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Hybrid vigour of cucumber singular hybrids derived with using directly crossing method

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Abstract: *The experiment was carried out during two seasons, the first season 2016 included the planting of cucumber seeds from different global origins, which symbolized P1 and P2-P10 in a plastic greenhouse with (506 m^2) area, in Yusufiya – Baghdad during Spring season (2017) the genotypes seeds were planted [10 parents and 27 singular hybrids with codes F1 and F2-F27 and three common commercial standard hybrids with codes C1, C2 and C3] according RCBD design with three replicates, The results showed that there were differences among of genotypes, extracted hybrids and standard hybrids in all measured indices, the genotype P8 was superior in single leaf area and the genotype P5 was superior in the fruits number per plant and plant yield 15.93 fruits per plant , 1.80 kg respectively compared with all other genotypes, the hybrids F12 (P5×P2) , F13(P5×P3) , F15 (P5×P7) , F16 (P5×P8), F17 (P5×P9) and F27(P9×P10) in the number of nodes before formation of first flower male, as well as the plants didn't gave any male flower, the hybrids F25 (P9 × P6) and F27 were higher in the fruits number per plant with values 14.33 and 14.93 fruits per plant respectively, The hybrid F27 gave the highest yield 2.19 kg.plant^{-1} also most of hybrids showed a desired hybrid abundance, 12 hybrids gave a hybrid abundance compared with best of parents in leaf area, the highest value obtained from hybrid F22 (P9 × P1) by 48.77%. Five hybrids to be early in nodes growth until first female flower appearance also 13 extracted hybrids gave heterosis in fruits number and 15 hybrids in plant yield, the highest value of heterosis obtained from F27 that gave 45.41, 69.77% respectively, five hybrids excelled gave the highest hybrid vigor in leaf area, while 8 hybrids excelled in total chlorophyll compared with highest standard hybrids, six extracted hybrids gave significant accelerating compared with lowest standard hybrids in number of nodes until appearance of first female flower, most of extracted hybrids gave significant hybrid vigor in yield indicators, the hybrid F27 gave the highest hybrid vigor in fruits number and plant yield 48.89, 67.18% respectively, while the highest hybrid vigor of early yield obtained from hybrid F17(P5xP9) compared with highest standard hybrids.*
Keywords*: Cucumber , Hybridization , Hetrobeliosis , Cucurbits.*
** This research is a part of PH.D. thesis to the second researcher.*

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I. Introduction

The phenomenon of hybrid vigor is one of the most important genetic phenomena that lead to increase of production of a several crops including cucumber *Cucumis sativus* L. that belongs to the cucurbitacea family and it is one of very important crop, due to the increasing demand by the producer and consumer for its economic and consumer importance, Although the imported hybrids is characterized by high production and the quality of its fruits, but its seeds are very expensive and may not be adapted to the conditions of our country due to high or low temperatures and high soil salinity (Al-gumar, 1999). It has become necessary for plant breeders to develop local hybrids by of crossing between locally pure lines to extract singular hybrids or imported pure lines characterized by a good degree of diversity to ensure getting vigor hybrids, The hybrid vigor in quantitative genetic is superior of hybrid than the average of its parents or superior of its best parents (Bernardo, 2002). It is a phenomenon that is specialized in the size of the hybrid , growth rate and fertility and increase their ability to resist diseases and insects compared with its parents (Sabouh et al., 2010). Since the discovery of hybrid vigor, many researchers and scientists have worked to discover this phenomenon which associated with first-generation hybrid, including East, Shull and Wright, then followed by many researchers to study this phenomenon (Sahooki, 2006). Researchers who studied the phenomenon of hybrid vigor in the cucurbitacea family which include the cucumber (Hayes and Jones, 1916) they found an increase by 24-39% in yield of first-generation plants compared with the highest parents (Bairagi et al., 2002). Many studies on this phenomenon were followed in cucumber plants by Bhairagi et al.(2005), Pati et al.(2015), Kaur, Dhall(2017) Kumar and Kumar(2017). Based on the above, the aim of the research was to extracte singular hybrids suitable for open agriculture through direct crossing between lines imported from global resources and diversity.

II. Materials and methods

The seeds of ten lines of cucumber were cultivated: Beth Alpha (Occupied Palestine), 205, 206 (Taiwan), Marketmore76 (America), 44 (Russia), Nindin, Esvier (Netherlands), Green Titan, Smart Green (Korea) Xin Huan Gua (China) which were named by the symbols (P1, P2, P3, P4, P5, P6, P7, P8, P9 and P10) respectively in a plastic house (506 m^2) in the Yusufiya south of Baghdad for the autumn season 2016 on 15/9/2016 in the terraces with width 0.8 m and length of 56 m inside plastic greenhouse which include five terraces, every terrace included two lines, the distance between the plants 0.4 m. These parents were introduced in direct crosses program, which was carried out with full control of the factors that ensure pollination, safe and successful. When the fruits mature, Seeds of 27 individual hybrids were stored for replanting in the following season, the experiment was carried out in the 2017 in spring season to compare 40 genotypes (10 parents and 27 singular hybrids F1-F27 and 3 commercial standard hybrids), Falcato hybrid from Nickreson company, Najem's hybrid and Ghazeer from Seminis company which called C1, C2 and C3 respectively, the seeds were planted in Sheets of cork include 209 holes, in one of the nurseries in Abu Ghraib area on 14/2/2017, the seedlings were moved to the experiment site at the college of Agriculture - University of Baghdad - Jadriya on 8/3/2017, the seedlings were planted on both sides of the terraces, the distance between the terraces and the other 1.75 m and between plant and the other 0.4 m and with ten plants in each of experimental unit according to the RCBD design with three replicates, the irrigation and control of weeds and diseases were carried out according needs, the results of study were measured according least significant difference LSD and 5% probability level (Al-Mohammadi and Al-Mahmoudi, 2012). The hybrid vigor was calculated compared with best of the parents in most indicators and compared with least parents to estimate early of maturity and fruit diameter (Puntha et al., 2017), and using the standard error to determine the significance of the hybrid vigor, the standard hybrid vigor was calculated compared with best of standard hybrids for most indicators and for the least standard hybrids in the early maturity and fruit diameter (Kumar et al., 2016).

III. Results and discussion

The results in Table 1 show that there are significant differences between the liness in vegetative growth indicators, P8 (216.33 $cm^2.leaf^{-1}$) was superior compared to all the lines in the leaf area, followed by P6 with a value 185.76 $cm^2.plant^{-1}$ also P3 and P9 were significant in chlorophyll concentration index with the highest values 288.51, 277.49, 282.62 $mg.100gm^{-1}$ respectively, and P5, P8, P9 and P10 lines gave early maturity respectively compared with best parents in the number of nodes until the first male flower, that didn't gave male flower, also the P5 and P9 lines were significant in nodes number (2.33 nodes for both) before formation of the first female flower. There was a difference between the hybrids resulting crossing in the vegetative growth and early maturity indicators because of the variation between the two parents, which reflected the behavior of these crossing, the hybrids F11 (P3 × P10), F19 (P6 × P2) and F27 (P9 × P10) (P2 × P6) gave the highest value in leaf area 231.71, 230.93 and 218.56 cm^2 respectively, The concentration of chlorophyll F4 (P2 × P6) gave the the highest value of 337.13 $mg.100gm^{-1}$ which was superior compared with most other hybrids. The hybrids F12, F13, F15, F16, F17 and F27 were early in the number of nodes until the first male flower which didn't gave any female flower also the hybrids F13, F15, F17 and F27 were early in the number of nodes before the appearance of the first female flower 2.33, 2.33, 2.00 And 1.67 nodes, respectively, The results of Table 1 showed that the extracted hybrids were superior compared with the standard hybrids, Three hybrids (F11, F19, F22) were superior in single leaf area and seven hybrid (F1, F2, F4, F7, F14, F22 and F27) gave the highest values of total chlorophyll concentration in leaves, the hybrids F12, F16, F15, F16, F17, and F27 did not give any male flower (0.00) in comparison with two hybrids C2 (2.33 nodes) and C3 (4.00 nodes) , eight hybrids was superior in the number of nodes until the formation of the first female flower compared to all of standard hybrids, as well as according to the results of table 2 There were significant differences between the lines in the indicators of the crop, The P5 was superior of all lines in the number of fruits per plant (15.93) and plant yield (1.80 kg). P3, P5 and P9 did not differ significantly between them in total yield 5.97, 5.94 and 5.99 tons. ha^{-1}, respectively) were significantly different from the rest of other lines in the early yield index, line P8 gave the highest coefficient of fruit form 11.47 followed by the P10 line which gave the coefficient of fruit shape 10.15, this in agreement with results of Przybecki et al. (2004). The differences between the lines led to an improvement in the indicators of the yield of extracted hybrids , the superiority of the hybrid F27 in the number of fruits (14.93 fruits per plant) which did not differ significantly with the hybrid F25 (14.33) but it differed significantly with most of other hybrids, the hybrid F27 gave the highest value of plant yield 2.19 kg which was higher than all other hybrids, followed by hybrids F8, F17 and F21 with values 1.95, 1.93 and 1.98 kg, respectively, while in the early yield , the hybrid F17 gave a value 7.64 $ton.ha^{-1}$, which did not differ significantly with F15 hybrid (7.24 $tons.ha^{-1}$) and superior compared with most other hybrids, while the hybrids F2, F25, F27 (10.52, 10.33 and 10.39 respectively) did not differ from each other in the fruit form factor but they differed significantly with all other hybrids, there are significant differences between the extracted hybrids and the standard hybrids, there is superiority of thirteen extracted hybrids on all standard hybrids in number of fruits per Plants and the majority of the breeds derived from the standard hybrids in the plant yield and the early yield and the superiority of thirteen hybrids On all hybridization scales in fruit form factor, Kushwaha et al. (2011) and Kumar et al. (2010) in cucumber, most of the extracted hybrids gave the highest rates of plant yield and early yield, Thirteen hybrids were the best compared with all standard hybrids in fruit form factor, Kushwaha et al. (2011) and Kumar et al (2010) of cucumber.

Table 1. Vegetative growth and maturation indicators for cucumber hybrids derived from the direct crosses system (F) and their parents (P) and the standard hybrids (C) in the Spring season of 2017**.**

	Leaf Area (cm^2)	Chlorophyll (mg.100 g $^{-1}$)	nodes before the appearance of the first male flower	nodes before the appearance of the first female flower
P1	57.58	240.70	3.00	5.67
P2	135.41	288.51	3.33	5.67
P3	158.39	277.49	3.67	6.33
P4	91.74	234.66	4.67	7.33
P5	118.09	250.58	0.00	2.33
P6	185.76	229.51	3.00	5.67
P7	159.27	244.46	3.67	5.67
P8	216.33	228.63	0.00	3.00
P9	146.91	282.62	0.00	2.33
P10	156.64	207.96	0.00	2.67
(P2×P1) F1	147.63	291.66	3.00	5.67
(P2×P3) F2	169.65	321.72	3.33	6.00
(P2×P5) F3	139.29	267.68	2.33	4.00
(P2×P6) F4	177.17	337.13	2.33	4.67
(P2×P9) F5	148.42	251.96	3.00	4.33
(P2×P10) F6	185.45	253.96	3.00	4.67
(P3×P1) F7	156.87	220.56	3.00	5.00
(P3×P5) F8	195.47	281.37	3.00	3.67
(P3×P6) F9	190.57	241.48	3.67	6.33
(P3×P9) F10	135.46	253.72	3.00	4.00
(P3×P10) F11	231.71	221.39	3.67	4.67
(P5×P2) F12	162.87	210.92	0.00	2.67
(P5×P3) F13	197.74	239.87	0.00	2.33
(P5×P4) F14	114.88	281.41	1.33	3.33
(P5×P7) F15	161.07	212.27	0.00	2.33
(P5×P8) F16	161.36	217.65	0.00	3.00
(P5×P9) F17	125.21	182.49	0.00	2.00
(P6×P1) F18	144.12	225.63	3.00	4.33
(P6×P2) F19	230.93	216.73	3.67	6.00
(P6×P3) F20	192.64	226.96	3.67	6.00
(P6×P9) F21	192.85	186.50	2.33	5.00
(P9×P1) F22	218.56	301.71	2.00	4.00
(P9×P2) F23	116.80	250.46	2.00	4.33
(P9×P3) F24	123.25	195.50	3.00	5.67
(P9×P6) F25	191.08	199.67	2.67	4.67
(P9×79) F26	138.25	213.60	2.00	2.67
(P9×P10) F27	202.20	317.33	0.00	1.67
C1	188.18	241.64	0.00	3.67
C2	169.63	248.93	2.33	5.00
C3	178.46	222.64	4.00	5.67
L.S.D	17.87	24.19	0.37	0.17

Table 2. Yield and its components for cucumber hybrids derived from the direct crosses system (F) and their parents (P) and the standard hybrids (C) in the Spring season of 2017.

	Fruit No./Plant	Plant yield (Kg)	Early Yield (ton.ha^{-1})	Fruit Index
P1	8.53	0.88	3.08	4.25
P2	8.07	1.37	4.96	7.95
P3	9.27	1.43	5.97	5.90
P4	7.47	1.08	2.87	6.07
P5	15.93	1.80	5.94	3.75
P6	9.80	1.10	4.89	6.71
P7	8.83	1.00	3.82	8.22
P8	9.60	1.38	3.67	11.47
P9	10.27	1.29	5.99	7.67
P10	9.27	1.14	4.95	10.15

	Fruit No./Plant	Plant yield (Kg)	Early Yield (ton.ha^{-1})	Fruit Index
(P2×P1) F1	10.40	1.39	6.05	5.85
(P2×P3) F2	9.13	1.57	5.17	10.52
(P2×P5) F3	9.50	1.64	5.31	6.45
(P2×P6) F4	10.37	1.71	6.57	6.98
(P2×P9) F5	10.63	1.47	5.40	9.25
(P2×P10) F6	10.70	1.68	3.67	9.18
(P3×P1) F7	11.75	1.78	6.09	6.52
(P3×P5) F8	13.07	1.95	5.77	6.43
(P3×P6) F9	10.13	1.49	4.81	7.71
(P3×P9) F10	13.00	1.82	6.64	8.04
(P3×P10) F11	10.60	1.49	6.04	7.93
(P5×P2) F12	13.20	1.28	3.14	5.41
(P5×P3) F13	13.20	1.73	5.41	5.95
(P5×P4) F14	10.03	1.19	3.11	5.22
(P5×P7) F15	11.87	1.74	7.24	5.78
(P5×P8) F16	12.37	1.82	3.87	5.65
(P5×P9) F17	10.90	1.93	7.64	6.09
(P6×P1) F18	12.67	1.72	5.41	5.40
(P6×P2) F19	9.57	1.41	5.86	5.71
(P6×P3) F20	10.33	1.56	5.11	6.61
(P6×P9) F21	13.53	1.98	6.03	5.80
(P9×P1) F22	12.30	1.67	4.90	6.44
(P9×P2) F23	10.43	1.50	4.00	8.34
(P9×P3) F24	9.67	1.46	3.92	8.00
(P9×P6) F25	14.33	1.96	4.21	10.33
(P9×79) F26	12.63	1.74	6.18	9.62
(P9×P10) F27	14.93	2.19	3.79	10.39
C1	10.03	1.28	3.33	4.73
C2	9.07	1.31	3.93	5.97
C3	8.90	1.24	3.64	6.59
L.S.D	1.70	0.21	0.71	1.08

The results of Table 3 show significant positive heterosis of hybrids F1, F2, F6, F8, F11, F12, F13, F19, F21, F22, and F27 in single leaf area with values 9.02%, 7.11%, 18.39%, 23.41%, 46.29%, 20.28%, 24.84%, 24.31%, 3.82%, 48.77% and 29.09%, respectively, while the hybrids F2, F4, F14, F22 and F27 gave a significant hybrid vigor in the concentration of chlorophyll with values 11.51%, 16.85% , 12.30% , 6.95% and 9.95% respectively, the results also indicate that there is a significant negative hybrid vigor compared to the low parents (the negative values of the hybrid vigor are desired in early indicators), the hybrids F4, F7, F17, F18 and F27 gave lowest values of nodes number before appearance of first female flower by -17.70%, -11.82%, -14.16%, -23.57%, and -28.47% respectively, All positive values of hybrid vigor were controlled under the influence of dominance genes that led to increase of vegetative growth indicators while the negative values of hybrid vigor compared with the highest parents were due to the effect of partial dominance genes that cause weakness in vegetative growth indicators and all negative values of hybrid vigor that desired for early indications is due to the dominance genes of the earliest parents, while all the positive values in these indicators were related by the influence of partial dominance genes, this is in agreement with results of Hanchinmani et al,2009 and Batakurki et al, (2012). The results of Table 4 show that there is a significant positive of hybrid vigor for a several of extracted hybrids in yield and its components for the hybridization of the cucumber derived by direct crossing, thirteen hybrids showed a positive hybrid vigor in the number of fruits per plant, the hybrid F27 gave the highest heterosis by (16.77%), while sixteen hybrids showed positive heterosis and significant hybrid vigor in plant yield, four of which were characterized by a hybrid vigor more than 50%, it is F27 (69.77%), F18 (56.48%), F21 (53.49%) and F25 (51.94%) ,In the early yield, the hybrids F1, F4, F10, F15, F17, F18 and F19 gave positive hybrid vigor and significant compared with the highest of two parents, In the fruit form factor, ten extracted hybrids were better than their highest parents, the hybrid F25 gave the highest heterosis of fruit form factor 34.63%, The positive values of the hybrid vigor compared with highest of parents are controlled by dominance genes, which led to increase the indicators of yield and its components, the negative values are controlled by partial dominance genes while the values which close to zero were controlled by dominance genes, these results in agreement with results of Cramer and Wehner, (1999), Singh et al, (2012) and Singh et al (2016).

Table 3 . Heterosis (%) for cucumber hybrids derived from the direct crosses system compared to the highest parents in term of vegetative growth and the lowest parents in term of the number of nodes before female blossoming in the spring season of 2017.

	Leaf Area	Chlorophyll	nodes before the appearance of the first female flower
(P2×P1) F1	9.02	1.09	-0.06
(P2×P3) F2	7.11	11.51	5.82
(P2×P5) F3	2.87	-7.22	71.67
(P2×P6) F4	-4.62	16.85	-17.70
(P2×P9) F5	1.03	-12.67	85.98
(P2×P10) F6	18.39	-11.98	74.78
(P3×P1) F7	-0.96	-20.52	-11.82
(P3×P5) F8	23.41	1.40	57.37
(P3×P6) F9	2.57	-12.98	11.70
(P3×P9) F10	-14.48	-10.23	71.67
(P3×P10) F11	46.29	-20.22	74.78
(P5×P2) F12	20.28	-26.89	14.45
(P5×P3) F13	24.84	-13.56	0.14
(P5×P4) F14	-2.72	12.30	43.06
(P5×P7) F15	1.13	-15.29	0.14
(P5×P8) F16	-25.41	-13.14	28.76
(P5×P9) F17	-14.77	-35.43	-14.16
(P6×P1) F18	-22.42	-6.26	-23.57
(P6×P2) F19	24.31	-24.88	5.82
(P6×P3) F20	3.70	-18.21	5.82
(P6×P9) F21	3.82	-34.01	114.59
(P9×P1) F22	48.77	6.75	71.67
(P9×P2) F23	-20.50	-13.19	85.98
(P9×P3) F24	-22.19	-30.83	143.20
(P9×P6) F25	2.86	-30.82	100.29
(P9×79) F26	-13.20	-25.99	14.45
(P9×P10) F27	29.09	9.95	-28.47
S.E	3.80	2.88	9.07

Table 4 . Heterosis (%)for cucumber hybrids derived from the direct crosses system compared to the highest parents in term of yield and its component in the spring season of 2017.

	Fruit No./Plant	Plant yield	Early Yield	Fruit Index
(P2×P1) F1	21.92	1.69	22.03	-26.40
(P2×P3) F2	-1.47	9.79	-13.46	32.31
(P2×P5) F3	-40.36	-8.70	-11.08	-18.92
(P2×P6) F4	5.78	24.57	10.07	-12.22
(P2×P9) F5	3.54	7.51	-9.80	16.35
(P2×P10) F6	15.43	22.38	-26.08	-9.57
(P3×P1) F7	26.75	24.38	2.01	10.50
(P3×P5) F8	-17.97	8.48	-3.41	8.97
(P3×P6) F9	3.40	4.08	-19.50	14.94
(P3×P9) F10	26.58	27.27	10.93	4.87
(P3×P10) F11	14.35	4.00	1.11	-21.84
(P5×P2) F12	-17.14	-29.16	-47.11	-31.99
(P5×P3) F13	-17.14	-3.81	-9.36	0.92
(P5×P4) F14	-37.02	-34.09	-47.73	-14.04
(P5×P7) F15	-25.51	-3.52	21.87	-29.71
(P5×P8) F16	-22.37	0.96	-34.81	-50.73
(P5×P9) F17	-31.58	7.04	27.53	-20.57
(P6×P1) F18	29.25	56.48	10.66	-19.48
(P6×P2) F19	-2.38	2.68	18.22	-28.20
(P6×P3) F20	5.44	9.09	-14.39	-1.56
(P6×P9) F21	31.78	53.49	0.72	-24.33
(P9×P1) F22	19.77	29.11	-18.24	-16.04
(P9×P2) F23	1.59	16.15	-33.27	4.90
(P9×P3) F24	-5.87	1.98	-34.57	4.36
(P9×P6) F25	39.57	51.94	-29.79	34.63
(P9×79) F26	23.01	34.75	3.13	17.03
(P9×P10) F27	45.41	69.77	-36.67	2.37
S.E	4.56	4.67	4.17	3.97

The results of table 5 show a significant differences in hybrid vigor among extracted hybrids by direct crossing system compared best of the standard hybrids in vegetative growth indicators, Six hybrids gave a standard hybrid vigor compared to best of the standard hybrids in leaf area as the hybrids F8 (3.87%) , F11 (23.13), F13 (5.08%), F19 (22.71%), F22 (16.14%) and F27 (7.45%). While eight hybrids gave total chlorophyll concentration index included the hybrid F4 Which gave the highest standard hybrid vigor in this character (35.43%), also there are eight extracted hybrids gave a significant negative hybrid vigor in the number of nodes before appearance of first female flower, the highest negative values obtained from the hybrid F27 (-54.59%) this results in agreement with results of Moradipour et al (2016) and Kumar et al (2016). The results of Table 6 indicate that there is a significant positive hybrid vigor in the indicators of the yield and its components compared with highest of standard hybrids, the hybrid F17 gave the highest standard hybrid vigor of 94.77% in the early yield, the hybrid F12 gave the highest hybrid vigor in fruit form factor of 34.98%, similar results obtained by Puneth et al, (2017) and Sharma et al (2016). We conclude from this study there were significant differences between the lines imported in all measured indicators, this indicating that there was a genetic difference between the parents used in this study, also results showed the superiority of the extracted hybrids by direct crossing in most of yield indicators, especially the hybrid F27 (P9 × P10) which was superior in number of fruits per plant and plant yield also the hybrid F17 (P5 × P9) was superior in the early yield, as well as in the early indicators, which significantly surpassed compared with standard hybrids, finally, number of extracted hybrids is characterized by a positive heterosis in the plant yield and total production.

Table 5. Heterobeletiosis (%) for cucumber hybrids derived from the direct crosses system compared to the highest standard hybrids in term of vegetative growth and the lowest standard hybrids in term of the number of nodes before female blossoming in the spring season of 2017.

	Leaf Area	Chlorophyll	nodes before the appearance of the first female flower
(P2×P1) F1	-21.55	17.17	54.41
(P2×P3) F2	-9.85	29.24	63.49
(P2×P5) F3	-25.98	7.53	8.99
(P2×P6) F4	-5.85	35.43	27.16
(P2×P9) F5	-21.13	1.22	18.07
(P2×P10) F6	-1.45	2.02	27.16
(P3×P1) F7	-16.64	-11.40	36.24
(P3×P5) F8	3.87	13.03	-0.09
(P3×P6) F9	1.27	-2.99	72.57
(P3×P9) F10	-28.02	1.92	8.99
(P3×P10) F11	23.13	-11.06	27.16
(P5×P2) F12	-13.45	-15.27	-27.34
(P5×P3) F13	5.08	-3.64	-36.42
(P5×P4) F14	-38.95	13.05	-9.17
(P5×P7) F15	-14.41	-14.73	-36.42
(P5×P8) F16	-14.25	-12.57	-18.26
(P5×P9) F17	-33.46	-26.69	-45.50
(P6×P1) F18	-23.41	-9.36	18.07
(P6×P2) F19	22.71	-12.94	63.49
(P6×P3) F20	2.37	-8.83	63.49
(P6×P9) F21	2.48	-25.08	36.24
(P9×P1) F22	16.14	21.20	8.99
(P9×P2) F23	-37.93	0.62	18.07
(P9×P3) F24	-34.50	-21.46	54.41
(P9×P6) F25	1.54	-19.79	27.16
(P9×79) F26	-26.53	-14.19	-27.34
(P9×P10) F27	7.45	27.48	-54.59
S.E	3.46	3.28	6.99

Table 6 . Heterobeletiosis (%) for cucumber hybrids derived from the direct crosses system compared to the highest standard hybrids in term of yield and its component in the spring season of 2017.

	Fruit No./Plant	Plant yield	Early Yield	Fruit Index
(P2×P1) F1	3.69	6.35	54.01	19.14
(P2×P3) F2	-8.94	19.85	31.47	-10.01
(P2×P5) F3	-5.28	25.45	35.07	22.94
(P2×P6) F4	3.36	30.28	67.20	19.14
(P2×P9) F5	6.02	12.43	37.48	9.00
(P2×P10) F6	6.68	27.99	-6.70	22.94
(P3×P1) F7	17.15	35.78	54.96	30.54
(P3×P5) F8	30.28	49.06	46.73	27.38
(P3×P6) F9	1.03	13.61	22.28	19.14
(P3×P9) F10	29.61	38.93	69.07	12.04
(P3×P10) F11	5.68	13.52	53.59	23.70
(P5×P2) F12	31.61	-2.66	-20.06	34.98
(P5×P3) F13	31.61	32.16	37.69	26.74
(P5×P4) F14	0.03	-9.44	-20.99	29.40
(P5×P7) F15	18.31	32.57	84.20	19.14
(P5×P8) F16	23.30	38.73	-1.47	26.74
(P5×P9) F17	8.67	47.07	94.37	15.34
(P6×P1) F18	26.29	31.40	37.69	22.94
(P6×P2) F19	-4.62	7.38	49.21	17.87
(P6×P3) F20	3.02	19.08	30.05	7.73
(P6×P9) F21	34.93	51.15	53.52	19.14
(P9×P1) F22	22.63	27.14	24.61	19.14
(P9×P2) F23	4.02	14.38	1.71	7.73
(P9×P3) F24	-3.62	11.32	-0.27	26.74
(P9×P6) F25	42.90	49.62	7.01	-11.28
(P9×79) F26	25.96	32.70	57.20	7.73
(P9×P10) F27	48.89	67.18	-3.48	7.73
S.E	3.08	3.42	5.91	5.46

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