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Heterosis in cucumber (*Cucumis sativus.* L.)

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Abstract
The present investigation entitled "Heterosis and Combining ability in cucumber (*Cucumis sativus.* L.)" was conducted during *Kharif*, 2013 to *Summer* 2014 under naturally ventilated polyhouse at the College of Horticulture and Forestry, Jhalawar. The material comprising of 7 parental lines, 42 F_1s and one check variety were evaluated in a Randomized Block Design with three replications. The observations were recorded for fifteen characters viz., days to germination, days to fruit maturity from anthesis, days to anthesis of first male flower, days to anthesis of first female flower, node at which first male flower appeared, node at which first female flower appeared, fruit length (cm), fruit diameter (cm), fruit weight (g), days to fruit harvesting, yield per plant (kg), number of branches per plant, vine length at 30 DAS and final harvesting stage (cm) and total soluble solids. The data were subjected to analysis of variance, heterosis over mid parent, better parent and check variety and effects (Griffing, 1956, Model 1 Method 1) for each characters. Cross combination Hilton x Swarna Sheetal was the best cross as it manifested 28.78 percent, 17.87 percent and 15.99 percent heterosis over mid, better and standard parent. Heterosis for yield per plant ranged from -36.10 percent to 25.78 percent over mid parent -41.26 percent to 17.87 percent over better parent and -39.74 percent to 15.99 percent over standard parent. The analysis of variance for experimental design revealed the existence of adequate genetic variability in the experimental material for all the traits under study.

Keywords: Heterosis, cucumber, (*Cucumis sativus.* L.), combining ability, conducted

Introduction
Cucumber (*Cucumis sativus* L.), a member of family Cucurbitaceae is grown as summer and rainy season crop in low and mid hills of Western Himalaya from April to August and fruits are available from June to October to the plains. The crop raised in the hills being of high quality and off-season brings good returns to the growers. F1 hybrids in cucumber as in many vegetable crops have several well-known advantages over open-pollinated varieties and hence, provide a scope for the breeder to find out more appropriate combination to develop superior hybrids.

The F1's are early, vigorous, high yielding, tolerant to diseases and insect-pests and more efficient in the use of water and fertilizers. Currently, the farmers are purchasing hybrid seeds from the private firms, who are charging exorbitantly. To tide over the situation, there is need to make concentrated efforts to develop F1 hybrids and making their seed available to the farmers at a reasonable price. For the development of superior hybrids, estimates of general combining ability of parents and specific combining ability of the crosses help in proper selection of parents for hybridization. Moreover, use of gynoecious lines for developing cucumber hybrids makes the production of F1 seed more cost effective.

Materials and Methods
The present material comprised of fifty genotypes involving seven parents (Three gynoecious and four monoecious). They all possible 52 F1s combinations and one check variety were evaluated in RBD design with three replications during summer, 2014 under naturally ventilated polyhouse condition at College of Horticulture and Forestry, Jhalawar. Observations were recorded on fifteen important characters, viz., days to germination, days to fruit maturity from antheis, days to anthesis of first male flower, days to anthesis of first female flower, node number at which first male flower appeared, node number at which first female flower appeared, fruit length (cm), fruit diameter (cm), fruit weight (g), days to fruit harvesting, number of branches per plant, yield per plant (kg), vine length at 30DAS and final stage of harvesting and total soluble solids. Combining ability analysis was done by using Model 1 and

Method l of Griffing (1956) [6]. Heterosis was calculated as the percentage of F1 performance in the favorable direction of its better parent as suggested by Hayes *et al*. (1955) [3].

Results and Discussion

The hybrids varied in magnitude and direction of heterosis for most of the characterss. The significant heterobeltiosis observed for days to germination in cross combination *viz.*,Swarna Sheetal x Swarna Ageti (-46.80%), Swarna Ageti x Kian (-46.63%) and JWRC-1 x Poinsette (-46.49%); days to fruit maturity from anthesis in Hilton x Swarna Ageti (-20.55%), Isatis x JWRC-1 (-16.27%) and JWRC-1 x Hilton (-15.92%); days to anthesis of first male flower in Swarna Ageti x Kian (-36.02%), Swarna Sheetal x Hilton (-29.84%) and Poinsette x JWRC-1 (-24.70%); days to anthesis of first female flower in Swarna Ageti x Kian (-40.55%), Kian x Swarna Ageti (-38.41) and Isatis x Swarna Ageti (-37.20%); heterosis for node number at which first male flower appeared in Poinsette x Swarna Sheetal (-53.15%) and Isatis x Swarna Ageti (-45.16%); for node number at which first female flower appeared in cross JWRC-1 x Isatis (-48.89%) and Swarna Ageti x Hilton (-48.75%) and for days to fruit harvesting in Swarna Sheetal x Kian (-33.37%), Swarna Sheetal x Hilton (-32.35%) and Swarna Ageti x Kian (-27.08%). (Table 1)

The heterosis for earliness has also been reported by Hulchins (1939) [4] and Om *et al.* (1987) [8] in cucumber; Bhattacharya *et al.* (1970) [1] in muskmelon; Maurya and Singh (1994) [5] and Singh *et al*. (1996) [14] in bottle gourd; Munsi and Sirohi (1993) [7] in bitter gourd and Tyagi (1997) [15] and Sharma (2002) [13] in ridge gourd which support the present finding.

Out of 45 crosses, considering three best crosses for s.c.a. effects identified for 15 characters, 42 were the produce of parents having atleast one or both the parents with high g.c.a. effects, whereas three crosses were the produce of low x low g.c.a. effects, suggesting thereby the importance of parents having high g.c.a. effects in the production of crosses expected to give high s.c.a. effects.

It was also noted that most of the hybrids which flowered earlier than the better or check variety also showed earliness in maturity indicating the positive association between these two characters. However, the hybrids flowered earlier need not necessarily borne the fruit at lower nodes. Cross combinations viz., Hilton x Poinsette (58.69), Hilton x Swarna Sheetal (58.57) and Kian x Swarna Ageti (32.51) expressed positively significant heterosis for vine length. Above findings are in accordance with the results reported by Prajapati, (2008) [9] and Prasad and Singh (1992) [10]. A desirable degree of vegetative growth is essential for realizing high fruit yield. Regarding the fruit length, one crosses expressed positively significant heterosis over heterobeltiosis in cross combination *viz.*, Hilton x Swarna Sheetal (9.88%), Isatis x Swarna Sheetal (8.66%) and Kian x Swarna Sheetal (7.35%).However, the cross combinations namely Isatis x Swarna Sheetal (28.13%) have recorded higher heterosis for fruit diameter. For average fruit weight the crosses *viz.*, Kian x Swarna Sheetal (21.46) and Hilton x Swarna Sheetal (15.54) showed higher heterosis and JWRC - 1 x Kian (66.27%) for total soluble solids. These reports are similarly Randhawa and Singh (1990) [11] and Rao *et al.* (2000) [12]. Considering the overall performance in respect of fruit yield per plant, most promising three hybrids *viz.*, Hilton x Swarna Sheetal and Poinsette x JWRC-1, exhibited high heterotic effects. These crosses have higher *sca* effects due to involvement of average x poor and average x good parents.

Table 1: Top three best better performing F_1 over better parent for different characters in cucumber

Characters	No. of crosses with Significant heterosis	Three best cross combination with heterosis value (%)
Days to germination	25	Swarna Sheetal x Swarna Ageti (-46.80%), Swarna Ageti x Kian (-46.63%), JWRC-1 x Poinsette **(**-46.49%**)**
Days to fruit maturity from Anthesis	12	Hilton x Swarna Ageti (-20.55%), Isatis x JWRC-1 (-16.27%), JWRC-1 x Hilton (-15.92%)
Days to anthesis of first male flower	12	Swarna Ageti x Kian (-36.02%), Swarna Sheetal x Hilton (-29.84%), Poinsette x JWRC-1 (-24.70%)
Days to anthesis of first female flower	22	Kian x Swarna Ageti (-38.41%), Isatis x Swarna Ageti (-37.20%), Swarna Sheetal x Isatis (-36.30%)
Node at which first male flower appeared	10	Poinsette x Swarna Sheetal (-53.13%), Isatis x Swarna Ageti (-45.16%), Isatis x Poinsette (-40.74%)
Node at which first female flower appeared	24	JWRC-1 x Isatis (-48.89%), Swarna Ageti x Hilton (-48.75%), Poinsette x Kian (-48.28%)
Fruit length	3	Hilton x Swarna Sheetal (9.88%), Isatis x Swarna Sheetal (8.66%), Kian x Swarna Sheetal (7.35%)
Fruit diameter	1	Isatis x Swarna Sheetal (28.13%)
Fruit weight	4	Kian x Swarna Sheetal (21.46%) Hilton x Swarna Sheetal (15.54%)
Days to fruit harvesting	15	Swarna Sheetal x Kian (-33.37%), Swarna Sheetal x Hilton (-32.35%),
Yield per plant	8	Hilton x Swarna Sheetal (17.87%), Poinsette x Kian (17.69%),

		Hilton x Kian (7.14%) Kian x JWRC-1 (58.92%),
Number of branches per plant	10	Hilton x JWRC-1 (58.38%), Isatis x Swarna Sheetal (51.31%) Hilton x Poinsette (58.69%),
Vine length at 30 DAS	3	Hilton x Swarna Sheetal (58.57%), Kian x Swarna Ageti (32.51%)
Vine length at final stage of Harvesting	7	Kian x Swarna Sheetal (26.84%), Swarna Sheetal x Kian (21.30%)
Total soluble solids (%)	1	JWRC-1 x Kian (66.27%)

* Significance at 5%
** Significance at 1%

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