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Short communication

Heterosis and inbreeding depression in tomato under low temperature regime

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ABSTRACT

Heterosis and inbreeding depression was studied in tomato under low temperature regime. A total of six parental lines comprising of two cold set (Pusa Sheetal and Pusa Sadabahar) and four non-cold set (Booster, DT-39, Pusa Uphar and Chiku) were crossed in a diallel fashion without reciprocals to obtain 15 F_1s. Significant positive as well as negative heterosis over better and mid-parent for first fruit set was recorded in most of the crosses. Maximum heterosis over better parent was recorded in cross PSH × DT 39 (-7.55%). Hybrids PS × CH (51.92%) followed by PSH × PU (46.88%) had the maximum heterosis over better parent in desirable positive direction. Hence, PSH × PS and PSH × CH F_1 hybrids could be recommended for growing successfully under low temperature regime because of their ability to set fruit, early and higher total yield.

Key words: Heterosis, imbreeding depression low temperature, tomato.

Tomato [*Solanum lycopersicon* (Mill.) Wettsd.] is one of the most important commercial crops grown extensively in the tropical and sub-tropical region of the world. It is widely grown both under green house as well as field condition. In India, tomato is grown over an area of 0.63 million ha with annual production of 12.43 million tonnes (Anon, 1). The cultivation of tomato is restricted to few/specific months in north Indian plains due to extreme temperature prevailing during winter and summer months. The optimu m night temperature for good fruit set in tomato is 15-20°C (Went, 10). Although many sources of cold tolerance have been reported and even used in breeding programmes, not much is known about the genetic factors underlying this trait, except that the inheritance is complex. Fruit set seems to be controlled by recessive factors. In our country, a wide range of genetic variability with respect to different quantitative and qualitative traits available in this crop. A speedy improvement of these traits can be brought by assessing the genetic variability and exploitation of heterosis. Heterosis is one of the most efficient breeding methods for obtaining varieties having high yield as well as quality fruits which are important for realizing economic gain. Due to high yielding potential, the hybrid varieties of tomato are now gaining popularity among growers. Hence, a study was conducted to determine magnitude of heterosis and explore the possibilities of utilizing the hybrid vigour at commercial scale.

The present investigation was carried out at experimental field of the Division of Vegetable Science, IARI, New Delhi. A total of six parental lines comprising of two cold set (Pusa Sheetal and Pusa Sadabahar) and four non-cold set (Booster, DT-39, Pusa Uphar and Chiku) were crossed in a diallel fashion without reciprocals to obtain 15 F_1s. The nursery sowing of parental lines was done on 1st November and was transplanted to main field on 3rd December. All cultural practices recommended for successful cultivation of tomato crop were practiced. Hybridization among parental lines was carried out by hand emasculation and pollination during March to produce F_1 seeds, the F_1s were transplanted to main field on 5th December. All F_1s were allowed to self to produce F_2 seeds. All parents, F_1s and F_2s were transplanted on raised beds in experimental field with spacing of 45 cm between plants. The experiment was laid out in randomized block design (RBD) with three replications.

Among the F_1 hybrids, the best performances with maximum heterosis percentage in favourable direction over mid-parent or better parent for different characters. Significant positive as well as negative heterosis over better and mid-parent for first fruit set was recorded in most of the crosses. Maximum heterosis over better parent was recorded in cross PSH × DT 39 (-7.55%). Majority of the crosses in present study showed negative heterosis for days to first fruit set which confirm to the work of Govindarasu *et al.* (5). An early flowering is not always a vital criterion for determining earliness, as some hybrids which exhibited early flowering could not show earliness in harvest. Therefore, days taken to first harvest are equally important in determining the earliness of the hybrids. Except for one cross PS × CH (0.31%) all the crosses expressed significant

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heterosis over mid parent and better parent for days to first fruit harvest. Significant negative heterosis was recorded in most of the crosses. Maximum heterosis over better parent was expressed by cross PSH x PS (-8.79%). Joshi and Thakur (6) also reported similar results. In contrast, Rai *et al.* (8) and Chaudhary and Malhotra (2) did not observe heterosis in desirable negative direction.

Days to 50% flowering, first fruit set, and first fruit harvest were considered important indicators for earliness in hybrids. Maximum heterosis over mid parent and better parent was observed in cross PSH × PS (-14.88 and -11.56%, respectively) for days to 50% flowering. Similarly, negative heterosis in desirable direction was observed by Joshi and Thakur (6). Significant inbreeding depression was recorded in three crosses, *viz.*, PSH × PS (-10.64%), PSH × B (-5.88%) and PSH × CH (-3.36%). A close relationship between heterosis response and inbreeding depression was observed, *i.e.*, crosses with high heterosis showed high inbreeding depression. This could be due to high magnitude of non-additive gene effect. Similar result was also reported by Rai *et al.* (8), while working on tomato.

Hybrid PSH × PS (158.49%) followed by PS × Booster (139.36%) expressed maximum heterosis over better parent in desirable positive direction. Maximum heterosis over mid parent was expressed by cross PSH × PS (133.77%). High heterosis for yield per plant was also reported by Wang *et al.* (9), Chaudhary and Malhotra (2), and Dudi and Sanwal (3). Five crosses exhibited positive significant inbreeding depression for yield per plant ranging between 4.17 per cent (PS × DT-39) to 24.30 per cent (PSH × DT-39). Earlier workers, Rai *et al.* (8), and Pandey and Dixit (7) have also reported similar type of inbreeding depression.

Higher plant height in determinate plant types is desirable and not in indeterminate types especially under field conditions. PHS × CH (34.66%) expressed the maximum significant heterosis over better parent. Significant high positive heterosis for height was also observed by Chaudhary and Malhotra (2), and Dudi and Sanwal (3). Significant positive and negative inbreeding depression was exhibited by all the nine crosses. Maximum inbreeding depression was recorded in cross PS x B (22.76 %) following by PSH × CH (21.96%). PSH × CH revealed significant heterosis in F_1 coupled with high inbreeding depression in F_2 generation. These results are in agreement with the findings of Pandey and Dixit (7).

Average fruit weight directly influenced the total yield per plant. Observation taken on this character revealed that PS × CH (51.92%) followed by PSH × PU (46.88%) had maximum heterosis over better parent in desirable positive direction. These results are in consonance with Joshi and Thakur (6). Significant positive inbreeding depression for fruit weight was found in six crosses. Similar results were also reported by Rai *et al.* (8), whereas, Pandey and Dixit (7) observed both positive and negative inbreeding depression for fruit weight. Significant heterosis over better parent for number of fruits per plant was expressed in eight out of nine crosses. Maximum heterosis was recorded in cross PSH × PS (68.99%). Both positive and negative heterosis over mid parent was observed in all the crosses except in cross PSH × PU. Similar results were also reported by Joshi and Thakur (6). Maximum inbreeding depression was recorded in cross PSH × PS (12.16%) followed by PS × DT-39 (9.92%).

Positive and negative inbreeding depression for fruit per plant was also reported by Rafael and

Table 1. Per cent heterosis and inbreeding depression for first fruit set, first harvest and 50% flowering.

F_1	First fruit set			Days to first harvest			Days to 50% flowering		
	BP	MP	ID	BP	MP	ID	BP	MP	ID
PSH × PS	-5.20**	-3.17*	-12.20**	-8.79**	-6.85**	-4.96**	-11.56**	-14.88**	-10.64*
PSH × B	6.97**	2.96**	-2.25	-3.92**	0.57	-0.51	-5.68**	2.39**	-5.88**
PSH × DT-39	-7.55**	-1.41	-3.09	-5.39**	-1.95**	-2.11*	-2.58**	1.01	-1.90
PSH × PU	5.85**	2.78*	-0.68	-1.97**	3.58**	-3.18*	-7.45**	0.27	-0.10
PSH × CH	6.37**	12.69**	-0.51	0.95*	3.94**	-3.76*	7.92**	11.53**	-3.36*
PS × B	-6.69**	5.24**	-1.67	7.77**	-3.42**	-2.74*	-9.20**	0.19	-2.78
PS × DT-39	2.42*	11.40**	3.54*	-3.89**	3.03**	-2.34*	3.24**	8.91**	1.27
PS × PU	1.65	13.12**	2.12	-2.21**	6.80**	-3.68*	-1.47*	8.50**	1.82
PS × CH	-1.36	8.61**	1.71	-0.31	6.19**	4.82**	1.98**	7.22**	-2.27
CD at 5%	2.78	2.28	2.31	2.16	1.83	1.38	1.28	2.36	2.84

*, ** Significant at 5 and 1% levels, BP = Better parent, MP = Mid parent.

Table 2. Per cent heterosis and inbreeding depression for yield/plant, plant height, number of fruits/plant and fruit weight.

F_1	Yield/plant (kg)			Plant height (cm)			No. of fruits/plant			Fruit weight (g)		
	BP	MP	ID	BP	MP	ID	BP	MP	ID	BP	MP	ID
PSH × PS	158.49**	133.77**	15.15**	4.96*	20.70**	13.39**	68.99**	15.86**	12.16**	-16.00*	-11.62*	12.16**
PSH × B	76.60**	48.84	18.13**	24.05**	21.27**	15.98**	16.24**	-16.34**	5.28**	1.16	6.74**	5.28**
PSH × DT-39	64.62**	68.24**	24.30**	-0.28	-0.74	5.60**	15.73**	-7.69**	-1.16	28.78**	25.69**	-1.13
PSH × PU	113.36**	82.32**	6.57**	10.36**	12.63**	20.00**	13.46*	2.77	6.80**	46.88**	38.49**	6.80**
PSH × CH	108.88**	59.20**	14.38**	34.66**	20.23**	21.96**	37.55**	-26.66	-0.59	39.98**	34.55**	0.59
PS × B	139.36**	39.86**	12.98**	-3.70	8.61**	22.76**	2.75	-29.85**	1.26	8.79**	7.75**	1.26
PS × DT-39	47.69**	9.71	4.17**	-9.90**	3.18	18.12**	20.04**	-8.88	9.92**	9.69**	0.01	9.92**
PS × PU	23.06**	-26.98**	-24.38**	-8.65**	6.86**	16.93**	-23.19**	-33.50**	7.31**	38.28**	21.48**	7.31**
PS × CH	72.32**	-10.99	6.06**	2.97	7.44**	-2.43	65.93**	16.69**	5.80**	51.92**	36.24**	5.80**
CD at 5%	0.333	0.312	0.33	3.05	2.35	2.39	2.93	2.28	2.05	3.14	2.87	2.84

*, ** Significant at 5 and 1% levels of significance, respectively

Eduardo (4) and Rai *et al.* (8). Based on the heterosis performance of crosses for various characters, PSH × PS ranked top position for most of the characters followed by PSH × CH. Hence, PSH × PS and PSH × CH F_1 hybrids could be recommended for growing successfully under low temperature regime because of their ability to set fruit, early and higher total yield.

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