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Heterotic Performance and Gene Action for Yield, Yield Components and Resistance to the Two –Spotted Spider Mite in Cucumber

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ABSTRACT

Nine accessions of cucumber and Beta alpha cultivars from North Central Regional Plant Introduction Station (USDA) *viz*, PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26) , PI 169392 (20) ,Beta-alpha (B), PI 178885 (2), PI 218036 (3) and PI 390238 (4) as well as their twenty one F_1 hybrids in a line × tester meeting design were used in the present study to estimate heterosis percentage (relative to both mid and better parents), potence ratio and combining ability (general and specific) data were recorded for some characters in cucumber (*Cucumis sativus* L.) beside estimating resistance to the two – spotted spider mite, *Tetranychus urticae* Koch. The experiment was conducted at Kaha Research Farm, Kaliobia Governorate under unheated plastic house in three successive seasons, 2015, 2016 and 2017. The obtained results reflected that significant differences were observed between all the studied characters. In some crosses, high rate of parent heterosis and potence ratio values were observed for the traits supporting the over dominance hypothesis. Other degrees of dominance were observed in many crosses concerning some traits. These results revealed that the hybrid vigor is important for commercial production of cucumber hybrid. Estimates of GCA effects showed that the parent PI 109483 (P25) as well as a line showed that it's the best parent for early and total yield while, PI 169352 (24) was the best parent for early, total yield, average fruit weight and fruit length and PI 169392 (20) was the best parent for earliness characters. But PI211984 (26) and Beat alpha were the best parents for reducing number of movable stages of *T. urticae*. Estimates of SCA effects cleared that the F_1 cross (P23×P2) was the best combination for early, total yield and the period to first female flower anthesis. Also, the F_1 cross (B ×P3) was the best combination for total yield, early yield, main stem length and the average fruit of weight. The F_1 cross (P26×P4) was the best cross for total yield, early yield and number of node carried first female flower. The F_1 cross (P32×P2) was the best cross for reducing number of movable stages of *T. urticae,* as well as, decreasing the level infestation of the two spider mites on cucumber plants.

Keywords: Cucumber, Heterosis, Combining ability, *Tetranychus urticae* Koch.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important vegetable crops that belong to family cucurbitaceae where it is grown all over the world due to it's good source of vitamins, minerals, fibers and high water content as well as its flesh is rich in potassium. In 2015, the total area cultivated with cucumber was about 55620 feddan with total productivity of 495982 tons with an average yield of 8.917 ton / feddan. (Ministry of Agriculture and Land Reclamation Statistics, Egypt, 2015). It had become an important commercial crop for local market or exportation. The Line × Tester analysis gives a fairly good idea of both general and specific combining abilities of parents and hybrid combinations (Ahmed *et al*. 1998). Verma *et al*. (2000) estimated combining ability effects in cucumber with a line × tester method comprising 21 hybrids obtained by crossing seven lines and three testers. Significant differences were observed among the parents and hybrids for GCA and SCA, respectively. Parents K27080, LC-3, C-12 and GY2 were found good general combiners for yield and yield component traits. High SCA effects for yield and other characters were exhibited by the cross combinations JLG × C-12, K 27080 × C-12 and K 27080 × LC-3. Singh *et al*. (2011) recorded combining ability effects for different characters of cucumber in a line x tester mating design comprising 12 lines and 3 testers and their 36 F_1 hybrids. The result revealed high and significant differences among the parents and hybrids for most of the characters except number of nodes to male flower, female flower and length of fruit. Among the parents, CC-5, BSC-1, and CC-7 were found to be good general combiners for number of primary branches per plant, weight of fruit, number of fruit per plant and fruit yield per plant. The cross combination VRC-18 × CC-5, BSC-1 × CC-5 and CC-7 × CHC were found to be good combinations for fruit yield and its related contributing characters.

Heterosis breeding can be one of the most viable options for breaking the present yield barriers (Devi *et al*.,2017). Different heterosis values and potence ratio for cucumber were reported by several authors viz., Awad (1996), Dogra *et al*. (1997) and El Sayed (2015), who mentioned that the positive value of potence ratio indicated the over dominance for total yield and main stem length characters and partial dominance for fruit weight, fruit length and period to first female flower anthesis characters. Awny *et al*. (1992) mentioned that, the genotypic means square were significant for days for female flowering. The results showed that, no specific hybrid was the highest for heterosis values for the (M.P) or the (B.P), in the same time; the hybrid (Victory × Lama) cleared that the highest values of heterosis for most traits. All hybrids showed variable results for all traits. The two hybrids (Ieang Gaea × Victory) and (Victory × Cool green) showed the highest heterosis values from the (B.P). Thakur *et al*. (2017) mentioned that in six genotypes were used to develop 15 F_1 hybrids of cucumber by half diallel mating design. The mean sums of squares were highly significant for all the characters. The genotypes P1-618860, UHF-CUC-1, UHF-CUC-2 and Khira-75 were found superior on the basis of mean performance for earliness and related yield characters. Appreciable heterosis was observed over better parent for most of the studied characters. The F_1 hybrids were found to be superior in performance over better parent for various characters were Khira-75 x PI-618860 (16.30 and 65.71), Khira-75 x UHF-CUC-2 (23.48 and 60.22) and Khira-75 x UHF-CUC-1(23.01 and 59.60) including yield per plot and per hectare respectively where they can be exploited for commercial cultivation. Although host plant resistance alone or in combination with other methods is environmentally safe and compatible with IPM, however this strategy is practical only when resistant varieties of crops are available and identified. Even a moderate level of resistance in a crop can have a positive impact and can reduce the number of pesticide applications (Srivastava, 1993).*Tetranychus urticae Koch* is one of the most important pests of greenhouse cucumbers, especially under hot and dry conditions (Hussey and Scopes, 1985). This species is adapted to various environmental conditions and the greenhouses are ideal areas for that, which can complete a generation in one week (Düzgünes and Çobanolu, 1983). *T. urticae* Koch feeds on the plant sap causing serious damage varying according to the degree of infestations (Iskander *et al. 2002)*. Spider mites are the most common mites attacking woody plants. This mite has been reported infesting over 200 species of plants. A number of vegetable crops such as tomatoes, squash, eggplant, cucumber are also subject to two spotted spider mite infestations and damage. It is also a severe pest in greenhouses as well as on open field crops during summer plantation causing a variety of degrees of damage and lately yield losses Heikal and Ali (2000) , Faris *et al*.(2004), Hanfy (2004), Abu-Zaid (2007), Ghallab *et al*.(2011), El-Saidy *et al*.(2012) and Azouz *et al*. (2014). Shoorooei1 *et al*. (2012) evaluated ten accessions of cucumber from the National Gene Bank, Karaj. They found maximum number of mites were observed at C104 (12.79±0.53) and C118 (12.3±0.4) and minimums were observed in C90 (5.58±0.65) and C39 (5.82±0.46). Therefore, the mentioned accessions were supposed to be typically susceptible and resistant to *T.urticae* respectively. The objectives of the present investigation were to estimate the magnitude of heterosis as well as genetic components and for traits under study in a line × tester meeting design to recognize desirable parents and their cross combinations as genetic resources for improving these important traits and to identify suitable material to be used in cucumber breeding programs. It is hoped that the present study may help cucumber breeder to produce new hybrid varieties of cucumber with tolerance to the two spotted spider mite.

MATERIALS AND METHODS

- **Horticulture study**

This study was carried out in 2015, 2016 and 2017 at Kaha Research Farm, Kaliobia Governorate under unheated plastic house (9 m x 59 m, 4m height).Nine cucumber accessions and Beta alpha (B) cultivars from North Central Regional Plant Introduction Station (USDA) *viz*, PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26) , PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 218036 (3) and PI 390238 (4). On 2015 the parental were planted three seasons for selfing to insure homozygosity.

Seven plants introduction viz., PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI 211984 (26), PI 169392 (20) and Beta-alpha (B) were used as females (Lines). Each of them was crossed with three other genotypes PI 178885 (2), PI 218036 (3) and PI 390238 (4) as males (Testers). Parents were crossed to produce the F_1 hybrid seeds in Line × Tester mating design.

Seeds of the nine parental lines, Beta alpha and their twenty one F_1's crosses were planted in seedling trays on the first of February (2016) in first season and on first of February (2017) in the second season. When the seedlings were 25 days old they were transplanted in the unheated plastic house. The experimental design was complete randomized block design with three replicates. Each plot contained 10 parents and their 21 F_1 hybrids. Each replicate consisted of 10 plants for each population spaced 50 cm apart.

Data were recorded as following

a. Vegetative characters

1- **Average main stem length (cm)**

Sample of ten plants for each experimental replicate was taken after 60 days after transplanting, and the Average main stem length was measured in centimeters from the cotyledon node to the top end.

2- Number of branches /plant

Sample of ten plants for each experimental replicate was taken after 60 days after transplanting and the branches per plant were counted.

b. Flowering characters

1- Number of days to first female flower anthesis.

2- Number of node carry first female flower.

c. Fruit characters

Ten fruits from each genotype were taken for determining average fruit characters as following:

1- **Fruit length (cm)**

Average fruit length was determined in centimeters using average of 10 fruits/ replicate by Vernier caliper.

2- **Fruit diameter (cm)**

Average fruit diameter was determined in centimeters using average of 10 fruits at the middle of the fruit by Vernier caliper.

3- **Fruit weight (g)**

Average fruit weight was determined in the marketable stage of the fruit.

d. Yield and it's component

1- **Early yield / plant (kg)**

Early yield per plant was determined by weighing all three first harvesting produced fruits per plant

2-**Total yield / plant (kg)**

Total yield per plant was determined by weighing all produced fruits per plant.

- **Resistance to *Tetranychus urticae* Koch**

This study was carried out in 2016 and 2017 at Kaha Research Farm, Kaliobia Governorate under unheated plastic house (9 m x 59 m, 4m height). Seeds of the nine parental lines, Beta alpha and their twenty one F_1's crosses were planted in seedling trays on 1^{st} of February (2016) in the first season and on 1^{st} of February (2017) in the second season. When the seedlings were 25 days old they were transplanted in the unheated plastic house. The experimental design was complete randomized block design with three replicates. Each plot contained 10 parents and their 21 F_1 hybrids. Each replicate consisted of 5 plants for each population spaced 50 cm apart.

- **Sampling technique for *T. urticae* infestation**

The plant leaves in this trait were left to natural infestation. Two weeks after transplanting the cucumber seedlings to the greenhouse, five leaves randomly chosen from different levels of plants were picked up from each replicate and then kept in tightly closed paper bags where were transferred to the laboratory at the same day to estimate the number of movable stages of *T. urticae* were estimated by counting the total number per two square inches randomize chosen of lower surface of the leaves with the aid of a stereomicroscope. Samples were taken 7 days intervals for each experiment and the sampling continued for 10 weeks.

Statistical analysis

Variation among different materials were tested by the normal F test and the comparison among means of the studied materials were done by using the New L.S.D test (Snedecor and Cochran, 1990). Combining ability effects and genetic components were estimated by using Line × Tester analysis according to Singh and Choadhary (1977) on season 2017. Average degree of heterosis (ADH%) was estimated as the increase or decrease percent of F_1 performance over the mid-parent (MP) and better parent

(BP) on season 2017 (Sinha and Khanna, 1975) as following;

$$\textbf{Heterosis based on MP} = \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100$$

$$\textbf{Heterosis based on HP} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$$

Potence ratio (PR) was estimated to determine the nature of dominance and its direction on season 2017 (Smith, 1952) as following:

$$\textbf{Potence ratio (P R \%)} = \frac{\overline{F_1} - \overline{MP}}{\frac{1}{2} \times (\overline{P_2} - \overline{P_1})}$$

Where: $\overline{MP}$, $\overline{BP}$, $\overline{F_1}$, $\overline{P_2}$ **and** $\overline{P_1}$ **are the mid-parents, mean of best parent in the trait, mean of F_1 hybrids and the means of means of the high and low parents, respectively.**

The statistical analysis (ANOVA) of the obtained data for *Tetranychus urticae* Koch infestation was performed by using SAS program (SAS Institute (2010), which runs under WIN. Also the difference between means was conducted by using New Least Significant Difference test in this program.

RESULTS AND DISCUSSION

A- Mean performance:

Obtained data from ten genotypes and their twenty one cucumber hybrids from season 2016, 2017 and the combined 2016 and 2017 were presented in Table (1) and Table (2). No significant differences were found between the two years of study for all tested genotypes for all traits. Moreover, significant differences were found among genotypes for all studied traits indicating wide diversity among the parental materials was used in this study. These results are in agreement with Thakur *et al*. (2017) who reported that the analysis of variance of twenty one cucumber genotypes (parents and hybrids) showed significant differences for all characters, while disagreed with that obtained by Airina (2013) who reported that the analysis of variance for 15 characters in 25 genotypes showed significant variability for 9 characters. There were no significant differences for the characters length of main vine, branches/plant, node at which first female flower emerged and length of fruit.

Wide range was observed among genotypes for main stem length on the combined seasons. The hybrids B × P 4 and P 26× P 2 had the tallest main stem length over all other evaluated genotypes (2.56 and 2.54 m respectively with no significant between them), but P 20 × P 4 ranked second for this trait (2.46 m). Meanwhile, P 23 × P 3 gave the shortest main stem length (1.27m).

Table 1. Mean performance of the ten parents and their twenty one crosses of cucumber for main stem length, number of branches, number of days to anthesis first female flower, number of node carried first female flower and average fruit weight in 2016 , 2017 and combined seasons 2016 and 2017.

Genotypes[z]	Main stem length (m)			No. of branches			No. of days to anthesis first female flower			No. of node carried first female flower			Average fruit Weight (g)		
	2016	2017	Com[y]	2016	2017	Com[y]	2016	2017	Com[y]	2016	2017	Com[y]	2016	2017	Com[y]
P25	1.84	1.66	1.75	5.56	6.43	6.00	28.20	30.26	29.23	2.80	2.83	2.81	133.56	133.53	133.55
P24	2.20	2.18	2.19	8.26	8.56	8.41	25.66	25.86	25.76	2.60	2.53	2.56	143.00	148.53	145.70
P23	1.86	1.74	1.80	13.03	13.33	13.18	25.63	25.40	25.51	2.70	2.66	2.68	105.13	105.25	105.18
P32	2.25	2.22	2.24	14.80	13.66	14.23	29.23	31.46	30.35	2.46	2.46	2.46	149.10	151.10	150.10
P26	1.69	1.71	1.70	13.96	12.20	13.08	22.70	22.66	22.68	3.33	3.33	3.33	81.90	81.50	81.70
P20	1.79	1.77	1.76	7.93	7.66	7.80	22.06	23.06	22.56	1.73	1.76	1.75	83.23	80.56	81.90
B	1.82	1.69	1.75	8.60	8.16	8.38	24.86	25.03	24.95	2.13	2.13	2.13	64.83	64.90	64.86
P2	2.41	2.39	2.40	12.16	12.16	12.17	27.66	26.40	27.03	3.36	3.20	2.28	102.90	101.36	102.13
P3	2.19	2.16	2.18	14.10	14.40	14.25	24.03	25.36	24.70	2.10	2.13	2.11	103.96	100.33	102.15
P4	2.23	2.24	2.23	10.50	11.16	10.83	28.00	28.13	28.06	2.66	2.56	2.61	71.63	67.66	69.65
P25 × P2	2.15	2.16	2.15	11.83	10.00	10.91	27.96	27.93	27.95	2.86	2.76	2.81	124.43	127.30	125.86
P24 × P2	2.20	2.15	2.18	14.63	14.56	14.60	27.56	26.63	27.10	3.60	3.46	3.53	164.43	158.16	161.30
P23 × P2	1.76	171	1.75	7.86	7.90	7.88	24.33	26.40	25.36	2.46	2.53	2.50	96.93	98.73	97.83
P32 × P2	2.43	2.30	2.36	14.73	14.90	14.81	31.76	33.20	32.48	2.66	2.53	2.60	157.10	166.23	161.66
P26 × P2	2.45	2.45	2.54	15.23	16.16	15.70	34.76	35.13	34.95	3.60	3.50	3.55	104.76	108.70	106.73
P20 × P2	2.02	1.92	1.97	7.46	7.00	7.23	23.00	22.53	22.76	2.76	2.93	2.85	110.86	109.00	109.93
B × P2	1.80	1.72	1.76	10.23	10.96	10.60	29.73	30.20	29.97	2.60	2.46	2.53	90.96	98.03	94.46
P25 × P3	1.71	1.71	1.71	10.36	10.76	10.56	22.86	24.80	23.83	2.36	2.16	2.26	115.80	121.61	118.48
P24 × P3	1.39	1.43	1.41	5.23	5.00	5.11	24.43	25.10	27.76	3.43	3.33	3.38	155.73	152.26	154.00
P23 × P3	1.31	1.22	1.27	7.83	8.00	7.91	27.26	26.60	26.93	3.33	3.00	3.16	96.66	92.73	94.70
P32 × P3	1.97	1.98	1.97	10.36	10.36	10.36	23.73	24.90	24.31	2.56	2.53	2.55	92.43	88.30	90.36
P26 × P3	1.59	1.57	1.58	10.50	10.66	10.58	25.56	26.00	25.78	3.46	3.46	3.46	118.43	112.66	115.55
P20 × P3	2.12	2.21	2.16	9.03	8.86	8.95	28.46	28.06	28.26	1.46	1.53	1.50	99.86	96.36	98.11
B × P3	2.36	2.30	2.33	11.70	12.83	12.26	27.63	27.06	27.35	3.30	3.13	3.21	142.33	143.60	142.96
P25 × P4	2.00	2.03	2.01	10.40	10.60	10.50	27.70	28.30	28.00	3.60	3.40	3.50	104.23	102.22	103.23
P24 × P4	2.30	2.32	2.31	11.96	12.10	12.03	25.06	25.60	25.33	2.33	2.23	2.28	123.63	120.96	122.30
P23 × P4	2.31	2.32	2.31	7.73	8.33	8.03	29.33	28.73	29.03	2.43	2.23	2.33	117.06	124.46	120.76
P32 × P4	1.98	1.97	1.97	8.13	7.66	7.90	31.03	33.43	32.23	2.40	2.46	2.43	144.76	141.80	143.28
P26 × P4	2.20	2.21	2.21	11.56	12.70	12.13	25.86	27.70	26.78	2.66	2.63	2.65	90.02	92.83	91.43
P20 × P4	2.44	2.47	2.46	8.30	8.56	8.43	24.28	26.20	25.23	2.83	3.10	2.96	93.23	101.66	97.45
B × P4	2.55	2.57	2.56	12.30	12.90	12.60	24.40	25.50	24.95	3.13	3.13	3.13	90.50	86.10	88.30
N.L.S.D$_{(0.05)}$	0.69	0.74	0.65	4.33	4.84	4.08	4.5	6.15	4.5	0.62	0.87	0.69	15.35	18.76	16.58

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26), PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 218036 (3) and PI 390238 (4). Y, Combined seasons.

Wide range was observed among genotypes for number of branches on the combined seasons. The hybrid P 26 × P 2 which had the largest branch number (15.70), while the hybrids P 32 × P 2 and P 24 × P 2 ranked the second for this trait (14.81 and 14.60 respectively with no significant between them). Meanwhile, P 24 × P 3 gave the fewest branch number (5.11). Number of days to anthesis first female flower on the combined seasons ranged from 34.95 (P 26 × P 2) to 22.56 days (P 20). The parent P 20 had the fewest number of days to first female flower anthesis (22.56 day) while the parent P 26 (22.68 day) ranked the second in this trait followed by the cross (P 20 × P 2) where there was no significant different among them.

Number of node carried first female flower on the combined seasons ranged from 1.50 (P 20 × P 3) to 3.55 (P 26 × P 2). The hybrid (P 20 × P 3) had the fewest number of node carried first female flower (1.50), while P 20 ranked the second for this trait (1.75) with no significant difference between them. Meanwhile, (P 26 × P 2) cross gave the largest number of node carried first female flower (3.55). Average fruit weight ranged from 161.66 g (P 32 × P 2) to 88.3 g (B × P4). The hybrids (P 32 × P 2) and (P 24 × P 2) had heaviest average fruit weights with no significant differences were found between them In contrast; Beta alpha gave the lowest average fruit weight (64.86 g) on the combined seasons. These findings were similar with Abd EL- Hafez *et al*. (1997) who studied 5 lines of cucumber with their hybrids, stating presence of highly significant differences for fruit weight.

Narrow range was observed among genotypes in fruit diameter. Fruit diameter on the combined seasons ranged from 3.06 cm (P 26 × P 3) to 2.10 cm (P 32 × P 3). The hybrid (P 26 × P 3) had the largest fruit diameter, but P 20 × P 2 (2.90 cm) ranked the second for this character without existence of significant differences between them.

These findings were similar to Lower *et al*. (1982) in their research on crossing cucumber genotypes reported that significant differences for fruit diameter were noticed. Wide range was observed among genotypes for fruit length character on the combined seasons in the hybrid (P 24 × P 3) that had the tallest fruit length (18.98 cm) while the parent (P 24) ranked the second for this trait (18.42 cm) with no significant differences. Meanwhile, P 4 gave the shortest fruit length (10.65 cm). Wide range was observed among genotypes for early yield character. The hybrid (P 25 × P 3) gave the highest early yield (2.33 kg/p) but it was not significantly different from P 24 × P 3 (2.13 kg/p) which ranked the second for early yield. Meanwhile, (P 23) gave the lowest early yield (0.25 kg) on the combined seasons. Also, (P 24 × P 4) and (P 24 × P 3), 4.78 and 4.63 kg/p, respectively produced the highest total yield with no significant differences from them. The least total yield was produced by Beta alpha (1.06 kg/p).

Table 2. Mean performance of the ten parents and their twenty one crosses of cucumber for fruit diameter, fruit length, early yield and total yield, in 2016 , 2017 and combined seasons 2016 and 2017 .

Genotypes[z]	Fruit diameter/cm			Fruit length/cm			Early yield/kg/p			Total yield/kg/p		
	2016	2017	Com[y]	2016	2017	Com[y]	2016	2017	Com[y]	2016	2017	Com[y]
P25	2.63	2.60	2.61	14.62	14.63	14.63	1.32	1.45	1.38	2.30	2.46	2.38
P24	2.40	2.40	2.40	17.70	19.10	18.42	0.56	0.55	0.55	1.38	1.49	1.43
P23	2.30	2.40	2.35	12.73	13.13	12.93	0.25	0.25	0.25	1.16	1.23	1.19
P32	2.36	2.30	2.33	17.96	17.76	17.86	0.68	0.68	0.68	1.78	1.88	1.83
P26	2.40	2.51	2.46	12.56	12.73	12.65	0.87	0.89	0.88	2.25	2.28	2.26
P20	2.53	2.43	2.48	13.10	13.69	13.53	0.51	0.52	0.51	1.27	1.37	1.32
B	2.36	2.40	2.36	11.40	11.16	11.28	0.26	0.27	0.26	0.99	1.12	1.06
P2	2.46	2.23	2.35	13.56	13.66	11.61	0.51	0.53	0.52	1.13	1.19	1.16
P3	2.50	2.50	2.50	15.03	14.50	14.76	0.53	0.50	0.51	1.17	1.27	1.22
P4	2.53	2.46	2.50	10.66	10.63	10.65	0.52	0.57	0.54	1.17	1.23	1.20
P25 × P2	2.36	2.33	2.35	17.20	16.36	16.78	1.50	1.55	1.52	4.51	4.84	4.67
P24 × P2	2.70	2.66	2.68	18.13	18.33	18.23	2.01	2.15	2.08	4.03	4.23	4.13
P23 × P2	2.33	2.26	2.30	16.36	16.30	16.33	1.35	1.44	1.39	3.15	3.39	3.27
P32 × P2	2.63	2.60	2.60	18.03	17.16	17.60	0.90	0.94	0.92	3.05	3.40	3.23
P26 × P2	2.80	2.93	2.86	14.36	14.50	14.42	1.05	1.01	1.03	2.55	2.87	2.71
P20 × P2	2.90	2.90	2.90	13.36	14.16	13.90	0.84	0.89	0.87	1.90	2.14	2.02
B × P2	2.73	2.76	2.75	12.30	12.83	12.56	0.59	0.67	0.63	1.34	1.74	1.54
P25 × P3	2.73	2.73	2.73	15.10	14.73	14.91	2.31	2.46	2.33	4.05	4.38	4.21
P24 × P3	3.06	2.86	2.96	18.73	19.23	18.98	2.08	2.18	2.13	4.49	4.78	4.63
P23 × P3	2.33	2.23	2.28	14.30	14.36	14.33	0.53	0.55	0.54	2.17	2.40	2.28
P32 × P3	2.16	2.16	2.10	14.16	13.93	14.05	0.91	0.93	0.91	3.54	3.73	3.63
P26 × P3	3.03	3.10	3.06	14.13	13.83	13.98	0.74	0.73	0.74	2.22	2.46	2.34
P20 × P3	2.46	2.46	2.46	12.56	12.90	12.73	0.96	0.99	0.98	2.20	2.38	2.29
B × P3	2.76	2.60	2.68	16.50	16.43	16.46	1.04	1.05	1.04	2.13	2.34	2.24
P25 × P4	2.53	2.50	2.51	14.30	14.10	14.20	1.94	2.10	2.04	4.17	4.46	4.32
P24 × P4	2.56	2.50	2.53	13.26	13.53	13.40	1.66	1.55	1.60	4.69	4.88	4.78
P23 × P4	2.46	2.30	2.38	19.23	19.20	14.21	0.82	0.64	0.73	1.60	1.63	1.62
P32 × P4	2.70	2.70	2.70	17.53	17.56	17.55	0.60	0.98	0.79	3.42	3.57	3.49
P26 × P4	2.93	2.83	2.86	13.80	13.70	13.75	1.04	1.10	1.07	3.05	3.26	3.15
P20 × P4	2.70	2.63	2.66	16.23	16.10	16.16	0.79	0.72	0.75	1.16	1.38	1.27
B × P4	2.20	2.26	2.23	14.53	14.40	14.46	0.74	0.79	0.77	1.68	1.81	1.74
N.S.L.D$_{(0.05)}$	0.37	0.36	0.33	1.81	1.72	1.70	0.20	0.19	0.19	0.25	0.20	0.23

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26), PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 218036 (3) and PI 390238 (4). Y, Combined seasons.

Resistance to *Tetranychus urticae* Koch

In two seasons, *T. urticae,* resistance was studied in ten parental genotypes and their 21 F_1 grouped into five classes.

Obtained results showed that the average number of motile stages of the two spotted spider mites *T. urticae* per 2 square inches to the ten parents and their twenty one crosses of cucumber plants during two successive seasons 2016, 2017 seasons and combined season are presented in Table (3). As shown in Table (3) obtained data and statistical analysis is cleared that no significant differences were found between the two years of study for all tested genotypes, moreover, significant differences were found among genotypes for the studied traits indicating wide diversity among the parental materials. Taha *et al*. (1993) reported that the level infestation of spider mites on genotypes, hybrids and varieties of soybean plants could classified according to their relative susceptability as the following: highly resistance, resistance, intermediate, susceptible and highly susceptible, they added that the either extreme were considered resistance (R) or susceptable (S), while the rest was considered intermediate for their relative susceptability of spider mite infestation.

During the first season the obtained data revealed that the parental genotypes (P25) and (P20) were highly resistance whereas, they received an average number of mites ranged from 12.10±1.39 movable stages/two inches^2 (P25) and 13.2±1.26 movable stages / two inches^2 (P20). While, the hybrids (P20 × P2), (B × P2), (P20 × P4) and (P26 × P3) were received an average numbers of mites ranged from 11.73±1.57 movable stages / two inches^2 (P20 × P2) to 12.64 ±2.17 movable stages /two inches^2 (P26 × P3) therefore, it could be classified as highly resistance hybrids. On the other hand the parental (P32) recorded an average number of mite individuals 49.55± 13.36 mobile stages/ two inches^2, it was highly susceptible one, also the hybrid (P26 × P2) was highly susceptible during the first season, it aggregated an average of 47.12±10.11 mobile stages/ two inches^2.

The genotype P3 and hybrids (P24 × P2), (P23 × P2) and (P23 × P3) were relative susceptible because of the harbored numbers of the spider mite individuals 30.91±8.48 , 31.10±6.45 and 31.44±2.82 mobile stages/ two inches^2 during the first season of the study. The parental genotypes B, P24 and P4, also the hybrids (P32 × P2), (P25 × P2), (P32 × P4) and (P23 × P4) were intermediate in their relative susceptibility to spider mite infestation, whereby, they aggregated an average numbers of (21.05±3.91), (23.19±3.30) and (25.40±4.37),(21.75±2.87), (23.20±3.01), (24.27±5.93) and (23.47±7.71) mobile stages/ two inches^2 for the parental genotypes and hybrids, respectively.

Table 3. Mean rate of number of movable stages of *Tetranychus urticae* Koch/two inches^2 to the ten parents and their twenty one crosses of cucumber in 2016, 2017 and combined seasons.

Genotypes Z	2016 season	2017 season	Combined season
P25	12.10±1.39 h	21.29±2.89 fghijk	16.69±1.79 hijkl
P24	23.19±3.30 cdefgh	28.78±3.52 cdef	25.98±3.17 defgh
P23	16.79±3.10 fgh	19.03±2.23 fghijk	17.91±1.98 ghijkl
P32	49.55±13.36 a	38.09±5.12 bcde	43.82±7.71 a
P26	19.33±5.26 fgh	14.70±3.17 ghijk	17.02±4.19 ghijkl
P20	13.12±1.26 h	15.75±2.71 ghijk	14.43±1.67 ijkl
B	21.05±3.91 defgh	23.48±3.10 fghij	22.26±3.05 fghijk
P2	19.59±2.83 efgh	17.87±5.20 ab	27.66±2.07 abcde
P3	38.31±9.28 abc	34.68±3.89 fghij	36.50±4.92 bcdef
P4	25.40±4.37 cdefg	24.14±3.21 fghij	24.77±3.05 efghij
P25 × P2	23.20±3.01 cdefgh	24.45±4.27 fghij	23.83±3.37 efghijk
P24 × P2	30.91±8.48 bcdefg	34.42±8.41 abc	32.66±8.15 abcd
P23 × P2	31.10±6.45 bcdefg	35.16±11.37 a	33.13±7.34 ab
P32 × P2	21.75±2.87 defgh	18.90±0.91 jk	20.325±1.77 hijkl
P26 × P2	47.12±10.11 a	39.76±3.22 cdef	43.44±6.63 abc
P20 × P2	11.73±1.57 h	9.70±1.70 k	10.72±1.38 l
B × P2	11.81±0.97 h	13.37±3.18 fghijk	12.59±1.72 hijkl
P25 × P3	35.19±4.93 abcd	30.12±3.77 cdef	32.66±3.55 bcdef
P24 × P3	15.97±2.37 hg	13.84±1.74 hijk	14.905±1.48 ijkl
P23 × P3	31.44±2.82 bcdef	25.18±2.63 efghi	28.31±1.97 cdefg
P32 × P3	17.91±1.56 fgh	20.44±11.51 efgh	19.175±1.93 fghijkl
P26 × P3	12.64±2.17 h	15.45±4.17 fghijk	14.05±2.86 hijkl
P20 × P3	34.68±4.37 abcde	30.95±3.48 defg	32.81±2.56 bcdef
B × P3	14.91±3.25 h	12.64±1.50 hijk	13.77±1.95 jkl
P25 × P4	41.57±11.85 ab	38.73±10.89 bcd	40.15±8.47 ab
P24 × P4	13.62±3.29 h	17.47±4.51 fghijk	15.54±3.10 hijkl
P23 × P4	23.47±7.71 cdefgh	24.19±4.30 fghij	23.83±4.76 efghijk
P32 × P4	24.27±5.93 cdefgh	27.16±6.05 defg	25.72±5.39 defghi
P26 × P4	13.28±1.62 h	12.45±2.02 ijk	12.86±1.30 kl
P20 × P4	12.46±1.29 h	14.07±4.92 fghij	13.26±2.74 ghijkl
B × P4	19.73±4.13 efgh	23.76±2.26 fghij	21.75±2.34 fghijkl

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26) , PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 218036 (3) and PI 390238 (4) .The means with the same letters in the same columns are not significantly different at alpha = 0.05 level.

The rest of genotypes (P25), (P20), (P23), (P2) and (P26) and hybrids (B × P2), (P20 × P2), (P20 × P4), (P26 × P3), (P26 × P4), (P24 × P4) and (B × P3) were resistance to spider mite infestation Table (3), These results coincided with that obtained by Taha *et al*. (2001) and El-Sanady *et al*. (2008) who evaluated soybean varieties for their relative susceptibility to spider mite infestation. In the second season (2017) the obtained results in most parental genotypes and hybrids showed similar trend Table (3).

B- Average degree of heterosis and potence ratio

Mid, better parents heterosis and potence ratio of all the studied traits are presented in Tables (4, 5 and 6). Regarding the estimates of heterosis based on MP it revealed that positive hybrid vigour for main stem length was observed in ten crosses. Regarding the estimates of heterosis based on BP, it revealed that positive hybrid vigour for main stem length was observed in seven crosses.

Table 4. Relative heterosis (MP) , heteobeltiosis (BP) and potence ratio (PR) for main stem length, number of branches, number of days to anthesis first female flower and number of node carried first female flower during 2017 season.

Crossesz	Main stem length			No. of branches			No. of days to anthesis first female flower			No. of node carried first female flower		
	Heterosis		PR	Heterosis		PR	Heterosis		PR	Heterosis		PR
	MP%	BP%		MP%	BP%		MP%	BP%		MP%	BP%	
P25 × P2	6.6	-9.6	0.3	7.5	-17.8	0.2	-1.4	5.8	-0.2	-8.4	2.4	-1.3
P24 × P2	-5.9	-10.0	-1.2	40.5*	19.7	2.3	1.9	2.9	1.8	20.7*	36.7*	1.7
P23 × P2	-17.2	-28.4	-1.1	-38.0*	-40.7*	-8.3	1.9	3.9	1.0	-13.6	-4.8	-1.4
P32 × P2	-0.2	-3.7*	-0.05	15.4	9.0	2.6	14.7	25.7**	1.6	-10.6	2.8	-0.8
P26 × P2	19.5	2.5	1.7	32.6*	32.5	199	43.2*	55*	5.6	7.1	9.3	3.6
P20 × P2	-7.7	-19.6	-0.5	-29.4	-42.4	-1.2	-8.89	-2.3	-1.3	18.1	66.4*	0.6
B× P2	-15.6	-28.0	-0.9	7.8	-9.8	0.4	17.4*	20.6*	6.5	-7.6	15.4	-0.3
P25 × P3	-10.4	-20.8*	-0.8	3.3	-25.2	0.08	-10.8	-2.2	-1.2	-12.9	1.4	0.9
P24 × P3	-34.1*	-34.4	-74.0	-56.4*	-65.2*	-2.2	-2.0	-1.0	2.0	42.8*	56.3*	5.0
P23 × P3	-37.4*	-43.5*	-3.4	-42.3*	-44.4*	-10.9	4.7	4.8	61.0	25.2	40.8*	2.2
P32 × P3	-9.5	-10.8*	-7.0	26.1	-28.0	-9.9	-12.3	-1.8	-1.1	10.2	18.7	1.4
P26 × P3	-18.8	-27.3	-1.6	-19.8	-25.9	-2.4	8.2	14.7	1.4	26.7*	62.4*	1.2
P20 × P3	12.5	2.3	1.2	-19.6	-38.4*	-0.6	15.9	21.6	3.3	-21.3	-13.0	-2.2
B × P3	19.4	6.4	1.5	13.7	-10.8	0.4	7.4	8.1	11.2	46.9*	46.9*	∞
P25 × P4	4.10	-9.3	0.2	20.5	-5.0	0.7	-3.0	0.6	-0.8	26.1	32.8*	5.2
P24 × P4	4..9	3.5	3.6	22.7	8.4	1.7	-5.16	-1.0	-1.2	-12.4	-11.8	-21.0
P23 × P4	16.5	3.5	1.3	-31.9*	-37.5*	-3.6	7.3	13.1	1.4	-14.5	-12.8	-7.6
P32 × P4	-11.6	-12.0	-26.0	-38.2*	-43.9*	-3.8	12.1	18.8*	2.1	-1.9	0.0	-1.0
P26 × P4	11.8	-1.3	0.9	8.7	4.0	1.9	9.0	22.2	0.8	-10.7	2.7	-0.8
P20 × P4	23.19	10.2	-1.9	9.0	-23.2	-0.4	2.3	13.5	0.2	43.5*	76.1*	2.3
B × P4	30.7*	14.7	2.2	33.5	15.5	2.1	-4.0	1.8	-0.6	33.4*	46.9*	3.6

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26) , PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 218036 (3)and PI 390238 (4). * - Significant at 5 % level,

These findings were similar to Airina (2013) who reported that hybrid EC 709119 x CS-123 (102.98%) and EC 709119 x IC 538155 (96.95%) exhibited significant positive heterosis over mid parent for the character main stem length trait.

Based on the potence ratio (P.R) showed that six crosses *viz*. (P 26 × P 2), (P 20 × P 3), (B × P 3), (P 24 × P 4), (P 23 × P 4) and (B × P 4) indicated over dominance to the tallest parent. Nine crosses *viz*. (P 24 × P 2), (P 23 × P 2), (P 24 × P 3),(P 23 × P 3),(P 26 × P 3), (P 25 × P 4), (P 24 × P 4), (P 32 × P 4) and (P 20 × P 4) indicated over dominance to the shortest parent. Three crosses reflected partial dominance for the tallest parent *viz*. (P 25 × P 2),(P 25 × P 4) and (P 26 × P 4). Four crosses reflected partial dominance to the shortest parent *viz*. (P 32 × P 2), (P 20 × P 2), (P 25 × P 3) and (P 32 × P 3).

Regarding the estimates of heterosis based on MP it revealed that significant positive hybrid vigour for branches number was shown in two crosses P 24 × P2, P 26 × P2 (40.5,32.6 %). Significant negative hybrid vigour for number of branches was observed in six crosses. Six crosses (P 24 × P 2), (P 32 × P 2), (P 26 × P 2), (P 24 × P 4), (P 26 × P 4) and (B × P 4) showed that dominance to the high number of branches parent. On the other hand, eight crosses showed dominance to the lowest number of branches parent.

The evaluated crosses showed significant negative hybrid vigour for number of days to anthesis first female flower based on MP or BP. Meanwhile, over dominance towards the lowest number of days to anthesis first female flower parent was observed in four crosses (P 20 × P 2, P 25 × P 3, P 32 × P 3 and P 24 × P 4). Dominance towards the lowest number of days to anthesis first female flower parent was observed in one cross P 24 × P 4.

These findings were similar to Kumar *et al.* (2017) who reported over dominance in nine crosses towards lower number of days to first female flower appearance.

None of the evaluated crosses showed significant negative hybrid vigour for number of node carried first female flower based on neither MP nor BP. Meanwhile, over dominance towards the lowest pistillate node parent was observed in five crosses *viz,* (P 25 × P 2), (P 23 × P 2), (P 20 × P 3), (P 24 × P 4) and (P 23 × P 4). Also, dominance towards the lowest pistillate node parent was observed in one cross namely P 32 × P 4. Partial dominance towards the lowest pistillate node parent was observed in three crosses *viz,* (P 32 × P 2), (B × P 2) and (P 26 × P 4). On the other hand, ten crosses showed over dominance towards the highest pistillate node parent and two crosses showed partial dominance towards the highest pistillate node parent. These findings were similar to Kumar *et al.* (2017) who reported over dominance in nine crosses towards the lowest pistillate node parent.

Regarding the estimates of heterosis based on MP revealed significant positive hybrid vigour for average fruit weight in twelve crosses namely (P 24 × P 2), (P 32 × P 2), (P 26 × P 2), (P 20 × P 2) , (P 24 × P 3) , (P 26 × P 3), (B × P 3), (P 23 × P 4) ,(P 32 × P 4), (P 26 × P 4), (P 20 × P 4) and (B × P 4). Only three crosses showed significant positive hybrid vigour for average fruit weight based on BP viz, B × P 3, P 25 × P 4 and P 20 × P 4 (43.1, 23.4 and 26.1%, respectively).

These results were similar to those of Thakur *et al*, (2017) that found two crosses had shown positive average degree of heterosis based on BP namely Khira-75 x UHF-CUC-1 (2.30% & 14.14) for average fruit weight.

Over dominance towards the heaviest fruit weight parent was observed in eleven crosses *viz*, (P 24 × P 2) , (P 32 × P 2) , (P 26 × P 2), (P 20 × P 2) , (P 24 × P 3) , (P 26 × P 3) , (B × P 3) , (P 23 × P 4) (P 26 × P 4) , (P 20 × P 4) and (B × P 4). Seven crosses showed partial dominance towards the heaviest fruit weight parent. On the other hand, one crosses showed over dominance towards the slighter fruit weight parent.

Table 5. Relative heterosis (MP), heteobeltiosis (BP) and potence ratio (PR) for average fruit weight fruit diameter and fruit length during 2017 season.

Crosses[z]	Average fruit weight			Fruit diameter			Fruit length		
	Heterosis		PR	Heterosis		PR	Heterosis		PR
	MP%	BP%		MP%	BP%		MP%	BP%	
P25 × P2	8.3	-4.6	0.6	-3.5	-10.3	-0.4	15.6*	11.8	4.5
P24 × P2	26.5*	6.4	1.4	14.9*	10.8	4.2	11.9*	-4.0	0.7
P23 × P2	-4.4	-6.1	-2.3	-2.3	-5.8	-0.6	21.6*	19.2*	10.9
P32 × P2	31.6*	10.0	1.6	14.7*	13.0	9.5	9.2	-3.3	0.7
P26 × P2	18.8*	7.2	1.7	23.6*	16.7*	4.0	9.8	6.1	2.8
P20 × P2	19.8*	7.5	1.7	24.4*	19.3*	5.7	3.5	3.4	32.0
B × P2	17.9	-3.2	0.8	19.2*	15.0*	5.2	3.3	-6.1	0.3
P25 × P3	4.1	-8.7	0.2	7.0	5.0	3.6	1.1	0.6	2.5
P24 × P3	22.3*	2.5	1.1	16.6*	14.4*	8.2	14.4*	0.6	1.0
P23 × P3	-9.7	-11.8	-0.4	-8.9	-10.8	-4.4	3.9	-0.9	0.7
P32 × P3	-29.7*	-41.5*	-0.8	-10.0	-13.6	-2.4	-13.6*	-21.5*	-1.3
P26 × P3	23.9*	12.2	2.3	23.7*	22.5*	119	1.5	-4.6	0.2
P20 × P3	6.4	-3.9	0.5	-0.2	-1.6	0.1	-8.4	-11.0	-2.9
B × P3	73.8*	43.1**	3.4	6.1	4.0	3.0	28.0**	13.3**	2.1
P25 × P4	1.6	23.4*	0.04	-1.1	-3.8	-0.4	11.6	-3.6	0.7
P24 × P4	11.6	-18.5*	0.3	2.8	1.6	2.3	-8.9	-29.1*	-0.3
P23 × P4	43.9*	18.2	2.0	-5.3	-6.5	-4.3	61.6*	46.1*	5.8
P32 × P4	29.6*	-6.1	0.7	13.4*	9.7	4.0	23.7*	-1.1	0.9
P26 × P4	24.4*	13.9	2.6	13.8.*	12.7	13.8	17.2*	7.6	1.9
P20 × P4	37.1*	26.1*	4.2	7.5	6.9	12.3	32.4**	17.6*	2.5
B × P4	29.8*	27.2	14.3	-6.9	-8.1	-5.6	32.1*	29.0*	13.2

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26) , PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 218036 (3) and PI 390238 (4). * - Significant at 5 % level,

These results were similar to data of Abd-Rabou and Zaid (2013) which indicated that potence ratio of seven cucumber hybrids was higher than one, indicating over dominance of this trait towards the heavy parent. On the contrary, two hybrids showed over dominance and one revealed partial dominance towards the lighter parent. Kumar *e al*. (2017) had reported over dominance towards the heaviest fruit weight parent in top ten hybrids of forty eight crosses for average fruit weight in cucumber. Regarding the estimates of heterosis based on MP revealed significant positive hybrid vigour for fruit diameter in nine crosses namely P 24 × P 2, P 32 × P 2, P 26 × P 2, P 20 × P 2, B × P 2, P 24 × P 3, P 26 × P 3, P 32 × P 3 and P 26 × P 4 (14.9, 14.7, 23.6, 24.4, 19.2, 16.6, 23.7, 13.4 and 13.8%, respectively). Five crosses observed significant positive hybrid vigour for fruit diameter based on BP viz, P 26 × P 2, P 20 × P 2, B × P 2, P 24 × P 3 and P 26 × P 3 (16.7, 19.3,15.0,14.4 and 22.5% respectively) .

Thirteen crosses reflected over dominance to the large parent *viz*. (P 24 × P 2) , (P 32 × P 2) ,(P 26× P 2) , (P 20 × P 2) , (B × P 2), (P 25 × P 3) ,(P 24 × P 3) , (P 26 × P 3), (B × P 3) , (P 24 × P 4) , (P 32 × P 4) , (P 26 × P 4) and (P 20 × P 4).

On the other hand, four crosses showed that over dominance to the widest parent namely (P 23 × P 3), (P 32 × P 3), (P 23 × P 4) and (B × P 4). Meanwhile, three crosses showed partial dominant to the widest parent.

Regarding the estimates of heterosis based on MP revealed significant positive hybrid vigour for fruit length in ten crosses namely P 25 × P 2, P 24 × P 2, P 32 × P 2, P 24 × P 3, B × P 3, P 23 × P 4, P 32 × P 4, P26 × P 4, P 20 × P 4 and B × P4 (15.6, 11.9, 21.6, 14.4, 28.0, 61.6, 23.7, 17.2, 32.4 and 32.1%, respectively).

Five crosses revealed significant positive hybrid vigour for fruit length based on BP viz, P 23 × P 2, B × P 3, P 23 × P 4, P 20 × P 4 and B × P 4 (15.2, 13.3, 46.1, 17.6 and 29.0%, respectively).

Ten crosses reflected over dominance to the longest parent *viz*, (P 25 × P 2), (P 23 × P 2), (P 26 × P 2), (P 20 × P 2), (P 25× P 3), (B × P 3),(P 23 × P 4), (P 26 × P 4), (P 20 × P 4) and (B × P 4). One cross reflected dominance to the longest parent *viz*, (P 24 × P 3) and seven crosses reflected partial dominance to the longest parent *viz*, (P 24 × P 2), (P 32 × P 2), (B × P 2), (P 23× P 3), (P 26 × P 3), (P 25 × P 4)and (P 32 × P 4). On the other hand, one crosses reflected partial dominance to the shortest parent *viz*, (P 24 × P 4).

Regarding the estimates of heterosis based on MP revealed significant positive hybrid vigour for early yield in eighteen crosses P 25 × P 2, P 24 × P 2, P 23 × P 2, P 32 × P 2, P 26 × P 2, P 20 × P 2, B × P 2, P 25 × P 3, P 24 × P 3, P

32 × P 3, P 20 × P 3, B × P 3, P 25 × P 4, P24 × P 4 ,P 23 × P 4, P 32 × P 4, P 26 × P 4 and B × P 4.

Regarding the estimates of heterosis based on BP revealed significant positive hybrid vigour for early yield in eighteen crosses namely P 25 × P 2, P 24 × P 2, P 23 × P 2, P 32 × P 2, P 26 × P 2, P 20 × P 2, B × P 2, P 25 × P 3, P 24 × P 3, P 32 × P 3, P 20 × P 3, B × P 3, P 25 × P 4, P 24 × P 4 ,P 23 × P 4, P 32 × P 4, P 26 × P 4 and B × P 4.

Table 6. Relative heterosis (MP), heteobeltiosis (BP) and potence ratio (PR) for early yield, total yield and number of movable stages of *Tetranychus urtice* Koch during 2017 season.

Crossesz	Early yield			Total yield			number of movable stages of *T. urticae*		
	Heterosis		PR	Heterosis		PR	Heterosis		PR
	MP%	BP%		MP%	BP%		MP%	BP%	
P25 × P2	56.5*	6.8*	1.2	165.2*	96.7*	4.7	-24.8*	36.8	2.8
P24 × P2	298.1*	290.9	161.0	215.6*	183.8*	19.2	47.5	92.6	2.0
P23 × P2	269.1*	171.6*	7.5	180.1*	175.6*	109.0	90.7*	96.7*	29.6
P32 × P2	77.3*	77.3*	∞	121.4*	80.8*	5.4	-32.4*	5.7	-0.8
P26 × P2	42.2*	13.4	1.6	65.3*	25.8*	2.0	144.1*	170.4*	14.8
P20 × P2	69.5*	67.9*	73.0	67.1*	56.2*	9.5	-42.2*	-38.4	-6.7
B × P2	67.5*	26.4	2.0	50.6*	46.2*	16.7	-35.3	-25.1	-2.6
P25 × P3	152.3*	69.6	59.4	134.8*	78.0*	4.2	7.6	41.4	0.3
P24 × P3	315.2*	296.3*	66.2	246.3*	220.8*	30.9	-56.3	51.9	-6.0
P23 × P3	46.6	10.0	1.4	92.0*	88.9*	57.5	-6.18	32.5	-0.2
P32 × P3	80.5*	75.4*	27.6	136.8*	98.4*	7.0	-43.8	-41.0	-9.3
P26 × P3	5.0	-17.9	0.1	38.5*	7.8*	1.3	-37.4	5.1	-0.9
P20 × P3	94.1*	90.3*	48.0	80.3*	73.7*	21.2	22.7	96.5	0.6
B × P3	172.7*	110.0*	5.7	95.8*	84.2*	15.2	-56.5	-46.1	-2.9
P25 × P4	112.1*	44.8*	2.5	141.7*	81.3*	4.2	70.5	81.9	11.2
P24 × P4	176.7*	171.9*	99.0	258.8*	227.5*	27.0	-34.0	-27.6	-3.8
P23 × P4	56.0*	12.2	1.4	32.5*	32.5*	∞	12.1	27.3	1.1
P32 × P4	78.1*	71.9*	21.5	129.5*	89.8*	6.2	-12.7	12.5	-0.5
P26 × P4	50.6*	23.5	2.3	85.7*	42.9*	2.8	-35.8	-15.3	-1.4
P20 × P4	32.1	26.3	7.0	6.1	0.7	1.1	26.2	-6.6	-1.2
B × P4	88.0*	38.9	2.4	54.0*	47.1*	11.5	-0.2	1.1	-0.1

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26) , PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 218036 (3) and PI 390238 (4). * - Significant at 5 % level,

Twenty crosses *viz* (P 25 × P 2), (P 24 × P 2), (P 23 × P 2), (P 32 × P 2), (P 26 × P 2), (P 20 × P 2), (B × P 2), (P 25 × P 3), (P 24 × P 3), (P 23 × P 3), (P 32 × P 3), (P 20 × P 3), (B × P 3), (P 25 × P 4), (P 24 × P 4) (P 23× P 4), (P 32× P 4), (P 26 × P 4), (P 20 × P 4) and (B × P 4) indicated over dominance for the high yielding parents. Meanwhile, only one cross indicated partial dominance to low yielding parent (P 26 × P 3).

Regarding the estimates of heterosis based on MP and BP revealed significant positive hybrid vigour for total yield in all crosses except (P 20 × P 4). These results are similar to those of Hanchinamani and Patil (2009) which showed positive heterosis over better parents for most of the horticultural traits in cucumber, where only three of 75 heterosis estimates, were negative for total yield/plant.

All crosses indicated over dominance to the high yielding parents.

These results are similar to the data of Abd-Rabou and Zaid (2013) who had reported potence ratio in 10 hybrid combinations of cucumber for marketable yield per plant which exhibited over dominance towards the higher parent in five hybrids.

Regarding heterosis based on MP revealed significant negative hybrid vigour for number of movable stages of *T. urticae* in three crosses *viz*. (P 25 × P 2), (P 32 × P 2) and (P 20 × P 2).

Thirteen crosses revealed negative hybrid vigour for number of movable stages of *T. urticae* based on M.P. Seven crosses revealed negative hybrid vigour for number of movable stages of *T. urticae* based on B.P. Eight crosses *viz.* (P 20 × P 2), (B × P 2), (P 24 × P 3), (B × P 3), (P 32 × P 3),(P 24 × P 4) ,(P 26 × P 4) and (P 20 × P 4) indicated over dominance to the lower number of movable stages parent. Six crosses exhibited over dominance to higher number of movable stages parent *viz*. (P 25 × P 2), (P 24 × P 2), (P 23 × P 2), (P 26 × P 2), (P 25 × P 4) and (P 23 × P 4).

C- Combining ability effects

The estimated effect of GCA for the parental lines and SCA for the F_1 crosses, are presented in tables (7 and 8, respectively).

Regarding GCA effects, the following parental lines showed significant positive effect values for different traits and could be considered as the best combiners: P4 (for main stem length); B and P2 (for branches number); P24, P32 and P2 (for average fruit weight); P26 (for fruit diameter); P24, P23 and P32 (for fruit length); P25, P24 and P3 (for early yield); P25, P24 and P32 (for total yield). On the other hand, the following lines showed significant negative effects for earliness as number of days to anthesis first female flower and number of node carried first female flower; P20 and P3 (for number of days to anthesis first female flower); P32and P20 (for number of node carried first female flower); P26 and B (for number of movable stages of *T. urticae* Koch).

Table 7. General combining ability effects GCA of parental lines for studied characters of cucumber during 2017 season.

Parents	Main stem length	No. of branches	No. of days to anthesis first female flower	No. of node carried first female flower	Average fruit weight
			Lines		
P25	-0.10	0.06	-0.81	-0.01	0.55
P24	-0.08	0.03	-1.30	0.22	27.45*
P23	-0.25*	-2.43*	-0.01	-0.20	-11.04*
P32	0.08	0.46	1.85*	-0.27*	15.76*
P26	0.03	2.66*	1.74*	0.41*	-11.61*
P20	0.14	-2.37*	-1.73*	-0.27*	-14.00*
B	0.18	1.71*	0.26	0.12	-7.11*
			Testers		
P2	0.07	1.12*	1.45*	0.09	7.38*
P3	-0.27*	-1.01*	-1.27*	-0.05	-1.04
P4	0.20*	-0.11	-0.18	-0.04	-6.34*
SE lines	0.12	0.88	1.03	0.15	4.05
SE tester	0.08	0.56	0.67	0.10	2.65
SE (g i- gj)lines	0.17	1.25	1.46	0.22	5.73
SE(g i- gj)testers	0.11	0.82	0.95	0.14	3.75

Parents	Fruit diameter	Fruit length	Early yield	Total yield	Number of movable stages of *T. urticae*
			Lines		
P25	-0.06	-0.34	0.82*	1.41*	34.3*
P24	0.08	1.61*	0.74*	1.49*	--1.7
P23	-0.32*	1.20*	-0.33*	-0.67*	49.6*
P32	0.10	0.80*	-0.26*	0.41*	-13.8
P26	0.36*	-1.40*	-0.26*	-0.28*	-21.8*
P20	0.07	-1.02*	-0.34*	-1.18*	-20.0
B	-0.05	-0.85*	-0.37*	-1.18*	-26.6*
			Testers		
P2	0.05	0.25	0.025	0.08	14.9*
P3	0.006	-0.35	0.060*	0.06	-13.5
P4	-0.056	0.10	-0.085*	-1.4*	-1.4
SE lines	0.07	0.37	0.04	0.04	10.57
SE tester	0.04	0.24	0.02	0.30	6.9
SE (g_i- g_j) lines	0.10	0.52	0.06	0.06	14.9
SE(g_i- g_j) testers	0.06	0.34	0.04	0.04	9.7

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26), PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 218036 (3) and PI 390238 (4). * - Significant at 5 % level,

Table 8. Specific combining ability effects SCA of twenty one crosses for studied characters of cucumber during 2017 season.

Crosses[z]	Main stem length	No. of branches	No. of days to anthesis first female flower	No. of node carried first female flower	Average fruit weight
P25 × P2	0.13	-1.58	0.33	-0.10	3.01
P24 × P2	0.16	2.88*	0.41	0.36	6.97
P23 × P2	-0.11	-1.30	-4.10*	-0.15	-13.96
P32 × P2	0.22	2.80*	1.46	-0.07	26.73
P26 × P2	0.30	1.86	4.57*	0.20	-3.42
P20 × P2	-0.24	-2.26	-3.70*	0.31	-0.73
B × P2	-0.51*	-2.39	1.01	-0.54*	-18.60*
P25 × P3	0.02	1.33	-2.03	-0.56*	5.31
P24 × P3	-0.31	-4.53*	0.02	0.37	9.51
P23 × P3	-0.22	0.93	1.56	0.46*	-11.52
P32 × P3	0.11	0.40	-3.83*	0.07	-42.76*
P26 × P3	-0.22	-1.49	-1.88	0.31	8.98
P20 × P3	0.19	1.73	4.50**	-0.93**	-4.92
B × P3	0.37*	1.62	1.65	0.27	35.40*
P25 × P4	-0.17	0.25	1.70	0.66*	-8.32
P24 × P4	0.12	1.65	-0.44	-0.73*	-16.49*
P23 × P4	0.30	0.36	2.53	-0.30	25.49*
P32 × P4	-0.36*	-3.20*	2.36	0.002	16.02*
P26 × P4	-0.80*	0.36	-2.68	-0.52*	-5.56
P20 × P4	0.04	0.53	-0.79	0.62*	5.66
B × P4	0.01	0.77	-2.67	0.27	-16.80*
S.E. (s_{ii})	0.21	1.53	1.79	0.27	7.02
S.E.(s_{ij}-s_{kl})	0.30	2.17	2.53	0.38	9.92

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32) PI211984 (26), PI 169392 (20) ,Beta-alpha, PI 178885 (2), PI 21803 (3) and PI 390238 (4). *Significant at 5 % level,

These lines could be considered good combiners for breeding to these characters.

These findings were similar to those were obtained by Wadid *et al*. (2003) that found significant negative GCA effects for earliness in PI 267742. Genotypic differences of GCA for number of branches were reported by Rawat (2002), Singh *et al*. (2011) and Mule *et al*. (2012) in monoecious lines of cucumber. Jat *et al*. (2016) also found estimated GCA effects among seven parental lines revealing the line GPC-1 with highest negative GCA effect in desirable direction for node number of first female flower (-0.63). The parental line Pusa Uday exhibited highest GCA effects (1.69, 0.53and 21.04) for the characters fruit length, fruit diameter and average fruit weight, respectively.

For specific combining ability effects of the F_1 crosses, the best combinations were : B × P3 (for main stem length); P24 × P 2 and P32 × P2 (for branch number) ; B × P3, P23 × 4 and P32 × P4 (for average fruit weight); P25 × P3 and P32 × P4 (for fruit diameter) ; P24 × P3, P32 × P3, B × P3, P23 × P4, P32 × P4 and P20 × P4 (for fruit length); P24 × P2, P23 × P2, P25 × P3, P24 × P3, B × P3, P25× P4 and P26 × P4 (for early yield) ; P23 × P2, P20 × P3, B × P3, P24 × P4, P32 × P4 and P26 × P4 (for total yield). Meanwhile, the best combinations for earliness as number of days to anthesis first female flower and number of node carried first female flower were P23 × P2, P20 × P2 and P32 × P3 (for number of days to anthesis first female flower); B × P2, P25 × P3, P20 × P3, P24 × P4 and P26 × P4 (for number of movable stages of *T.*

urticae). While P25 × P2, P32 × P2, P20 × P2, P24 × P3 and P23 × P4 combination gave negative SCA values.

Table 8. Continued Specific combining ability effects SCA of twenty one crosses for studied characters of cucumber during 2017 season.

Crosses[z]	Fruit diameter	Fruit length	Early yield	Total yield	Number of movable stages of *T. urticae*
P25 × P2	-0.24*	1.05	-0.51*	0.20*	-48.2*
P24 × P2	-0.06	1.05	0.16*	-0.49*	72.5*
P23 × P2	-0.05	-0.60	0.54*	0.83*	79.7*
P32 × P2	0.06	0.70	-0.03	-0.25*	-63.0*
P26 × P2	-0.07	0.23	0.03	-0.08	34.2
P20 × P2	0.18	-0.47	-0.01	0.08	-67.5*
B × P2	0.17	-1.97*	-0.19*	-0.30*	-7.6
P25 × P3	0.20*	0.02	0.37*	-0.25*	8.6
P24 × P3	0.18	2.55*	0.16*	0.09	-41.6*
P23 × P3	-0.04	-1.9*	-0.38*	-0.14*	-31.3
P32 × P3	-0.33*	1.94*	-0.09	0.10	33.4
P26 × P3	0.14	0.17	-0.27*	-0.46*	1.5
P20 × P3	-0.21*	-1.14*	0.06	0.35*	47.0*
B × P3	0.05	2.23*	0.15*	0.31*	-17.7
P25 × P4	0.03	-1.06	0.15*	0.05	39.5*
P24 × P4	-0.12	-3.60*	-0.32*	0.40*	-30.8
P23 × P4	0.09	2.50*	-0.15*	-0.70*	-48.4*
P32 × P4	0.26*	1.24*	0.11	0.15*	29.6
P26 × P4	-0.06	-0.41	0.24*	0.54*	-35.7
P20 × P4	0.02	1.61*	-0.06	-0.43*	20.5
B × P4	-0.20*	-0.26	0.04	-0.01	25.3
S.E. (s_{ii})	0.12	0.64	0.07	0.08	18.3
S.E.(s_{ij}-s_{kl})	0.17	0.91	0.10	0.11	25.8

z PI 109483 (25), PI 169352 (24), PI 169395 (23), PI 211117 (32), PI211984 (26) , PI 169392 (20) , Beta-alpha, PI 178885 (2), PI 218036 (3) and PI 390238 (4). *Significant at 5 % level,

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قوة الهجين والفعل الجينى للمحصول ومكوناته والمقاومة للعنكبوت الاحمر فى الخيار

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استخدمت فى هذه الدراسة عشرة اباء مستوردة من مركز الاصول الوراثية بالولايات المتحدة الامريكية وهما الاب الاول (25) 109483 و الاب الثانى (24)169352 و الاب الثالث (23) 169395 والاب الرابع (32) 211117 والاب الخامس (26) 211984 والاب السادس (20) 169392 والاب السابع بيت ألفا أستخدمت كأمهات والاباء الثامن (2) 178885 و التاسع (3) 218036 والعاشر (3) 390238 استخدمت كأباء فى التهجين بنظام line × tester لانتاج 21 هجين ليتم تقيمها مع الأباء وتقدير قوة الهجين بالنسبة لمتوسط الأبوين والأب الأفضل وايضا تقدير معدل التفوق و القدرة العامة والخاصة على الائتلاف لبعض صفات المحصول ومكوناتة للخيار وايضا تقييم صفة المقاومة للعنكبوت الأحمر . أجريت هذة الدراسة فى محطة بحوث الخضر بقها بمحافظة القليوبية فى الفترة من 2015 حتى 2017. وجدت إختلافات معنويه فى متوسطات كل الصفات المدروسه. حيث وجد فى بعض الهجن مستوى مرتفع من قوة الهجين ومعدل التفوق فى الصفات المدروسة مدعمة للسيادة الفائقة . كما وجدت انماط أخرى لمستوى السيادة فى بعض الهجن فى الصفات المدروسة . كما اوضحت هذه النتائج ان قوة الهجين مهمة لانتاج الهجن التجارية فى الخيار . وان القدرة العامة للتالف للاب (25) 109483 أفضل الأباء للمحصول المبكر والكلى و الاب (24) 169352 افضل الأباء لصفات المحصول الكلى والمبكر ومتوسط وزن الثمرة وطولها والأب (20) 169392 أفضل الأباء بالنسبة لصفات التبكير والابوين (26) 211984 وبيتا ألفا لصفة المقاومة للعنكبوت الأحمر . كما أظهرت القدرة الخاصة على التالف أن الهجين P23 × P2 أفضل الهجن بالنسبة لصفات المحصول المبكر والكلى وعدد الايام اللازمة لتفتح اول زهرة مؤنثة أيضا الهجين B × P3 أفضل الهجن لصفات المحصول المبكر والكلى و طول الساق الرئيسى و متوسط وزن الثمرة و الهجين P26 × P4 أفضل الهجن بالنسبة لصفات المحصول الكلى والمبكر ورقم العقدة الحاملة لأول زهرة مؤنثة وأخيرا كان الهجين P26 × P4 أفضل الهجن بالنسبة للعدد الاقل من الأطوار المتحركة للعنكبوت الأحمر مما يؤدي الي خفض معدل الاصابة بهذه الافة الاشد ضررا للمحصول .