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Combining ability and heterosis for TSS and seed traits in cucumber (*Cucumis sativus* L.)

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Abstract

Heterosis breeding plays a major role in crop improvement for better yield and quality attributes. Cucumber, being monoecious and cross pollinated in nature, contains more number of seeds per fruit and provides ample scope to harness hybrid vigour. Therefore, the present study was carried out to work out combining ability and heterosis for total soluble solids (°B) and seed traits *viz.,* seed germination (%), seed vigour index-I and vigour index-II. The experimental material comprised of F_1 and F_2 population of 18 crosses, developed by crossing six lines and three testers. All the nine parents and their hybrids (18) indicated highly significant differences among the parents, F_1's and F_2's for all the traits studied. Experimental results revealed that parents *viz*., LC-1-1, LC-2-2, CGN-20515, Poinsette and K-75 and cross combination *viz.,* LC-1-1 × K-75, LC-1-1 × Poinsette, LC-2-2 × K-75, LC-2-2 × Poinsette and CGN-20515 × Poinsette were found superior on the basis of overall performance and heterotic response (heterosis in F_1 and residual heterosis in F_2) for all the traits viz.*,* TSS, seed germination and SVI-I and -II. These parents and hybrid combinations could be exploited commercially for the development of hybrids/ varieties for better TSS and seed trait in cucumber.

Keywords: Cucumber, combining ability, heterosis, residual heterosis, seed germination, seed vigour, TSS

Introduction

Cucumber is a leading commercial salad crop and has become popular home garden vegetable in different continents. It is grown almost round the year both in open and under-protected conditions and brings profitable returns to the growers being off-season. Development of hybrid cultivars offers opportunities for improvement in production, earliness, uniformity, quality and resistance to biotic and abiotic stresses. The *per se* performance of parents may not always serve as an index of their genetic nicking ability (Allard 1960). In other words high performing parents do not necessarily give rise to good hybrid. Heterosis is rather a function of specific cross combination, which may be utilized for commercial exploitation of heterosis (Reddy et al. 2014). Heterosis breeding is one of the most efficient tool to exploit the genetic diversity in cucumber because of its monoecious nature of flowering, more number of seeds per fruit and its round the year cultivation (Singh et al. 2010). Nevertheless, the cost of hybrid seed production is also very high. In this context, extent of residual heterosis in F_2 may be utilized to get heterotic effect with the lowest cost of seed production. Under such situations, it is important to have an objective judgement about a particular cross likely to produce transgressive recombinants which again depend upon heritable hybrid vigour and it can be inferred from the presence of heterosis in F_2 or successive generations. To develop hybrids, selection of suitable parents is of utmost importance. The studies of combining ability aims to identify parents with good general and specific combining ability (GCA and SCA) and depends on the availability of genetic variability in parents and the nature of genetic system operating in them, that predicts the efficiency of selection of parents (Legesse et al. 2009). Keeping in view these points, the present study was undertaken to evaluate the extent of heterosis both in F_1 and F_2 generations for fruit quality and seed traits of 18 cross combinations based on the estimates of combining ability and heterosis in cucumber.

Materials and Methods

Experimental site and material used: The present investigation was conducted at experimental farm of

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Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni- 173 230, Solan, HP, India during 2013 and 2014. Geographically, the place is located at an altitude of 1,270 meters above mean sea level lying between 35.5° North latitude and 77.8° East longitude and is characterized by subtropical climate. The soil of the research farm is sandy loam to clay loam in texture. The experimental materials used for the present investigations comprised of 18 crosses which were developed by crossing six lines and three testers as detailed below:

Cucumber genotypes used in the hybridization programme

SN.	Genotypes	Source
(a)	**Lines**	
1	CGN-20256	Centre for Crop Genetic Resources, the Netherlands
2	CGN-20515	Centre for Crop Genetic Resources, the Netherlands
3	CGN-21585	Centre for Crop Genetic Resources, the Netherlands
4	LC-1-1	Dhangota, Hamirpur, Himachal Pradesh, India
5	LC-2-2	Bhota, Hamirpur, Himachal Pradesh, India
6	LC-12-4	Gagal, Kangra, Himachal Pradesh, India
(b)	**Testers**	
1	K-75	UHF, Nauni, Solan, Himachal Pradesh, India
2	Japanese Long Green (JLG)	ICAR-IARI Regional Station, Katrain, Kullu, India
3	Poinsette	National Seeds Corporation, New Delhi, India
(c)	**Standard check cultivar**	
1.	Pusa Sanyog	ICAR-IARI Regional Station, Katrain, Kullu, India

Development of F_1 and F_2 generations: The crosses were attempted during the year 2012 as per Line × Tester design as suggested by Kempthorne (1957). During *Kharif* 2013, seeds of 18 crosses (F_1) along with parents (6 lines and 3 testers) were sown in randomized complete block design (RCBD) at a spacing of 100 × 30 cm in a plot of size 3.0 × 3.0 m, accommodating 30 plants per plot. Then each parent and cross (F_1) were selfed to get sufficient seeds of parents and F_2 to raise the crop in the next season.

Experimental design and experimentation

During *Kharif* 2014, parents, F_1 and F_2 population of 18 crosses along with the standard check (Pusa Sanyog) were evaluated in RCBD with three replicates. The seeds were sown in each hill at a spacing of 100 × 30 cm in a plot of size 3.0 × 3.0 m, accommodating 30 plants per plot. The standard intercultural operations and pest management practices were done as recommended in the "Package of Practices" for Vegetable Crops, (Anonymous 2014). The observations were recorded on TSS of fruits, seed germination and seed vigour index-I and II (SVI-I and SVI-II) from randomly selected fruits. The total soluble solids (TSS) of fruits were observed with the help of 'ERMA Hand Refractometer (AOAC 1970). The seed germination was determined by using seed germinator. Seed vigour index-I and II were calculated as per the formulae described by Abdul-Baki and Anderson (1973).

Statistical analysis:

The Line × tester analysis was done through OPSTAT software as per the model suggested by Kempthorne (1957). Similarly, for the estimates of heterosis (F_1) and residual heterosis (F_2) the data were calculated manually in MS Excel-2007 as the deviation of F_1 and F_2 mean from the better parent (BP) and standard check, respectively. Further, the statistical significance of all the estimates of heterosis was calculated through t-test formulae used by Wynne et al. (1970).

Results and Discussion

Mean Performance of parents and hybrids: The perusal of data presented in table 1 indicated significant differences among the parents and crosses for all the character under study. The observations recorded for total soluble solids (TSS) showed substantial variations (parents = 2.90-4.03 °B, F_1 = 2.88-4.07 °B and F_2 = 3.20-3.88 °B). Among the parents, maximum TSS of 4.03 °B was recorded in the genotype CGN-21585, followed by CGN-20256 and LC-1-1, and the cross combination CGN-21585 × Japanese Long Green, followed by LC-1-1 × K-75, CGN-21585 × Poinsette and LC-1-1 × Poinsette among F_1 and in F_2 (residual heterosis) crosses CGN-21585 × Japanese Long Green, followed by LC-1-1 × K-75, LC-2-2 × Poinsette, LC-1-1 × Poinsette and CGN-21585 × Poinsette were found superior for TSS of fruits in cucumber. For fruit quality traits, wide variation concerning to TSS are in agreement with Brar et al. (2011), Dogra and Kanwar (2011) and Kumar et al. (2016) who found significant differences among the studied genotypes of cucumber for TSS. Seed germination being the most vital component, all the parents and crosses exhibited ample variation for this trait (parents = 74.33-83.67%, F_1 = 68.00-84.00% and F_2 = 75.33-87.00%). The parent LC-1-1 recorded the highest seed germination (83.67%) followed by CGN-20515 and CGN-21585. In F_1, crosses LC-1-1 × K-75, CGN-20515 × Poinsette and CGN-20515 × K-75 and

Table 1: Mean performance of top five parents and hybrids (F_1 and F_2) for TSS and seed traits in cucumber

Traits	Range			Mean± S.E.(d)	Top five parents*	Top five cross combinations (F_1 & F_2) performed well along with performance of check cultivar*	
	Parents	Hybrids				F_1	F_2
		F_1	F_2				
Total Soluble Solids (°B)	2.90 to 4.03	2.88 to 4.07	3.20 to 3.88	3.25 ± 0.08 (F_1) 3.38 ± 0.09 (F_2)	CGN-21585 (4.03)	CGN-21585 × JLG (4.07)	CGN-21585 × †JLG (3.88)
					CGN-20256 (3.57)	LC-1-1 × K-75 (3.60)	LC-1-1 × K-75 (3.62)
					LC-1-1 (3.30)	CGN-21585 × Poinst. (3.53)	LC-2-2 × Poinst. (3.62)
					‡Poinst. (3.17)	LC-1-1 × Poinst. (3.50)	LC-1-1 × Poinst. (3.60)
					K-75 (3.13)	CGN-20256 × JLG (3.47)	CGN-21585 × Poinst. (3.52)
						Pusa Sanyog (3.43)	Pusa Sanyog (3.40)
Seed germination (%)	74.33 to 83.67	68.00 to 84.00	75.33 to 87.00	77.02 ± 0.90 (F_1) 81.62 ± 0.92 (F_2)	LC-1-1 (83.67)	LC-1-1 × K-75 (84.00)	LC-1-1 × K-75 (87.00)
					CGN-20515 (83.33)	CGN-20515 × Poinst. (83.33)	LC-1-1× Poinst. (86.33)
					CGN-21585 (83.00)	CGN-20515 × K-75 (81.33)	CGN-20256 × JLG (86.33)
					K-75 (82.33)	LC-1-1 × Poinst. (80.67)	CGN-21585 × K-75 (86.00)
					LC-2-2 (81.00)	LC-2-2 × Poinst. (80.33)	CGN-20515 × Poinst. (85.67)
						Pusa Sanyog (81.33)	Pusa Sanyog (84.00)
Seed vigour index-I	2084.60 to 2787.77	1947.37 to 3216.90	1864.69 to 3034.50	2413.84 ± 82.45 (F_1) 2420.70 ± 37.88 (F_2)	LC-2-2 (2787.77)	LC-1-1 × K-75 (3216.90)	LC-1-1 × K-75 (3034.50)
					LC-1-1 (2581.70)	LC-2-2 × Poinst. (2996.27)	LC-2-2 × K-75 (2992.15)
					K-75 (2435.01)	CGN-20515 × K-75 (2691.80)	CGN-20515 × K-75 (2940.40)
					CGN-20515 (2420.23)	LC-2-2 × K-75 (2604.73)	LC-2-2 × Poinst. (2656.10)
					Poinst. (2404.50)	LC-1-1 × Poinst. (2460.13)	CGN-20515× Poinst. (2560.30)
						Pusa Sanyog (2873.60)	Pusa Sanyog (2899.62)
Seed vigour index-II	663.20 to 1250.44	688.73 to 1996.00	671.61 to 1936.74	1094.55 ± 73.78 (F_1) 1101.73 ± 21.88 (F_2)	CGN-20515 (1250.44)	LC-1-1× K-75 (1996.00)	LC-1-1 × K-75 (1936.74)
					LC-1-1 (1246.26)	LC-2-2 × Poinst. (1804.60)	LC-2-2 × Poinst. (1648.82)
					LC-2-2 (1203.47)	LC-2-2 × K-75 (1359.20)	LC-2-2 × K-75 (1372.30)
					LC-12-4 (1203.24)	CGN-20515 × K-75 (1358.27)	LC-2-2 × JLG (1328.26)
					JLG (1060.52)	LC-1-1 × Poinst. (1264.20)	CGN-20515 × K-75 (1320.88)
						Pusa Sanyog (1301.20)	Pusa Sanyog (1303.03)

†JLG = Japanese Long Green; ‡Poinst. = Poinsette; *Significant at 5% level of significance

in F_2 LC-1-1 × K-75 followed by LC-1-1 × Poinsette, CGN-20256 × Japanese Long Green and CGN-21585 × K-75 were found superior for this trait. Seed vigour index determines the vitality and germination of any crop. Seed vigour index-I and II exhibited significant differences amongst parents, F_1 and F_2. The SVI-I and SVI-II varied from 2084.60-2787.77 and 663.20-1250.44, respectively among parents. In F_1, it ranged from 1947.37-3216.90 (SVI-I) and 688.73-1996.00 (SVI-II) and in F_2, it varied from 1864.69-3034.50 (SVI-I) and 671.61-1936.74 (SVI-II). Among the parents, SVI-I and -II was recorded highest in LC-2-2, LC-1-1 and CGN-20515. In F_1 and F_2 generations, the crosses LC-1-1 × K-75, LC-2-2 × Poinsette, CGN-20515 × K-75 and LC-2-2 × K-75 were found superior for seed vigour index-I and II. These results are in consonance with Nerson (2007) and Kumar et al. (2013), who had also reported wide variation for seed germination and seed vigour index in cucumber. The common approach of selecting parental lines based on the basis of *per se* performance does not necessarily give fruitful results (Allard 1960). Therefore, we have estimated combining ability and heterosis both in F_1 and F_2 generations for all the traits studied.

Combining ability studies:

The significant estimates of GCA and SCA for parents and hybrids respectively have been presented in the table 2. It revealed that the parent CGN-21585 followed by LC-1-1 and Japanese Long Green in F_1 and CGN-21585 and Poinsette in F_2 generation had significant positive GCA effects for total soluble solids (TSS), which showed that they are good general combiners for the trait under study. Similar results for significant desirable GCA effects of different parental lines and testers in cucumber had also been reported by Singh and Sharma (2006), Brar et al. (2011) and Kumar et al. (2016) for TSS and other quality traits in cucumber. These parents may be utilized in hybridization programs for getting superior hybrid combinations or transgressive segregants. The GCA effects of parents for seed germination revealed that the genotypes LC-1-1, CGN-20515, Poinsette and LC-2-2 in F_1 and LC-1-1, CGN-20515 and K-75 in F_2 had significant positive GCA effects, which showed that these lines were good general combiners for seed germination. For SVI-I, parents, LC-2-2 followed by LC-1-1, K-75 and CGN-20515 were found good general combiners due to their significant positive GCA effects both in F_1 and F_2 generations. Similarly, for SV-II, the trend was almost found similar both in F_1 and F_2 generations and the genotype; LC-1-1, LC-2-2, K-75 and Poinsette were found good general combiners for this trait. The significant desirable GCA effects of different parents had also been reported earlier by Kumar (2013) for seed germination and SV-I and -II in cucumber.

SCA helps in identifying the best combinations for various traits. The different estimates of SCA effects for top hybrid combinations both in F_1 and F_2 for total soluble solids revealed that cross combination CGN-21585 × Japanese Long Green (good × poor), LC-1-1 × K-75 (good × poor), LC-1-1 × Poinsette (good × poor), CGN-20515 × K-75 (poor × poor) and CGN-20256 × Japanese Long Green (average × good) were found best specific cross combiners. The significant high positive SCA effects for TSS of fruits have also been reported by Brar et al. (2011) and Kumar et al. (2016) in cucumber. The hybrid combination LC-1-1 × K-75 (good × good), CGN-20256 × Japanese Long Green (poor × poor), CGN-21585 × Japanese Long Green (poor × poor), CGN-20515 × K-75 (good × good) and LC-12-4 × Japanese Long Green (poor × poor) in F_1 and crosses CGN-20256 × Japanese Long Green (poor × poor), CGN-20515 × Poinsette (good × good), CGN-21585 × K-75 (poor × good), LC-1-1 × Poinsette (good × poor) and LC-2-2 × Japanese Long Green (good × poor) in F_2 were found best specific cross combinations for seed germination. Further, significant positive SCA effects for seed vigour index-I in F_1 were exhibited by LC-1-1 × L-75 (good × good), LC-2-2 × Poinsette (good × good), CGN-20256 × Japanese Long Green (poor × poor), LC-12-4 × Poinsette (poor × good) and LC-12-4 × Japanese Long Green (poor × poor) and similar trend was found in F_2 generation. The SCA effects for seed vigour index-II in the present study revealed that three cross combination LC-1-1 × K-75, LC-2-2 × Poinsette and LC-12-4 × Japanese Long Green were significant good specific cross combinations in F_1 and these crosses involved the parents with good × good, good × good and poor × poor GCA effects, respectively for this trait. Similarly in F_2, LC-1-1 ×K-75, CGN-20256 × Japanese Long Green, LC-2-2 × Poinsette, LC-12-4 × Japanese Long Green and CGN-20515 × Poinsette, crosses exhibited significant positive SCA effects, which involved the parents with good × good, poor × poor, good × good, poor × poor and good × poor GCA effects, respectively. The interactions between positive and positive alleles in the crosses, which involved good × good general combiners, indicated the predominance of additive gene action; such effects can be fixed in the

Table 2: Estimates of general combining ability (GCA) and specific combining ability (SCA) effects for TSS and seed traits in cucumber

Traits	Top significant desirable parents*		Top significant desirable cross combinations*	
	F_1	F_2	F_1	F_2
Total soluble solids (°B)	CGN-21585 (0.43) LC-1-1 (0.16) [†]JLG (0.12)	CGN-21585 (0.20) [‡]Poinst. (0.03)	CGN-21585 × JLG (0.27) LC-1-1 × K-75 (0.24) LC-1-1 × Poinst. (0.17) CGN-20515 × K-75 (0.14) CGN-20256 × JLG (0.12)	CGN-21585 × JLG (0.26) LC-1-1 × K-75 (0.16) LC-2-2 × Poinst. (0.11) CGN-20256 × JLG (0.10)
Seed germination (%)	LC-1-1 (3.24) CGN-20515 (2.80) Poinst. (1.85) LC-2-2 (1.24)	LC-1-1 (3.56) CGN-20515 (1.56) K-75 (1.67)	LC-1-1 × K-75 (4.59) CGN-20256 × JLG (3.26) CGN-21585 × JLG (2.70) CGN-20515 × K-75 (2.37) LC-12-4 × JLG (1.82)	CGN-20256 × JLG (5.11) CGN-20515 × Poinst. (3.33) CGN-21585 × K-75 (2.22) LC-1-1× Poinst. (2.00) LC-2-2 × JLG (1.56)
Seed vigour index-I	LC-2-2 (280.39) LC-1-1 (279.56) K-75 (105.98) CGN-20515 (98.35)	LC-2-2 (312.01) CGN-20515 (244.40) K-75 (209.65) LC-1-1 (155.93)	LC-1-1 × K-75 (427.96) LC-2-2 × Poinst. (329.18) CGN-20256 × JLG (213.67) LC-12-4 × Poinst. (134.98) LC-12-4 × JLG (116.00)	LC-1-1 × K-75 (268.56) CGN-20256 × JLG (193.63) LC-12-4 × JLG (144.55) CGN-21585 × JLG (89.94) CGN-20515 × K-75 (85.98)
Seed vigour index-II	LC-1-1 (273.68) LC-2-2 (273.45) K-75 (107.39) Poinst. (85.00)	LC-2-2 (344.45) LC-1-1 (296.73) K-75 (135.50) Poinst. (22.91)	LC-1-1 × K-75 (435.28) LC-2-2 × Poinst. (266.50) LC-12-4 × JLG (156.45)	LC-1-1 × K-75 (399.16) CGN-20256 × JLG (182.88) LC-2-2 × Poinst. (176.12) LC-12-4 × JLG (85.38) CGN-20515 × Poinst. (82.76)

[†]JLG = Japanese Long green; [‡]Poinst. = Poinsette; [*]Significant at 5% level of significance

subsequent generations through selection. However, cross combinations involving good × average or good × poor or average × poor may be ascribed to interactions between dominant alleles from the good/average combiners and recessive alleles from the poor/average combiners (Kumar et al. 2016). These cross combinations indicated the presence of both additive and non-additive gene action, which may be used for exploiting F_1 hybrids. The present findings corroborated earlier work of Kumar (2013) for seed germination and seed vigour traits in cucumber.

Heterosis (F_1) and residual heterosis (F_2):

The estimates of heterosis revealed significant differences among the different cross combinations for all the traits under study (Table 3). Significantly higher heterosis over better parent was exhibited by LC-1-1× K-75 and LC-1-1 × Poinsette in F_1 and LC-2-2 × Poinsette, LC-12-4 × Poinsette, CGN-20515 × Japanese Long Green, LC-1-1 × K-75 and LC-2-2 × Japanese Long Green in F_2 generation. Similarly, over standard check CGN-21585 × Japanese Long Green and LC-1-1 × K-75 in F_1 and CGN-21585 × Japanese Long Green, LC-1-1 × K-75, LC-2-2 × Poinsette, LC-1-1 × Poinsette and CGN-21585 × Poinsette in F_2 recorded desirable heterosis for TSS. In overall, cross combinations LC-1-1 × K-75 and LC-1-1 × Poinsette performed consistently better over both the estimates of heterosis both in F_1 and F_2 generations for this trait. For seed germination, significantly positive heterosis over better parent in F_1 was exhibited only by LC-1-1 × K-75 and in F_2, CGN-20256 × Japanese Long Green, LC-1-1 × K-75, CGN-21585 × K-75, LC-1-1 × Poinsette and CGN-21585 × Poinsette had significant positive heterosis for this trait. Likewise, significant heterosis over standard check in F_1 exhibited by LC-1-1 × K-75 and CG-20515 × Poinsette and in F_2, LC-1-1 × K-75, CGN-20256 × Japanese Long Green, LC-1-1 × Poinsette and CGN-

Table 3: Cross combinations exhibited significant positive heterosis for TSS and seed traits over better parent and standard check cultivar in cucumber

Rank	**Total soluble solids (°B)**			
	Per cent increase over better parent (BP)*		**Per cent increase over standard check (SC)***	
	(F_1)	**(F_2)**	**(F_1)**	**(F_2)**
1.	LC-1-1 × K-75 (12.50)	LC-2-2 × Poinst. (18.69)	CGN-21585 × JLG (18.66)	CGN-21585 × JLG (14.12)
2.	LC-1-1 × [‡]Poinst. (9.37)	LC-12-4 × Poinst. (11.73)	LC-1-1 × K-75 (4.96)	LC-1-1 × K-75 (6.47)
3.	-	CGN-20515 × [†]JLG (10.65)	-	LC-2-2 × Poinst. (6.47)
4.	-	LC-1-1 × K-75 (9.70)	-	LC-1-1 × Poinst. (5.88)
5.	-	LC-2-2 × JLG (9.68)	-	CGN-21585 × Poinst. (3.53)
Rank	Seed germination (%)			
	Per cent increase over better parent (BP)*		Per cent increase over standard check (SC)*	
	(F_1)	(F_2)	(F_1)	(F_2)
1.	LC-1-1 × K-75 (11.51)	CGN-20256 × JLG (7.91)	LC-1-1 × K-75 (3.28)	LC-1-1 × K-75 (3.57)
2.	-	LC-1-1 × K-75 (3.98)	CGN-20515 × Poinst. (2.46)	CGN-20256 × JLG (2.77)
3.	-	CGN-21585 × K-75 (3.61)	-	LC-1-1 × Poinst. (2.77)
4.	-	LC-1-1 × Poinst. (3.18)	-	CGN-21585 × K-75 (2.38)
5.	-	CGN-20515 × Poinst. (2.81)	-	-
Rank	Seed vigour index-I			
	Per cent increase over better parent (BP)*		Per cent increase over standard check (SC)*	
	(F_1)	(F_2)	(F_1)	(F_2)
1.	LC-1-1 × K-75 (24.60)	LC-2-2 × K-75 (16.43)	LC-1-1 × K-75 (11.95)	LC-1-1 × K-75 (4.65)
2.	CGN-20515 × K-75 (10.55) (((10.55(10.55) (10.55)	CGN-20515 × K-75 (14.41)	-	LC-2-2 × K-75 (3.19)
3.	LC-2-2 × Poinst. (7.48)	LC-1-1 × K-75 (14.21)	-	-
4.	-	CGN-20515 × JLG (6.92)	-	-
5.	-	LC-2-2 × Poinst. (5.46)	-	-
Rank	Seed vigour index-II			
	Per cent increase over better parent (BP)*		Per cent increase over standard check (SC)*	
	(F_1)	(F_2)	(F_1)	(F_2)
1.	LC-1-1 × K-75 (77.32)	LC-2-2 × Poinst. (56.83)	LC-1-1 × K-75 (53.40)	LC-1-1 × K-75 (48.63)
2.	LC-2-2 × Poinst. (49.95)	LC-1-1 × K-75 (55.40)	LC-2-2 × Poinst. (38.69)	LC-2-2 × Poinst. (26.54)
3.	CGN-20515 × K-75 (39.53)	LC-2-2 × K-75 (32.16)	-	LC-2-2 × K-75 (5.32)
4.	CGN-20515 × Poinst.(31.53)	LC-2-2 × JLG (25.25)	-	-
5.	LC-12-4 × Poinst. (28.01)	CGN-20515 × K-75 (5.63)	-	-

[†]JLG = Japanese Long Green; [‡]Poinst. = Poinsette; [*]Significant at 5% level of significance

21585 × K-75 was found superior for this trait. Again, the cross combination LC-1-1 × K-75 found superior than better parent and standard check both in F_1 and F_2 generations. For seed vigour index-I, crosses LC-1-1 × K-75, CGN-20515 × K-75 and LC-2-2 × Poinsette in F_1 and LC-2-2 × K-75, CGN-20515 × K-75, LC-1-1 × K-75, CG-20515 × Japanese Long Green and LC-2-2 × Poinsette in F_2 generation recorded significant positive heterosis over better parent. Significant heterosis over standard check in F_1 was exhibited only by LC-1-1 × K-75, while in F_2 generation LC-1-1 × K-75 and LC-2-2 × K-75 revealed significant positive estimates of heterosis for seed vigour index-I. Further, the cross combination, LC-1-1 × K-75, LC-2-2 × Poinsette, CGN-20515 × K-75 and LC-12-4 × Poinsette exhibited significant positive estimates of heterosis over better parent for seed vigour index-II both in F_1 and F_2 generations. Similarly, heterosis over standard check in F_1 and F_2 generations was recorded by the crosses LC-1-1 × K-75 and LC-2-2 × Poinsette. In overall, cross combination LC-1-1 × K-75 performed consistently better in F_1 and F_2 generations for all the traits under study. The above mentioned cross combination which is likely to produce transgressive recombinants in the succeeding generations would mainly depends upon the residual heterosis in F_2 generation or the heritability of hybrid vigour as reported by Fasoulas (1981). Interestingly, higher number of crosses performed better in F_2 (residual heterosis) in comparison to F_1 for all the traits under study. This signifies the scope for exploitation of residual heterosis for transgressive segregant development in cucumber. Significant estimates of heterosis in F_1 generation had also been reported by Kumar (2013) for seed germination and seed vigour traits in cucumber.

सारांश

फसल सुधार में संकर ओज प्रजनन का महत्व, अधिक उपज एवं गुणवत्ता घटकों के लिये ज्यादा है। खीरे की उभयलिंगी तथा पर–परागित प्रकृति के कारण प्रति फल बीजों की संख्या सबसे अधिक होती है जिससे संकर ओज प्राप्त करने का अवसर बढ़ जाता है। इसलिये वर्तमान अध्ययन कुल विलेय ठोस (ब्रिक्स) तथा बीज गुण जैसे बीज जमाव (प्रतिशत), बीज ओज इण्डेक्स–I एवं ओज इण्डेक्स –II का संयोजन क्षमता और ओज ज्ञात करने के लिए किया गया। प्रायोगिक सामग्री में 6 लाईन x 3 टेस्टर से 18 संकरित एफ$_1$ तथा एफ$_2$ पौध संख्या को लिया गया। अध्ययन के सभी 9 पितृ व उनके संकरों (18) में पित्रों, एफ$_1$ व एफ$_2$ के मध्य सार्थक विविधता प्राप्त हुई। प्रायोगिक परिणामों से स्पष्ट होता है कि पित्रों जैसे– एल.सी.–1–1, एल.सी.–272, सी.जी.एन.–20515, प्वाइनसेट तथा के.–75 तथा संकर संयोजन जैसे– एल.सी.–1–1 x के.–75, एल.सी.–1–1 x प्वाइनसेट, एल.सी.–2–2 x के.–75, एल.सी.–2–2 x प्वाइनसेट एवं सी.जी.एम.–20515 x प्वाइनसेट समस्त क्षमता निष्पादन के आधार पर उत्तम पाये गये एवं ओज प्रतिक्रिया (एफ$_1$ में ओज व एफ$_2$ में अवशेष ओज) सभी गुणों जैसे कुल विलेय ठोस, बीज जमाव तथा एस.वी.आई.–I व II में देखा गया। ये सभी पितृ व संकर संयोजन का व्यवसायिक रूप से खीरा के संकरों व किस्मों में कुल विलेय ठोस तथा बीज गुणों के विकास में किया जा सकता है।

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