

SHORT COMMUNICATION

Expression of Heterosis and Combining Abilities (Gca & Sca) in Inter-Specific Crosses of Tomato (*Lycopersicon esculentum* Mill. syn. *Solanum lycopersicum* L.)**G Himanshu¹, N Rai^{*2}, RK Singh¹ and DB Singh¹**¹ Crop Improvement Division, Indian Institute of Vegetable Research, Jakhini, Shahanshahpur, Varanasi-221305, Uttar Pradesh, India² Allahabad Agriculture Institute–Deemed University Allahabad, Uttar Pradesh, India**Key Words: Heterosis, Combining ability and Interspecific hybrids**

Interspecific crosses among wild and cultivated lines of tomato revealed that wild line EC520061 was the best combiner for plant height, number of primary branches and pericarp thickness, EC528372 for the days to 50% flowering, seeds/fruit and number of locules, EC521080 for maximum fruit set (%) and fruits/plant, EC520049 for the total soluble solids and yield/plant. High specific combining ability coupled with high heterosis were recorded in cross combinations, Hisar Anmole x EC520061 for plant height and primary branches; Kashi Vishesh x EC521080, Punjab Chhuhara x EC521080 and Kashi Anupam x EC528372 for fruits/plant and locules/fruit ; Kashi Anupam x WIR-3957 for seed/fruit; Hisar Anmole x EC520049 and Punjab Chhuhara x EC528372 for the total soluble solids and yield/plant.

Tomato is grown in almost all parts of country (India), covering large area with high production (Sadhankumar *et al.*, 2007). Tomato is good source of vitamins and minerals. There are several species of tomato but only the fruits of two species, namely, *Solanum lycopersicum* (*Lycopersicon esculentum*) and *S. pimpinellifolium* are edible. Most of the *Solanum lycopersicum* based cultivars though they are high yielder are highly susceptible to abiotic and biotic stresses. However, wild species like *S. pimpinellifolium*, *S. habrochaites*, *S. cerasiformae*, *S. chilense*, *S. chmielewskii* and *S. peruvianum* have smaller fruit size but superior number of fruits with resistance/tolerance to several stresses. Keeping in view the importance of wild species of tomato, twenty-four crosses were made to know extent of heterosis, combining ability and gene action using wild species as one of the parent.

Four *Solanum lycopersicum* varieties namely, Punjab Chhuhara, Hisar Anmole, Kashi Anupam and Kashi

Vishesh as female parents and six testers of different wild species, viz., EC521080 (*S. pimpinellifolium*), EC520061 (*S. hirsutum*, syn. *S. habrochaites*), WIR-5032 (*S. chilense*), EC520049 (*S. chmielewskii*), EC528372 (*S. cerasiformae*) and WIR-3957 (*S. peruvianum*) were crossed in line x tester mating design at Indian Institute of Vegetable Research, Varanasi, during the year 2005-2006 to generate inter-specific F₁'s. Twenty four F₁s along with their parents were transplanted in Randomized Block Design (RBD) with three replications at spacing of 60 cm x 45 cm in plot size of 4.5 x 3.7 m during spring-rabi in 2006-2007. Ten plants in each replication were randomly selected from both parents and F₁s for recording data on plant height (cm), number of primary branches, days to flowering (50%), fruit set (%), fruits number/plant, fruit yield/plant (kg), seed number/fruit, locules number/fruit, pericarp thickness(mm) and total soluble solids(TSS). The mean data was statistically analysed to know the extent of heterosis (over best parent) and combining abilities (gca and sca) as per procedure given by Kempthorne (1957).

The extent of heterosis over the better parents of 24 crosses for yield and quality traits is presented in Table 1 and revealed that cross combinations Hisar Anmole x WIR-5032 and Kashi Anupam x WIR-5032 exhibited high and positive heterosis for plant height. Kumar *et al.* (1995) also reported similar finding in tomato. As regards number of primary branches, the positive and high heterosis was in Hisar Anmole x EC520061. Negative heterosis for early flowering and maturity is considered as a desirable feature for early yield. Negative and significant heterosis was recorded in cross combination Hisar Anmole x EC520061 and Punjab Chhuhara x EC520061. Negative heterosis for days to flowering was also reported by Premalakshme

*Author for Correspondence: E-mail: nrail964@gmail.com

Table 1. Mean performance of heterosis over better parent and mid parent

Characters	Crosses	Mean	Heterosis for BP (%)
Plant height	Hisar Anmole x WIR-5032	186.73	59.74**
	Kashi Anupam x WIR-5032	161.61	38.29*
	Hisar Anmole x EC520061	280.53	31.38**
	Kashi Vishesh x EC520061	273.77	28.21*
Number of primary branches	Hisar Anmole x EC520061	25.47	81.04**
	Kashi Vishesh x EC520049	15.50	65.48**
	Punjab Chhuhara x EC520049	14.00	49.47**
	Kashi Anupam x EC520049	13.67	45.91**
Days to 50% flowering	Hisar Anmole x EC520061	21.00	-33.68**
	Punjab Chhuhara x EC520061	21.00	-33.68**
	Hisar Anmole x WIR-5032	21.00	-30.77**
	Punjab Chhuhara x WIR-5032	21.00	-30.77**
Per cent fruit set	Hisar Anmole x EC521080	87.07	24.38**
	Kashi Vishesh x EC521080	82.10	17.29**
	Punjab Chhuhara x EC521080	80.17	14.52*
	Kashi Anupam x EC521080	77.77	11.10
Number of fruits/plant	Kashi Vishesh x EC520049	255.47	42.22*
	Kashi Anupam x EC528372	135.60	13.31
	Punjab Chhuhara x EC528372	117.13	-2.12
	Hisar Anmole x EC528372	112.83	-5.68
Fruit yield/plant (Kg)	Hisar Anmole x EC520049	4.47	244.70**
	Hisar Anmole x EC521080	1.85	43.41**
	Hisar Anmole x WIR-3957	1.78	37.98**
	Kashi Anupam x WIR-5032	2.71	5.03**
Number of locules/fruit	Kashi Vishesh x EC520061	2.00	-62.50**
	Hisar Anmole x EC521080	2.00	-60.00**
	Hisar Anmole x EC520061	2.00	-60.00
	Hisar Anmole x EC5032	2.00	-60.00**
Pericarp thickness (cm)	Kashi Anupam x EC520049	.32	62.50**
	Kashi Anupam x WIR-3957	.37	31.25**
	Hisar Anmole x WIR-3957	0.43	30.00**
	Kashi Vishesh x EC528372	0.40	25.00**
Number of seeds/fruit	Kashi Vishesh x EC520061	35.43	-76.44**
	Hisar Anmole x EC520061	29.80	-74.80**
	Kashi Anupam x EC520061	43.73	-71.86**
	Kashi Vishesh x WIR-3957	49.63	-66.99**
Total soluble solids (%)	Kashi Vishesh x WIR-3957	5.73	30.30**
	Hisar Anmole x WIR-3957	5.50	25.00**
	Hisar Anmole x EC520049	5.83	20.6**
	Kashi Anupam x EC520061	6.13	12.20**

* Significant at 0.05% level, **Significant at 0.01% level

et al. (2006) in tomato. Maximum fruit set (%) was recorded in cross combination Hisar Anmole x EC521080 and Kashi Vishesh x EC521080. Whereas, number of fruits per plant, one of the major component for yield, was the highest in Kashi Vishesh x EC520049. Highest heterosis for yield per plant was observed in cross combination Hisar Anmole x EC520049. The wide range of heterosis observed for yield is attributed to the genetic diversity of the parents used in hybrid combinations. In tomato, lesser number of locules in fruit which showed negative heterosis in cross combination Kashi Vishesh x EC520061, is considered desirable for good shape index. The negative heterosis

over better parents for this trait was also reported by Singh *et al.* (2008) which is in consonance with our findings. Heterosis over better parents for increase in pericarp thickness was recorded in cross combinations Kashi Anupam x EC520049 and Kashi Anupam x WIR-3957. Negative heterosis for number of seeds was recorded in cross combination Kashi Vishesh x EC520061. The highest heterosis for total soluble solids was recorded in Kashi Vishesh x WIR-3957.

Table 2 shows both combining abilities effect (gca and sca) indicating EC520061, EC521080, EC528372 and EC520049 were good general combiners for yield and quality contributing character. This suggests that parent

showing high sca and yield may be due to their high gca for number of fruits. Premalakshme *et al.* (2006) have also reported high sca for fruit yield due to high gca for number of fruits per plant. Specific combining ability in present investigation exhibited that the cross combinations Kashi Anupam x EC521080 and Hisar Anmole x EC520061 had high positive sca effect as well as high degree of heterosis for plant height, while, Hisar Anmole x EC5210061, Kashi Anupam x WIR-3957, Kashi

Anupam x EC520061, Kashi Vishesh x EC528372, Punjab Chhuhara x EC528372, Punjab Chhuhara x EC521080, Kashi Anupam x WIR-3957, Kashi Anupam x WIR-3957, Hisar Anmole x EC3957 and Hisar Anmole x EC520049 for number of primary branches, days to 50% flowering, per cent fruit set, fruit width, fruit length, number of fruits/plant, number of seeds/fruit, number of locules, pericarp thickness and fruit yield/plant, respectively. The crosses viz. Punjab Chhuhara x EC528372, Kashi Vishesh x WIR-

Table 2. General combing ability and Specific combining ability effect of the 10 parents and 24 F₁'s yield and quality traits

Parents and crosses	Plant height (cm)	No. of primary branches	Days to 50% flowering	Fruit set (%)	No. of fruits/plant	No. of seeds/fruit	No. of locules/fruit	Pericarp thickness (cm)	TSS (%)	Fruit/plant (kg)
Female Line										
Punjab Chhuhara	-15.96**	-1.03**	-0.50	-1.29	15.09**	-3.44**	-0.29*	0.02	-0.13	-0.27**
Kashi Vishesh	14.04*	0.52	1.50	-0.65	10.32**	-2.28*	0.15	-0.01	0.15	0.28**
Kashi Anupam	-12.47*	-0.26	0.50	-0.98	-18.75**	4.29**	0.15	0.00	-0.03	-0.19*
Hisar Anmole	14.38**	0.77*	-1.50	2.93	-6.66*	1.42	-0.01	-0.01	0.01	0.18*
Tester male										
EC521080	-9.38	-2.13**	-1.50	6.70*	94.06**	8.21**	0.21*	-0.01	0.04	0.45**
EC520061	70-62*	5.89**	1.50	-2.35	39.99**	-29.11**	-0.29**	0.07**	0.34**	-0.26**
WIR-5032	-19.62**	-1.74**	1.50	-0.90	-2.91	-5.49**	-0.04	0.00	-0.29**	-0.23**
EC520049	-14.88**	0.14	0.00	4.12	-20.94**	-5.87**	0.21*	-0.04*	0.38**	0.95**
EC528372	-22.52**	0.94**	-1.50	-3.37	-90.93**	21.65**	-0.46**	0.06**	-0.35**	-0.45**
WIR-3957	-4.23	-1.22**	0.00	-4.20	-19.28**	10.61**	-0.21*	0.05**	-0.11	-0.46**
SE (GCA) Line										
SE (GCA) Tester	2.46	0.17	0.00	1.33	1.44	0.49	0.05	0.00	0.05	0.05
SE (GCA) Tester										
Punjab Chhuhara x EC521080	-3.12	-214**	0.50	-0.32	155.20**	-11.52**	0.21	0.00	-0.22	1.03**
Punjab Chhuhara x EC520061	11.85*	-0.29	-2.50	9.97**	-45.76**	21.20**	0.29*	0.05**	-0.02	-0.41**
Punjab Chhuhara x WIR-5032	-10.74	1.60**	-2.50	-2.47	-14.26**	-27.32**	-0.04	-0.02	-0.23	0.25
Punjab Chhuhara x EC520049	21.49**	1.26**	5.00	-0.73	-35.40**	16.72**	0.21	0.02	-0.23	-0.61**
Punjab Chhuhara x EC528372	-20.28**	-0.26	0.50	-8.51**	-8.71*	1.34	-0.46**	0.02	0.80**	0.15
Punjab Chhuhara x WIR-3957	0.80	-0.15	-1.00	2.06	-15.06**	-0.42	-0.21	-0.07**	-0.10	0.08
Kashi Vishesh x EC521080	-7.75	2.29**	-1.50	0.98	-31.57**	19.52**	0.10	-0.04**	-0.20	0.26
Kashi Vishesh x EC520061	16.95**	-1.35**	1.50	-16.70**	45.74**	4.20**	-0.15	-0.02	0.00	0.77**
Kashi Vishesh x WIR-5032	-30.68**	-2.29**	1.50	-1.35	-29.93**	12.82**	-0.15	0.01	0.16	-0.80**
Kashi Vishesh x EC520049	7.09	1.20**	-3.00	6.86*	64.40**	-2.47*	0.10	0.05**	-0.87**	-0.61**
Kashi Vishesh x EC528372	1.12	-0.88*	-1.50	9.09**	-43.64**	4.04*	0.43**	0.05**	0.35**	0.91**
Kashi Vishesh x WIR-3957	13.27*	0.43	3.00	1.12	-4.9	-29.70**	-0.32**	-0.04**	0.59**	-0.52**
Kashi Anupam x EC521080	24.23**	-0.47	-0.50	-3.03	-88.64**	-2.55*	-0.24*	0.02	0.18	-0.95**
Kashi Anupam x EC520061	-52.17**	-3.53**	2.50	10.42**	40.67**	-3.47*	-0.15	0.08**	0.71**	0.43*
Kashi Anupam x WIR-5032	21.60**	2.03**	2.50	-1.62	51.17**	13.58**	0.15	0.00	-0.47**	1.57**
Kashi Anupam x EC520049	14.73*	0.16	-2.00	-0.71	-2.20	-10.68**	-0.24*	-0.06**	0.77**	-0.53**
Kashi Anupam x EC528372	6.70	1.97**	-0.50	0.22	43.59**	-29.6**	-0.57**	-0.06**	-0.21	-0.45**
Kashi Anupam x WIR-3957	-15.09*	0.11	-2.00	-5.28	-44.59**	32.78**	0.68**	0.02	-0.97**	-0.06
Hisar Anmole x EC521080	-13.36*	-0.01	1.50	2.36	-34.99**	-5.45**	-0.07	0.03	0.24	-0.34*
Hisar Anmole x EC5210061	23.38**	5.17**	-1.50	-3.69	-40.65**	-13.53**	0.01	-0.11**	-0.69**	-0.79**
Hisar Anmole x EC5032	19.85**	-1.34**	-1.50	5.44	-6.98*	0.92	-0.32**	0.01	0.53**	-0.52**
Hisar Anmole x EC520049	-43.32**	-2.61**	0.00	-5.42	-26.79**	-3.57**	-0.07	-0.01	0.33*	1.75**
Hisar Anmole x EC528372	12.45*	-0.83*	1.50	-0.80	8.77**	24.88**	0.60**	-0.01	-0.91**	-0.61**
Hisar Anmole x EC3957	1.03	-0.39	0.00	2.10	100.65**	-2.65*	-0.15	0.10**	0.49**	0.50**
SE ±	5.50	0.38	0.00	2.98	3.23	1.11	0.11	0.01	0.12	0.1577

* Significant at 0.05% level and **Significant at 0.01% level

3957 and Hisar Anmole x WIR-5032 were found the best specific combiners as well as exhibited high heterosis over best parent for TSS.

Thus present findings suggest that among wild species the lines EC520049, WIR-5032, EC528372 and EC521080 may be used as male parent for obtaining high yield along with better quality (TSS) F_1 's.

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