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Exploitation of heterosis for yield and its contributing traits in tomato, *Solanum lycopersicum* L

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ABSTRACT

Heterosis for yield and other component characters of 45 F_1 hybrids of tomato derived from the crosses between 15 lines and 3 testers through line x tester technique was studied. Maximum and significant heterosis in favourable direction was observed for yield, fruit number, plant height and fruits per cluster. Heterosis was appreciable in all hybrids, but was more in four hybrids viz Sioux x FT-5, S-1001 x Solan Vajr, EC-521041 x FT-5 and S-1001 x EC-15998.

Keywords: Heterosis, yield, tomato

INTRODUCTION

Tomato (*Solanum lycopersicum* L) is one of the most important, popular and widely grown vegetables in the world. It is the most remunerative cash crop of mid hills of Himachal Pradesh. The pace with which the F_1 hybrids of tomato are gaining popularity, it is demanding now to obtain such hybrids in public sector also, which have excellent quality and yield stability. The average fruit yield in tomato is very low as compared to Japan. Thus there is a vast scope for its improvement which can be achieved through breeding high yielding varieties/hybrids. Therefore, it was planned to develop high yielding tomato hybrids along with other contributing traits suitable for growing under hill conditions.

MATERIAL AND METHODS

The experimental material consisted of 15 lines viz EC-31761, EC-521067, EC-521041, EC-521054, EC-1914, EC-538146, EC-5888, EC-524087, EC-521051, EC-144336, EC-13736, EC-60531, Sioux, S-4 and S-1001 was crossed with three testers viz FT-5, Solan Vajr and EC-15998 in line x tester fashion to obtain forty five hybrid combinations in summer 2007 at the vegetable research farm of the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan. Crosses were made manually using the standard procedure of hand emasculation and pollination. F_1s were evaluated along with their parents for various horticultural traits

and compared with commercial hybrid Naveen. The experiment was laid out in Randomized Block Design with three replications. Eighteen plants of each entry (45 F_1, 15 lines, 3 testers and 1 check) were transplanted in first week of April 2008 at spacing of 90 x 30 cm. The standard cultural practices to raise tomato crop were followed as per the recommendations of the university. Observations were recorded on days to first flowering, plant height, number of fruits per cluster, number of fruits per plant, average fruit weight, fruit yield per plant, pericarp thickness, total soluble solids, ascorbic acid and harvest duration. Statistical analysis was done on the mean values and heterosis was determined as increase or decrease of F_1 hybrids over better parent and commercial hybrid Naveen.

RESULTS AND DISCUSSION

The mean performance of parents and crosses is presented in Table 1. The per cent of heterosis estimated over better parent and commercial hybrid Naveen is given in Table 2.

Perusal of data reveal that among lines minimum days taken to first flowering were recorded in EC-1914 (32.67 days). The testers FT-5, Solan Vajr and EC-15998 took 34.33, 35.67 and 33.67 days to first flowering, respectively. Among hybrids, minimum number of days for flowering were recorded in EC-13736 x Solan Vajr (32.00 days). The maximum significant negative heterosis over better parent for days to first flowering in tomato was recorded in EC-538146 x Solan Vajr (-8.41%). Only two cross combinations, EC-521041 x Solan Vajr (-6.56%) and EC-538146 x Solan Vajr (-8.41%) showed significant negative heterosis over better parent. Negative heterosis for days to first flowering was also reported by Premalakshme et al (2005). Out of forty five cross combinations, only three cross combinations, EC-538146 x Solan Vajr, EC-13736 x Solan Vajr and EC-13736 x EC-15998 were early in flowering to check Naveen.

The plant height is an important trait by which growth and vigour of plants are measured. Indeterminate varieties/hybrids are generally preferred due to longer harvest duration and less incidence of buckeye rot disease of tomato. Among lines, the maximum plant height was recorded in EC-524087 (175.22 cm). The plant height in testers was recorded 150.40 cm, 145.33 cm and 158.22 cm for FT-5, Solan Vajr and EC-15998 , respectively. Among F_1s, maximum plant height was recorded in EC-521041 x FT-5 (198.25 cm). The heterobeltiotic effects ranged from -29.13 to 33.26 per cent being lowest in S-4 x EC-15998 and highest in Sioux x Solan Vajr. Twenty seven cross combinations showed significant positive heterosis over check Naveen, highest being in EC-521041 x FT-5 (16.36%). Positive heterosis over

Table 1. Mean performance of parents, crosses and check for different horticultural traits in tomato

Parents	Days to first flowering	Plant height (cm)	Number of fruits per cluster	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)	Pericarp thickness (mm)	Total soluble solids (°B)	Ascorbic acid (mg/100g)	Harvest duration (days)
Lines										
EC-31761	36.37	155.00	3.21	19.57	56.16	1098.51	5.44	3.34	23.40	34.00
EC-521067	34.33	130.00	3.15	21.10	58.42	1230.60	5.25	2.12	28.88	33.33
EC-521041	37.00	152.50	2.38	20.73	70.25	1450.28	5.60	3.20	25.42	34.67
EC-521054	34.67	173.15	3.35	23.00	48.53	1115.10	4.73	3.54	36.12	35.00
EC-1914	32.67	170.37	3.40	22.27	44.68	994.02	4.94	4.20	25.20	34.33
EC-538146	35.67	145.00	3.25	21.25	56.32	1195.80	5.27	3.08	28.17	32.00
EC-5888	34.67	125.00	3.28	23.00	40.13	967.00	4.48	3.80	32.40	31.00
EC-524087	37.67	175.22	3.18	20.80	55.27	1148.61	5.22	3.00	30.38	37.00
EC-521051	34.00	165.34	3.23	19.37	52.13	1008.75	5.35	3.58	33.32	36.67
EC-144336	37.00	141.67	3.19	20.25	53.42	1080.70	5.30	3.24	34.57	32.33
EC-13736	33.00	137.50	3.13	23.21	38.17	931.34	3.33	3.87	34.48	32.67
EC-60531	33.33	168.24	3.60	22.32	42.28	942.60	4.02	3.75	36.15	28.67
Sioux	34.67	115.21	2.23	17.00	72.18	1227.06	5.70	3.90	21.28	33.00
S-4	35.00	162.28	2.98	17.80	58.00	1031.40	5.27	3.27	27.10	35.00
S-1001	34.00	78.75	3.00	15.50	70.50	1092.75	5.41	3.48	25.40	25.67
Testers										
FT-5	34.33	150.40	3.10	17.16	71.20	1102.60	5.60	3.50	23.80	34.00
Solan Vajr	35.67	145.33	2.56	19.62	72.50	1276.45	5.68	3.44	24.45	35.67
EC-15998	33.67	158.22	2.75	18.20	68.00	1106.22	5.54	3.35	23.53	32.00

Crosses										
EC-31761 x FT-5	37.00	179.84	3.35	21.94	67.24	1474.24	5.50	3.68	25.33	36.00
EC-31761 x Solan Vajr	35.33	183.38	2.70	19.32	76.28	1472.72	6.17	3.53	23.81	35.67
EC-31761 x EC-15998	37.33	192.15	3.40	24.00	57.50	1378.20	6.08	3.72	27.14	37.00
EC-521067 x FT-5	34.67	150.32	3.63	22.15	58.41	1290.78	5.48	3.56	26.27	34.33
EC-521067 x Solan Vajr	35.67	192.38	2.80	17.57	76.38	1340.92	5.57	3.58	23.42	37.67
EC-521067 x EC-15998	38.00	176.75	2.73	20.00	68.33	1360.62	6.10	3.54	27.57	35.00
EC-521041 x FT-5	37.33	198.25	4.20	22.80	75.30	1710.81	6.21	3.60	24.47	38.00
EC-521041 x Solan Vajr	33.33	185.47	3.77	24.20	60.52	1450.58	6.07	3.70	28.41	37.00
EC-521041 x EC-15998	35.67	172.42	3.80	23.53	62.47	1460.90	6.02	3.68	28.73	37.33
EC-521054 x FT-5	34.33	157.00	3.58	28.25	56.72	1600.23	5.75	3.77	26.23	36.00
EC-521054 x Solan Vajr	34.00	193.20	3.00	23.52	65.30	1535.85	5.82	4.25	27.10	38.00
EC-521054 x EC-15998	36.00	176.67	3.20	24.82	60.15	1490.91	5.70	3.67	29.23	36.67
EC-1914 x FT-5	38.00	170.88	3.20	20.50	81.75	1672.82	6.28	3.33	20.80	35.67
EC-1914 x Solan Vajr	33.67	185.37	3.42	22.42	68.46	1530.87	6.18	3.53	28.71	39.33
EC-1914 x EC-15998	35.67	140.00	3.53	25.47	52.28	1320.57	5.46	3.65	31.12	38.67
EC-538146 x FT-5	34.67	162.50	3.28	23.13	58.19	1340.93	5.49	3.74	33.83	36.00
EC-538146 x Solan Vajr	32.67	157.55	3.73	23.52	50.86	1190.22	5.02	3.72	30.40	32.67
EC-538146 x EC-15998	36.33	183.34	3.84	28.45	48.13	1353.24	5.08	4.15	29.62	38.00
EC-5888 x FT-5	35.33	189.53	3.38	18.58	57.47	1067.70	5.22	4.23	34.00	34.33
EC-5888 x Solan Vajr	35.00	190.50	2.80	20.80	53.58	1113.46	5.18	3.83	36.00	35.33
EC-5888 x EC-15998	35.67	168.26	3.82	23.58	50.41	1187.66	5.15	3.90	31.75	33.67
EC-524087 x FT-5	36.67	193.60	3.70	28.15	65.23	1834.22	6.17	3.45	28.92	39.67
EC-524087 x Solan Vajr	37.00	181.13	2.85	24.21	73.18	1770.60	6.26	3.51	30.74	38.00
EC-524087 x EC-15998	36.67	194.17	3.50	23.00	68.47	1573.80	6.08	3.85	28.53	39.33
EC-521051 x FT-5	35.00	165.00	2.31	21.54	66.24	1425.80	6.12	3.62	32.90	38.67
EC-521051 x Solan Vajr	35.67	190.24	3.42	20.47	73.32	1500.86	6.15	4.60	29.71	39.00

Table 2 (a). Heterobeltiotic effects and economic heterosis for different horticultural traits in tomato

Cross	Days to first flowering		Plant height (cm)		Number of fruits per cluster		Number of fruits per plant		Average fruit weight (g)	
	1	2	1	2	1	2	1	2	1	2
EC-31761 x FT-5	7.78*	12.12*	16.03*	5.55*	4.36*	-17.49*	12.11*	-10.45*	-5.56*	-18.50*
EC-31761 x Solan Vajr	-0.95	7.06*	18.31*	7.63*	-15.89*	-33.50*	-1.53	-21.14*	5.21*	-7.54*
EC-31761 x EC-15998	10.87*	13.12*	21.44*	12.78*	5.92*	-16.26*	22.64*	-2.04	-15.44*	-30.30*
EC-521067 x FT-5	0.99	5.06*	-0.05	-11.77*	15.24*	-10.59*	4.98*	-9.59*	-17.96*	-29.20*
EC-521067 x Solan Vajr	3.90*	8.09*	32.37*	12.91*	-11.11*	-31.03*	-16.73*	-28.29*	5.35*	-7.42*
EC-521067 x EC-15998	12.86*	15.15*	11.71*	3.74*	-13.33*	-32.76*	-5.21*	-18.37*	0.49	-17.18*
EC-521041 x FT-5	8.74*	13.12*	30.00*	16.36*	35.48*	3.44*	9.99*	-6.94*	5.76*	-8.73*
EC-521041 x Solan Vajr	-6.56*	1.00	21.62*	8.86*	47.26*	-7.14*	16.74*	-1.22	-16.52*	-26.64*
EC-521041 x EC-15998	5.94*	8.09*	8.97*	1.20	38.18*	-6.40*	13.51*	-3.96*	-11.07*	-24.28*
EC-521054 x FT-5	0.00	4.03*	-9.33*	-7.85*	6.87*	-11.82*	22.83*	15.31*	-20.34*	-31.25*
EC-521054 x Solan Vajr	-1.93	3.03	11.58*	13.39*	-10.45*	-26.11*	2.26	-4.00*	-9.93*	-20.85*
EC-521054 x EC-15998	6.92*	9.09*	2.03	3.69*	-4.48*	-21.18*	7.91*	1.31	-11.54*	-27.09*
EC-1914 x FT-5	16.31*	15.15*	0.30	0.29	-5.88*	-21.18*	-7.95*	-16.33*	14.82*	-0.91
EC-1914 x Solan Vajr	3.06	2.03	8.80*	8.80*	0.59	-15.76*	0.67	-8.49*	-5.57*	-17.02*
EC-1914 x EC-15998	9.18*	8.09*	-17.83*	-17.83*	3.82*	-13.05*	14.37*	3.96*	-23.12*	-36.63*
EC-538146 x FT-5	0.99	5.06*	8.05*	-4.62*	0.92	-19.21*	8.85*	-5.59*	-18.27*	-29.47*
EC-538146 x Solan Vajr	-8.41*	-1.00	8.41*	-7.53*	14.77*	-8.13*	10.68*	-4.00*	-29.85*	-38.35*
EC-538146 x EC-15998	7.90*	10.09*	15.88*	7.61*	18.15*	-5.42*	33.88*	16.12*	-29.22*	-41.66*
EC-5888 x FT-5	2.91	7.06*	26.02*	11.24*	3.05	-16.75*	-19.22*	-24.16*	-19.28*	-30.34*
EC-5888 x Solan Vajr	0.95	6.06*	31.08*	11.81*	-14.63*	-31.03*	-9.57*	-15.10*	-26.10*	-35.05*
EC-5888 x EC-15998	5.94*	8.09*	6.35*	-1.24	16.46*	-5.91*	2.52	-3.76*	-25.87*	-38.90*

EC-524087 x FT-5	6.82*	11.12*	10.49*	13.63*	16.35*	-8.87*	35.34*	14.90*	-8.38*	-20.93*
EC-524087 x Solan Vajr	3.73*	12.12*	3.37	6.31*	-10.38*	-29.80*	16.39*	-1.18	0.94	-11.30*
EC-524087 x EC-15998	8.91*	11.12*	10.81*	13.96*	10.06*	-13.79*	10.58*	-6.12*	0.69	-17.01*
EC-521051 x FT-5	2.94	6.06*	-0.21	-3.16	-28.48*	-43.10*	11.20*	-12.08*	-6.97*	-19.71*
EC-521051 x Solan Vajr	4.91*	8.09*	15.06*	11.66*	5.88*	-15.76*	4.33*	-16.45*	1.13	-11.13*
EC-521051 x EC-15998	6.92*	9.09*	-7.77*	-10.49*	3.72*	-17.49*	19.88*	-5.22*	-3.56*	-20.51*
EC-144336 x FT-5	-0.96	3.03	5.45*	-6.91*	11.29*	-12.56*	-9.53*	-25.22*	-5.14*	-18.13*
EC-144336 x Solan Vajr	0.00	8.09*	13.70*	-3.02	-1.88	-22.91*	9.38*	-9.59*	2.39	-10.02*
EC-144336 x EC-15998	10.87*	13.12*	15.88*	7.61*	12.23*	-11.82*	29.88*	7.35*	-5.49*	-22.10*
EC-13736 x FT-5	2.03	2.03	14.44*	1.02	10.22*	-15.02*	-9.00*	-13.80*	-32.30*	-41.58*
EC-13736 x Solan Vajr	-3.03	-3.03	22.19*	4.23*	23.00*	-5.17*	9.00*	3.27	-37.41*	-44.99*
EC-13736 x EC-15998	-1.00	-1.00	6.72*	-0.89	7.03*	-17.49*	-10.38*	-15.10*	-23.25*	-36.74*
EC-60531 x FT-5	2.01	3.03	-4.90*	-6.09*	2.22	-9.36*	17.38*	6.94*	-36.38*	-45.09*
EC-60531 x Solan Vajr	6.00*	7.06*	6.99*	5.65*	-10.28*	-20.44*	9.18*	-0.53	-29.49*	-38.04*
EC-60531 x EC-15998	4.02*	5.06*	-13.81*	-14.90*	-2.78	-13.79*	3.72*	-5.51*	-11.26*	-26.86*
Sioux x FT-5	5.83*	10.09*	29.88*	14.65*	44.19*	10.10*	66.08*	16.33*	2.05	-10.72*
Sioux x Solan Vajr	-0.98	4.03*	33.26*	13.67*	51.17*	-4.68*	13.20*	-9.35*	19.01*	4.58*
Sioux x EC-15998	8.91*	11.12*	21.03*	12.40*	49.09*	0.99	34.62*	0.00	6.98*	-6.40*
S-4 x FT-5	9.73*	14.15*	15.33*	9.84*	6.45*	-18.72*	29.78*	-5.71*	3.27*	-10.87*
S-4 x Solan Vajr	5.71*	12.12*	9.45*	4.25*	20.81*	-11.33*	3.06	-17.47*	14.21*	0.36
S-4 x EC-15998	1.96	4.03*	-29.13*	-32.50*	40.94*	3.45*	32.58*	-1.51	-11.50*	-27.05*
S-1001 x FT-5	2.94	6.06*	-13.56*	-23.70*	24.19*	-5.17*	29.49*	-9.31*	15.53*	-0.29
S-1001 x Solan Vajr	1.97	5.06*	27.30*	8.58*	36.00*	0.49	1.94	-18.37*	24.98*	9.83*
S-1001 x EC-15998	1.96	4.03*	10.11*	2.25	37.67*	1.72	16.76*	-13.27*	19.93*	2.48

1= Better parent, 2= Check
* Significant at 5% level of significance

Table 2 (b). Heterobeltiotic effects and economic heterosis for different horticultural traits in tomato

Cross	Fruit yield per plant (g)		Pericarp thickness (mm)		Total soluble solids (°B)		Ascorbic acid (mg/100g)		Harvest duration (days)	
	1	2	1	2	1	2	1	2	1	2
EC-31761 x FT-5	33.71*	5.88*	-3.56*	-27.03*	-1.79	-15.38*	5.14*	-10.46*	6.43*	-16.68*
EC-31761 x Solan Vajr	15.38*	0.00	-4.45*	-27.10*	8.63*	-5.08*	2.62	-14.11*	-2.62	-21.68*
EC-31761 x EC-15998	24.59*	8.82*	-0.88	-31.78*	9.75*	-6.46*	11.04*	-9.49*	15.34*	-10.72*
EC-521067 x FT-5	4.89*	0.97	-8.04*	-36.11*	-2.14	-15.69*	1.71	-13.38*	-9.04*	-13.59*
EC-521067 x Solan Vajr	5.05*	5.61*	0.91	-33.63*	-1.94	-14.31*	4.07*	-12.90*	-18.91*	-22.96*
EC-521067 x EC-15998	10.57*	5.01*	-6.24*	-32.65*	10.11*	-6.15*	5.67*	-13.87*	-4.54*	-9.31*
EC-521041 x FT-5	17.96*	9.60*	1.79	-15.32*	10.89*	-4.46*	2.86	-12.41*	-3.74	-19.51*
EC-521041 x Solan Vajr	0.02	3.73*	-0.88	-28.20*	6.87*	-6.62*	7.56*	-9.98*	11.76*	-6.55*
EC-521041 x EC-15998	0.73	7.67*	0.00	-27.69*	7.50*	-7.38*	9.85*	-10.46*	13.02*	-5.49*
EC-521054 x FT-5	43.51*	2.86	-3.56*	-20.79*	2.68	-11.54*	6.50*	-8.27*	-27.38*	-13.72*
EC-521054 x Solan Vajr	20.32*	6.53*	1.79	-23.98*	2.46	-10.46*	20.06*	3.41*	-24.97*	-10.86*
EC-521054 x EC-15998	33.70*	4.77*	-1.77	-26.20*	2.89	-12.31*	3.67*	-10.71*	-19.08*	-3.85*
EC-1914 x FT-5	51.72*	3.90*	-4.45*	-17.20*	12.14*	-3.38*	-20.71*	-18.98*	-17.46*	-31.58*
EC-1914 x Solan Vajr	19.93*	10.26*	5.36*	-24.22*	8.80*	-4.92*	-15.95*	-14.11*	13.93*	-5.56*
EC-1914 x EC-15998	19.38*	12.64*	3.59*	-34.63*	-1.44	-16.00*	-13.10*	-11.19*	23.49*	2.37
EC-538146 x FT-5	12.14*	5.88*	-3.56*	-33.63*	-1.96	-15.54*	6.86*	-9.00*	20.09*	11.28*
EC-538146 x Solan Vajr	-6.76*	-8.41*	-12.48*	-41.09*	-11.62*	-22.77*	8.14*	-9.49*	7.92*	0.00
EC-538146 x EC-15998	13.17*	18.75*	1.79	-33.02*	-8.30*	-21.85*	23.88*	0.97	5.15*	-2.57
EC-5888 x FT-5	-3.17	0.97	-8.04*	-47.15*	-6.79*	-19.69*	11.32*	2.92*	4.94*	11.84*
EC-5888 x Solan Vajr	-12.77*	-0.95	-5.36*	-44.89*	-8.80*	-20.31*	0.79	-6.81*	11.11*	18.42*

EC-5888 x EC-15998	7.36*	5.22*	-9.80*	-41.21*	-7.04*	-20.77*	2.63	-5.11*	-2.01	4.44*
EC-524087 x FT-5	59.69*	7.21*	6.26*	-9.21*	10.18*	-5.08*	-1.43	-16.06*	-4.81*	-4.87*
EC-524087 x Solan Vajr	38.71*	2.70	1.79	-12.36*	10.21*	-3.69*	2.03	-14.60*	1.18	1.12
EC-524087 x EC-15998	37.02*	6.30*	5.36*	-22.10*	9.75*	-6.46*	14.93*	-6.33*	-6.09*	-6.15*
EC-521051 x FT-5	29.31*	5.45*	3.59*	-29.42*	9.29*	-5.85*	1.12	-11.92*	-1.26	8.22*
EC-521051 x Solan Vajr	17.58*	6.35*	4.47*	-25.71*	8.27*	-5.38*	28.49*	11.92*	-10.83*	-2.27
EC-521051 x EC-15998	38.16*	0.00	-1.77	-24.35*	11.3*	-5.08*	-5.03*	-17.27*	-4.74*	4.41*
EC-144336 x FT-5	12.13*	9.79*	0.00	-38.80*	8.93*	-6.15*	-5.14*	-19.22*	-12.84*	-0.89
EC-144336 x Solan Vajr	6.45*	6.53*	1.80	-32.74*	6.51*	-6.92*	8.43*	-9.25*	-26.35*	-16.25*
EC-144336 x EC-15998	51.90*	30.93*	13.39*	-16.83*	8.30*	-7.69*	3.58*	-15.57*	-21.43*	-10.66*
EC-13736 x FT-5	-7.76*	-6.85*	-15.16*	-49.66*	-21.79*	-32.62*	11.11*	4.62*	8.56*	23.13*
EC-13736 x Solan Vajr	-10.05*	-15.90*	-19.64*	-43.17*	-23.94*	-33.54*	14.47*	7.79*	14.15*	29.47*
EC-13736 x EC-15998	-1.87	-1.04	-13.39*	-46.27*	-17.69*	-29.85*	4.91*	-1.22	2.32	16.05*
EC-60531 x FT-5	7.55*	0.97	-8.04*	-41.30*	-19.29*	-30.46*	6.13*	-3.16*	7.19*	27.47*
EC-60531 x Solan Vajr	-2.79	0.00	-4.45*	-38.58*	-4.58*	-16.62*	2.13	-6.81*	-6.94*	10.66*
EC-60531 x EC-15998	26.18*	5.22*	-9.80*	-30.91*	-0.72	-15.38*	-5.33*	-13.63*	-13.03*	3.42
Sioux x FT-5	71.14*	23.53*	12.51*	3.95*	10.53*	-3.08*	0.51	-4.62*	6.39*	-16.71*
Sioux x Solan Vajr	50.05*	12.14*	7.15*	-5.20*	14.39*	0.31	-14.87*	-19.22*	-14.11*	-30.92*
Sioux x EC-15998	54.08*	18.18*	4.47*	-6.41*	9.65*	-3.85*	-16.41*	-20.68*	13.47*	-12.17*
S-4 x FT-5	53.87*	12.37*	5.36*	-16.02*	10.89*	-4.46*	-4.00*	-18.25*	-10.41*	-20.13*
S-4 x Solan Vajr	31.08*	7.46*	2.68	-17.18*	11.27*	-2.77*	-9.88*	-24.57*	-24.35*	-32.57*
S-4 x EC-15998	31.27*	2.86	-3.56*	-28.12*	-0.72	-15.38*	2.69	-16.30*	-3.06	-13.59*
S-1001 x FT-5	62.85*	2.94	-6.24*	-11.11*	16.96*	0.77	-7.14*	-20.92*	-2.83	-18.82*
S-1001 x Solan Vajr	43.11*	7.46*	2.68	-9.57*	19.37*	4.31*	17.82*	-0.24	-6.50*	-21.88*
S-1001 x EC-15998	63.81*	17.72*	0.91	-10.29*	14.62*	-2.31	-3.16	-18.00*	2.05	-14.74*

1= Better parent, 2= Check
* Significant at 5% level of significance

better parent for plant height has also been reported by Rani and Veeraragavathatham (2008) and Sharma and Thakur (2008). Maximum number of fruits per cluster was recorded in EC-60531 (3.60) among lines. The testers FT-5, Solan Vajr and EC-15998 had 3.10, 2.56 and 2.75 fruits per cluster, respectively. Amongst crosses, maximum number of fruits per cluster was exhibited by Sioux x FT-5 (4.47). The heterosis over better parent was found maximum in Sioux x Solan Vajr (51.17 %). Twenty nine crosses showed significant positive heterosis over better parent for the given trait. The heterosis over check Naveen was recorded highest in Sioux x FT-5 (10.10%). Similar results were also reported by Harer et al (2006) and Sharma and Thakur (2008).

The number of fruits per plant is a major yield contributing character and it was found maximum in EC-13736 (23.21) among lines. The testers FT-5, Solan Vajr and EC-15998 had 17.16, 19.62 and 18.20 fruits per plant, respectively. Among crosses, Sioux x FT-5 had maximum number of fruits per plant (28.50). The heterosis over better parent was maximum in Sioux x FT-5 (66.08%). Out of forty five cross combinations, thirty one crosses exhibited significant positive heterosis over better parent for the trait. Seven cross combinations showed significant positive increase over Naveen, being highest in Sioux x FT-5 (16.33%). These results are in line with the results of Mirshamssi et al (2006) and Rani and Veeraragavathatham (2008).

High average fruit weight is of prime importance in breeding high yielding cultivars. The mean average fruit weight among lines was found maximum in Sioux (72.18 g). The testers FT-5, Solan Vajr and EC-15998 had fruit weight of 71.2 g, 72.50 g and 68.00 g, respectively. Among F_1s, maximum fruit weight was recorded in S-1001 x Solan Vajr (90.61 g). Heterosis over better parent was highest in S-1001 x Solan Vajr (24.98 %). Significant positive heterobeltiosis was exhibited by eleven crosses. Only two cross combinations S-1001 x Solan Vajr (9.83%) and Sioux x Solan Vajr (4.58%) showed significant positive increase over Naveen. Positive heterosis over better parent for average fruit weight was also reported by Singh et al (2005).

High fruit yield per plant is the ultimate goal of any breeding programme, so requires higher consideration. The mean fruit yield per plant was recorded highest in line EC-521041 (1450.28 g). The testers FT-5, Solan Vajr and EC-15998 gave fruit yield of 1102.60 g, 1276.45 g and 1106.22 g per plant, respectively. Among F_1s, the mean performance was found maximum in Sioux x FT-5 (2100.00 g). Maximum heterobeltiosis effect was recorded in Sioux x FT-5 (71.14%). Except nine cross combinations, all other cross combinations showed significant positive heterosis over better parent. Only one cross combination Sioux x FT-5 (3.95%) exhibited significant increase in fruit yield over Naveen. Similar results were also reported by Harer et al

(2006). Fruits having high pericarp thickness can withstand shipping and remain firm for more number of days as compared to thin fleshed fruits. The line Sioux had maximum pericarp thickness of 5.70 mm. The testers FT-5, Solan Vajr and EC-15998 showed pericarp thickness of 5.60 mm, 5.68 mm and 5.54 mm, respectively. Among F_1s, maximum pericarp thickness was found in S-1001 x Solan Vajr (6.78 mm). The maximum heterotic effect of pericarp thickness over better parent was found in S-1001 x Solan Vajr (19.37%). Only one cross combination S-1001 x Solan Vajr showed significant positive increase of 4.31 per cent over check Naveen. Positive heterosis over better parent for pericarp thickness has also been reported by Joshi et al (2005).

Total soluble solids directly influences flavour of tomato and is an important quality parameter in the processing industry. Total soluble solids among lines was found highest in EC-1914 (4.20 ^{0}B). The testers FT-5, Solan Vajr and EC-15998 had total soluble solids of 3.5 ^{0}B, 3.44 ^{0}B and 3.35 ^{0}B, respectively. Among F_1s, maximum total soluble solids was recorded in EC-521051 x Solan Vajr (4.60 ^{0}B). The highest heterobeltiotic effect was found in EC-521051 x Solan Vajr (28.49%). Only five crosses showed significant positive increase over check Naveen, the highest increase being in EC-521051 x Solan Vajr (11.92%). Similar results were also reported by Anita et al (2005). Ascorbic acid content is nutritionally an important constituent. Small fruited genotypes are generally richer in ascorbic acid content. Ascorbic acid content was found maximum in EC-60531 (36.15 mg/100 g) among lines. The testers FT-5, Solan Vajr and EC-15998 recorded ascorbic acid content of 23.8 mg/100 g, 24.45 mg/ 100 g and 23.53 mg/100 g, respectively. Among F_1s, maximum ascorbic acid content was found in EC-13736 x Solan Vajr (39.36 mg/100 g). The heterosis over better parent was maximum in EC-1914 x EC-15998 (23.49%). Cross EC-13736 x Solan Vajr showed highest positive increase of 29.47 percent over check Naveen for ascorbic acid content. Anita et al (2005) and Singh et al (2005) also found similar results.

Longer harvest duration is preferred in the present marketing system under Indian conditions because it not only avoids the glut in the market but the off season nature of the crop is also maintained. Days for harvest duration were recorded highest in line EC-524087 (37.00). The harvest duration for testers FT-5, Solan Vajr and EC-15998 was 34.00, 35.67 and 32.00 days, respectively. Amongst F_1s, maximum harvest duration was recorded in EC-144336 x EC-15998 (42.33 days). The heterosis over better parent was highest in EC-144336 x EC-15998 (30.93%). Thirty crosses exhibited significant positive heterobeltiosis for harvest duration. Maximum significant positive increase over

check Naveen was recorded in EC-144336 x EC-15998 (13.39%). Thakur et al (2004) and Sharma and Thakur (2008) have also reported similar results. So the heterosis was appreciable in all forty five hybrids, but was more in four hybrids viz Sioux x FT-5, S-1001 x Solan Vajr, EC 521041 x FT-5 and S-1001 x EC 15998. These hybrids can be selected for the exploitation of hybrid vigour and commercialization.

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