent heterosis, BPH = Better parent heterosis and P = Potence ratio.

hybrids refer to over dominance towards the lower parent, only L1×L3 referring to partitial dominance towards the lower parent. Also the best and mid parent heterosis values of all hybrids were negative.

These results are very important to continuo the breeding program to earliest hybrid.

Number of days for first female flower

The results indicated that the potence ratio at all hybrids refer to over dominance towards the higher parent, only L3×L4 referring to partitial dominance towards the lower parent. On contrast, the mid parent heterosis values of all hybrids were negative except L3×L4 was positive. On the other hand, the value of best parent heterosis were between (-9 to 12%).

Number of days for first male flower

The results indicated that the potence ratio at all hybrids refer to over dominance towards the lower parent, only L2×L4 referring to partial dominance towards the higher parent. Also, the mid parent heterosis values of all hybrids were negative except L2×L4 was positive. On the other hand, most values of best parent heterosis were positive except L1×L4 and L2×L4.

Fruit weight

The results indicated that the potence ratio at 5 of produced hybrids were negative, these values refer to dominance of this character towards the light parent, one of these hybrids (L2×L4) has partial dominance towards the heavy parent. The most of mid parent heterosis values of hybrids were average between positive and ranging from (-6 and 41 %). The hybrids L1×L2 and L2×L3 have high parent heterosis values of all hybrids (66 and 44%), on the other hand, the others hetrosis values of remind hybrids were negative.

Fruit length

The results indicated that the potence ratio at 2 of produced hybrids were positive refer to dominance (over and partial) at this character towards the length parent, 4 of hybrids were negative refer to dominance (over and partial) toward the short parents. Only (L2×L4) hasnegative value at best parent heterosis (-0.33), the other values of best parent heterosis were positive.

These results agree with Kirkbride, (1993) which reported that melon fruits vary in size and shape but most varieties have round fruits, about 8-10 cm in diameter. The morphology of melon is remarkably stable for some characters of particular organs, but for others characteristics of the same organ the morphology of the same organ can be highly variable.

Fruit width

The results indicated that the potence ratio at 3 of produced hybrids were lower than -1 referring to over dominance at this character towards the lower parent, the value of two of produced hybrids were positive (0.33 and 0.14) referring to partial dominance at this character towards the higher parent. The mid parent heterosis values of 4 hybrids ranged from (2 and 10 %), also the high parent heterosis values of 4 hybrids were ranging from (18 and 28%), on the

Total soluble solid

The results indicated that the potence ratio at most hybrids refer to over dominance towards the lower tss parent, only L2×L3 and L2×L4 referring to over

Table 6: Mid parent and better parent Heterosis and potence ratio for some fruit characteristics in F1 melon crosses.

Geno-types	Fruit weight (g)			Fruit width (cm)			tss			Flesh thickness(cm)			Fruit length (cm)		
	BPH	MPH	P	BPH	MPH	P	BPH	MPH	P	BPH	MPH	P	BPH	MPH	P
L1× L2	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
L1× L3	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23
L1× L4	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33
L2× L3	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
L2× L4	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
L3× L4	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28

MPH = Mid parent heterosis, BPH = Better parent heterosis and P = Potence ratio.

Table 7: Correlation coefficients among number of branches/plant and other related characters in melon.

	No. of days from first male flower	No. of days from first female flower	Flesh thic-ken	No. of leaves /plant	fruit length	sex ratio	No. of fruits per plant	stem length after 80 days	TSS	fruit wei-ght t(g)	fruit width
number of branches/plant	-0.71	-0.74	0.35	0.76*	0.10	0.54*	0.77*	0.78*	0.54*	0.74*	0.1515
number of days from first male flower		0.68*	-0.29	-0.81	-0.18	-0.56	-0.69	-0.74	-0.51	-0.67	-0.10
number of days from first female flower			-0.23	-0.69	-0.10	-0.60	-0.75	-0.78	-0.71	-0.61	-0.04
flesh thickne				0.22	0.41*	0.30	0.39	0.38	-0.03	0.43*	0.29
number of leaves/plant					0.07	0.65*	0.81*	0.82*	0.56*	0.50*	-0.02
fruit length						-0.02	0.06	0.02	-0.18	0.46*	0.61*
sex ratio							0.58*	0.81*	0.49*	0.47*	-0.15
number of fruits per plant								0.80*	0.51*	0.55*	0.01
stem length after 80 days									0.61*	0.63*	-0.12
TSS										0.31	-0.14
fruit width											0.36

Table 7: Average studied characters of L1, L2 and L1× L3 at two locations.

Genotypes	stem length after 80 days	number of branches/plant	number of leaves/plant	number of days from first male flower	number of days from first female flower	sex ratio	number of fruits per plant	fruit width	fruit length	Fruit shape index	Flesh thicken	fruit weight	TSS
L1	134.45	4.4	92.55	45.1	58.05	5.45	2.5	13.7	38.25	2.8	2.75	1274.8	2.45
L3	173.6	4.3	95.8	34.1	45.3	3.25	4.1	11.3	16.95	1.5	3.15	1069.3	4.6
L1× L3	209.15	6.1	106.4	37.9	45	3.5	6.3	13.85	27.85	2.05	3.2	1562.3	6.7

dominance towards the higher parent. The most of mid parent heterosis values of hybrids were average between positive and ranging from (-8 and 44 %). On the other hand, the value of best parent heterosis were between (-14 to 26%).

Flesh thickness (cm)

The results indicated that the potence ratio at 4 hybrids refer to over dominance towards the higher parent, only L1×L3 and L3×L4 referring to partial dominance towards the lower parent. The most of mid and parent heterosis values of hybrids were average between positive.

These results agreement with Arak (2011) studied six generations (P1, P2, F1, F2, BC1 P1 and BC1 P2) of melon and reported that heterosis was observed for fruit weight (31.61%), fruit length (22.64%), fruit diameter (11.23%), fruit shape index (10.03%) and total soluble solid (6.86%). Heterobeltiosis was obtained from positive heterosis which results as 17.02% for fruit length, 14.95% for fruit weight and 9.89% for fruit shape index.

Correlation

Correlation levels were computed for all the 9 characters. The results are presented in table 3.

Number of branches / plant

Showed positive and highly significant correlation with Number of leaves/plant (0.76), sex ratio (0.54), number of fruits per plant (0.77), stem length after 80 days (0.78), TSS (0.54) and fruit weight (g) (0.74) whereas no significant correlation was observed with all other characters.

Number of days from first male flower

No significant correlation was observed between number of days from first male flower and all other characters except number of days from first female flower showed positive and highly significant correlation with number of days from first male flower.

Number of days from first female flower

No significant correlation was observed between number of days from first male flower and all other characters.

Flesh thickness

No. of female flowers showed positive and highly significant correlation with fruit length (cm) (0.41) and fruit weight (g) (0.43), while all other characters showed no significant with number of female flowers.

Number of leaves/plant

A significantly correlation level was observed between number of leaves/plant with sex ratio (0.65), number of fruits per plant (0.81), stem length after 80 days (0.82), TSS (0.56) and fruit weight (g) (0.50), other characters showed no significant with number of leaves/ plant.

Fruit length (cm)

A significantly positive correlation level was observed for fruit length (cm) with fruit weight (g) (0.46) and fruit width (0.61).

Sex ratio

A significantly positive correlation level was observed for sex ratio with number of fruits per plant (0.58), TSS (0.49) and fruit weight (g) (0.47) but it was highly significant with stem length after 80 days (0.81).

Number of fruits per plant

The results refer to significant positive correlation level between number of fruits per plant and stem length after 80 days (0.80), TSS (0.51) and fruit weight (g) (0.55).

Stem length after 80 days

A significantly positive correlation level was observed for stem length after 80 days with TSS (0.61) and fruit weight (g) (0.63).

These results agreement with Arak (2011) studied six generations (P1, P2, F1, F2, BC1 P1 and BC1 P2) of melon and reported that a highly significant correlation was detected between fruit weight, fruit length, fruit diameter, fruit shape index and fruit flesh thickness.

Hector *et al.,* (2008) refer that regardless, the future for improvement of melon germplasm is bright when considering the knowledge base for both techniques and gene pools potentially useable for melon improvement.

As a conclusion, the used genotypes differed in significance indicating the presence of genetic differences among them. L1 and L3 and its hybrid were the best value of most studied characters table 8, these results refer that these lines available to used at new breeding program to produce marketable hybrid.

References

Abd Rabou, A.M. (2008). Biotechnological studies on cucumber plants. Ph. D. Thesis, Fac. Agric. Cairo University, Egypt.

Abdalla, A.M.A. and M.H. Aboul-Nasr (2002). Estimation of heterosis for yield and other economical characters of melon (*Cucumis melo* L.) in Upper Egypt. In: Proceedings of Cucurbitaceae Maynard DN (ed). , Naples, Florida, 11-16.

Abdelmohsin, M.E. and M. Pitrat (2008). Pleiotropic effect of sex expression on fruit shape in melon. In Pitrat M (ed.). Proceedings of the IXth EUCARPIA meeting on genetics and breeding of cucurbitaceae. INRA, Avignon, p. 551-555.

Arak Tira-Umphon (2011). Genetic Variability of Fruit Characteristics between Thai Melon (Cucumis melo var. conomon) and Cantaloupe (*Cucumis melo* L. var. cantalupensis) *Hybrids. Agricultural Sci. J.,* **42(3/1):** 211-214.

Bohn, G.W. and G.N. Davis (1957). Earliness in F1 hybrid muskmelons and their parent varieties. *Hilgardia,* **26:** 453–471.

Burger, Y., H.S. Paris, R. Cohen, N. Katzir, Y. Tadmor, E. Lewinsohn and A.A. Schaffer (2010). Genetic diversity of cucumis melo. *Hort. Rev.,* **36:** 165–198.

Cramer, C.S., T.C. Wehner and S.B. Donaghy (1999). Path SAS: A SAS computer program for path coefficient analysis of quantitativedata. *J. Heredity,* **90:** 260–262.

Dandan, Li., Yunyan Sheng, Huanhuan Niu and Li. Zheng (2019). Gene Interactions Regulating Sex Determination in Cucurbits. *Front Plant Sci.,* **10:** 1231.

Dhaliwal, M.S. (1995). A combining ability study in muskmelon using line 9 tester analysis. *Cucurbit. Genet. Coop Rpt.,* **18:** 34–36.

FAO (Food and Agriculture Organization) (2013). Database FAOSTAT. Available at [http://faostat.fao.org]. Accessed March 30, 2013.

Fisher, G. and M. Yates (1963). Statistical Tables for Biological, *Agricultural and Medical Research,* **6:** 62-63.

Hamdi, A., A.A. El-Chareib, S.A. Shafey and M.A.M. Ibrahim (2003). Genetic variability, heritability and expected genetic advance for earliness and seed yield from selections in *Hortic. Sci.,* **107:** 217—221.

Hector, G., Nuñez-Palenius, Miguel Gómez Lim, Neftalí Ochoa-Alejo and Rebecca Grumet (2008). Melon Fruits: Genetic Diversity, Physiology and Biotechnology Features. *Critical Reviews in Biotechnology,* **28(1):** 13-55.

Kirkbride, J.H. (1993). Biosystematic Monograph of the Genus Cucumis (Cucurbitaceae). Parkway Publishers, North Carolina.

Kultur, F., H.C. Harrison, J.E. Staub and J.P. Palta (2001). Spacing and genotype effects on fruit sugar concentration and yield of muskmelon. *Hort. Science,* **36:** 274-278.

Li-Jian, W., J.W. Li and Z.D. Wei (1995). Genetic analysis for major agronomic characters in cucumber (*Cucumis sativus* L.). *Acta-Horticulturae,* **402:** 388-391.

Lippert, F.L. and P.D. Legg (1972). Diallel analysis for yield and maturity characteristics in muskmelon cultivars. *Journal American Society Horticulture Science,* **97:** 87-90.

Lippert, L.F. and M.O. Hall (1982). Heritabilities and correlations in muskmelon from parent offspring regression analyses. J. Am. Soc.

Mallick, M.F.R. and M. Masui (1986). Origin distribution and taxonomy of melons. *Scientia Horticulturae*, **28:** 252-261.

Munger, H.M. and R.W. Robinson (1991). Nomenclature of *Cucumis melo* L. *Cucurbit Genet. Coop. Rpt.,* **14:** 43-44.

Ragab, M.A.E. (1984). Studies on the inheritance of some economic characters in cucumber (*Cucumis sativus* L.). Ph. D. Thesis Fac. Agric. Mansoura University. Egypt.

Rukam S. Tomar1, G.U. Kulkarni and D.K. Kakade (2008). Main Vegetable Research Station. Anand Agricultural University 112-118.

Selim M.A.M. (2019). Heterosis and combining ability for some fruit quality traits of egyptian melon inbred lines using line × tester analysis. *Egypt. J. Agric. Res.,* **97(1):** 317-342.

Sherpa, P., T. Seth, V.D. Shende, N. Pandiarana, S. Mukherjee and A. Chattopadhyay (2014). Heterosis, dominance estimate and genetic control of yield and post-harvest quality traits of tomato. *Journal of Applied and Natural Science,* **6:** 625–32.

Sinha, S.K. and R. Khanna (1975). Physiological, biochemical and genetic basisof heterosis. *Adv. Agron.,* **27:** 123-174.

Smith, H.H. (1952). Fixing transgressive vigor in Nicotiana rustica. pp. 161-174. J.W. Gowen (ed.), Heterosis, Iowa State Coll., Ames, Iowa.

Steel, R.G.D. and J.H. Torrie (1960). Principles and Procedures of Statistics with Special Reference to the Biological Sciences. Mc Graw Hill Book Company. Inc. New york.

Taha, M., K. Omara and A. El Jack (2003). Correlation among growth, yield, and quality characters in *Cucumis melo* L. *Cucurbit Genet. Coop. Rpt.,* **26:** 9-11.

Wang, Y.H., T. Joobeur, R.A. Dean and J.E. Staub (2007). Cucurbits. In Kole C (ed.) *Genome mapping and molecular breeding in plants,* **5:** – Vegetables. Springer-Verlag, Berlin- Heidelberg, p. 315-329.

Zalapa, J.E., J.E. Staub and J.D. McCreight (2008). Variance component analysis of plant architectural traits and fruit yield in melon (*Cucumis melo* L.). *Euphytica,* **162:** 129–143.

Zalapa, J.E., J.E. Staub and J. McCreight (2006). Detection of environmentally-independent QTL for yield-related traits using a recombinant inbred line population derived from exotic melon germplasm and Topmark. Theor. *Theoretical and Applied Genetics,* **114(7):** 1185-201.