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HETEROSIS AND INBREEDING DEPRESSION FOR SOME POST HARVEST QUALITY TRAITS IN TOMATO

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ABSTRACT

Nine promising and divergent varieties of tomato(*Lycopersicon esculentum Mill*) were crossed as per exclusive reciprocals diallel design. Low magnitude of heterosis over better parent for PH was observed in 15 crosses which ranged from - 1.13 (Sel. -18 X Pusa Ruby) to - 13.88 per cent (NT-3 X Punjab Chhuhara). Two best hybrids for ascorbic acid content were Sel.-18 X NT-3 (19.50%) and Money Maker X Punjab Chhuhara (19.04%), where as the cross Pusa Ruby X NT-3 (46.97%) exhibited high degree of heterosis for shelf life of fruits. In case of seed weight per fruits maximum negative heterosis was observed in cross Money Maker X Marglobe (-23.11%). However, three best heterotic crosses which were found promising as they coupled with other quality traits may be arranged in order Sel.-18 X Hisar Arun; Money Maker X Marglobe and Marglobe X Punjab Chhuhara, could be exploited commercially in hybrid varietal development programme. Inbreeding depression was also observed, though it was varied with crosses.

KEY WORDS : Heterosis, Inbreeding Depression, PH, Shelf life, Ascorbic acid

The phenomenon of heterosis has been exploited by plant breeders for the development of superior hybrids in large number of crops including tomato *Lycopersicon esculentum* Mill. Low pH, high ascorbic acid content, low degree of perishability and less seed content are considered important for the development of superior quality tomatoes for processing. Heterosis for these traits has been studied by many workers. Inspite of these studies, the exploitation of heterosis for post harvest quality traits in tomato has been negligible. Therefore, the present investigation was planned to study the extent of heterosis for these traits in several crosses involving some of the popular tomato varieties.

METERIALS AND METHODS

Nine popular varieties of tomato *viz.*, Sel.-18, Pusa Ruby, Pusa Early Dwarf, Money Maker, Marglobe, NT-3, Hisar Arun, Punjab Chhuhara and HS-101 were crossed as per diallel analysis. Thirty six hybrids, their F2'S and parents were transplanted during February, 1992 in randomised block design with three replications at the Vegetable Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Each plot comprised of a single row of 50 plants spaced 45x60 cm^2. Observations were recorded on PH, ascorbic acid (mg/100 g. edible part), shelf life (days) and seed weight (mg) per fruit. Heterosis for each cross was calculated as the percentage increase of F1 performance in the favouable direction above the better and mid parental performance. Inbreeding depression in percentage was determined from the mean value of different generations.

Table 1. Analysis of Variance for diffeent characters in F1 and F2 generations in a 9 x 9 diallel set of tomato

Characters		Mean sum of squares		
		Replications	Genotypes	Error
		2	44	86
pH	F_1	0.380	0.19**	0.030
	F_2	0.011	0.17**	0.015
Ascorbic acid	F_1	0.230	74.20**	5.130
	F_2	0.912	55.57**	1.810
Shelf life of fruits	F_1	2.020	66.250**	5.550
	F_2	6.820	43.470**	2.880
Seed weight per fruit	F_1	14.260	12044.190**	20.980
	F_2	519.080	11471.930**	648.48

RESULTS AND DISCUSSION

The analysis of variance (Table 1) showed significant variation due to treatments and genotypes. Fairly high degree of heterosis and inbreeding depression were observed for all the traits (Tables 2,3).

Low PH of juice is considered desirable for processing, therefore heterosis was estimated over lower valued (superior) parent. Significant heterosis over better parent was observed in 15 crosses with respect to PH which ranged from -1.13 (Sel.-18 X Pusa Ruby) to -13.88 per cent (NT-3 x Punjab chhuhara). Out of 36 hybrids, 24 hybrids exhibited negative heterosis over mid parent. Lomoljako and Simnov (1968) and Boos and Kochneva (1971) reported superiority of hybrids to parents, while higher pH in the hybrids was noted by Peter and Rai (1980). Similarly 35 crosses out of 36 showed negative inbreeding depression ranging from -1.61 (Sel.-18 x Pusa Ruby) to -7.65 (Pusa Early Dwarf x Hissar Arun) per cent. Negative estimates of inbreeding depression suggest the existance of transgressive segregation in the respective crosses. In these crosses, intense selection should be practised taking large segregating populations for isolating superior homozygous lines.

For ascorbic acid content, 20 hybrids revealed positive and significant heterosis over superior parent ranging from 4.40 (Money Maker X NT-3) to 19.50 (Sel.-18 X NT-3) per cent, while 29 crosses showed heterosis over mid parent. The best five hybrids that exhibited high heterosis for ascorbic acid content were Sel.-18 X NT-3 (19.50%), Money Maker X Punjab Chhuhara (19.04%), Pusa Ruby X HS-101 (18.52%) and Sel.-18 X Punjab Chhyhara (15.87%) and Sel-18 X Hisar Arun (15.66%). Similar reports regarding increase of ascorbic acid in the hybrids over their parents have been made by Jamwal *et al.* (1984) and by Bhuiyan *et al.* (1986). Significant and positive inbreeding depression was observed in 35 crosses.

Tomato fruit is perishable due to high moisture content. Therefore, attempt has been made to increase the shelf life of fruits. It was observed that six hybrids out of 36 showed positive and significant heterosis over mid parent. Among these, the crosses which showed heterosis greater than 15%, were Pusa Ruby X NT-3 (46.97%), Sel. - 18 X Hisar Arun (41.0%), NT-3 X HS-101 (32.03%), Pusa Ruby X Money Maker (30.92%) and Pusa Ruby X Hisar Arun (16.35%). Results showed that parents having medium storage periods contributed to higher degree of heterosis, Pathak and Mahayan (1988) observed good shelf life in Pusa Ruby and HS-101 while Kumar *et al.* (1989) reported good storability in Sel.-18. Besides heterosis, significant and positive inbreeding depression was observed in 22 crosses ranging from 5.26% (Pusa Ruby X Hisar Arun) to 43.75% (Hisar Arun X Punjab Chhuhara).

Manifestation of heterosis was also observed for seed weight per fruit. Low seed is considered desirable for tomato quality, while high seed has direct association with fruit size and yield. Eleven crosses showed positive and significant heterosis ranging from 8.0 (Pusa Early Dwarf X Money Maker) per cent to 13.03 (Hisar Arun X HS - 101) per cent. On the contrary, 14 crosses exhibited-8.43 (Pusa Ruby X NT-3) per cent to -23.41 (Money Maker X Marglobe) per cent negative and significant heterosis over better parent. Superior cross combinations for low seed weight fruit^{-1} were Money Maker X Marglobe (-23.41%), Pusa Ruby X Hisar Arun (-22.35%) Pusa Ruby X Pusa Early Dwarf (-21.17%) and Pusa Ruby X Money Maker (-19.67%) which exhibited negative and significant heterosis over better parent. Chattopadhyay and Pal (1981) reported that about 50% hybrids showed heterosis over better parent for seeds per fruit. The increased number of seeds in tomato hybrids over superior parent has also been reported by Milkhailov and Popova (1973). Significant and positive inbreeding depression was noted only in Money Maker X Punjab Chhuhara (38.06%).

For commercial production of hybrids one of the prerequisites is that F1 hybrids should significantly out yield the best quality commercial variety. The hybrids performing better than both the parents were selected and further exploited to select out standing pure lines.

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Table 2. Performance of parents, their F1s, percentage of heterosis over better parent (BP), mid parent (MP) and inbreeding depression (ID) for pH and ascorbic acid

Characters	pH				Ascorbic acid (%)			
	Mean	BP	MP	ID	Mean	BP	MP	ID
Parents								
1. Scl-18	4.60				32.20			
2. Pusa Ruby	4.40				21.42			
3. Pusa Early Dwarf	4.12				25.70			
4. Money Maker	4.00				30.00			
5. Marglobe	4.63				21.22			
6. NT-3	4.18				32.00			
7. Hissar Arun	4.51				32.81			
8. Punjab - Chhuhara	3.89				30.30			
9. HS-101	4.33				22.30			
Hybrids								
1 X 2	4.35	-1.13**	-3.26**	-1.61**	36.31	12.76**	35.43**	8.20**
1 X 3	4.36	5.82**	0.00	-4.78**	36.61	13.66**	26.45**	11.66**
1 X 4	4.32	7.46**	0.43**	-5.17**	33.54	4.13*	7.83**	10.45**
1 X 5	4.69	1.91++	1.63**	7.68**	32.81	1.89	25.21**	11.10**
1 X 6	4.21	-4.18**	-6.15**	-5.74**	38.48	19.50**	19.89**	13.73**
1 X 7	3.92	-13.08**	-13.87**	-5.35**	37.95	15.66**	16.75**	13.66**
1 X 8	3.95	1.54**	-6.95**	-3.04**	35.11	9.03**	12.35**	10.47**
1 X 9	4.38	1.15**	-1.90**	-4.11**	28.61	-11.14**	4.99**	10.86**
2 X 3	4.34	5.33**	1.88**	-5.07**	23.87	-7.12**	1.32	10.85**
2 X 4	4.36	9.00**	3.77**	-4.13**	26.11	-12.96**	1.56	1.94
2 X 5	4.26	-3.18**	-5.65**	-6.18**	23.41	9.29**	12.47**	8.63**
2 X 6	4.26	1.91**	-0.70**	-4.07**	26.51	-17.15**	-0.75	13.24**
2 X 7	4.20	-3.00**	-5.72**	-7.46**	36.70	9.88**	35.35**	8.33**
2 X 8	3.95	1.54**	-4.70**	-4.14**	28.80	-8.57**	11.36**	9.69**
2 X 9	4.39	1.46**	0.65**	-3.64**	26.43	18.52**	20.91**	10.54**
3 X 4	4.32	7.46**	6.36**	-4.24**	28.71	-4.30*	3.09**	9.09**
3 X 5	4.07	-1.21**	-6.97**	-5.73**	27.70	7.78**	20.67**	12.64**
3 X 6	4.07	-1.21**	-1.85**	-4.01**	33.60	5.00*	16.46**	9.62**
3 X 7	4.23	2.66**	-1.97**	-7.65**	35.71	6.91**	22.06**	8.80**
3 X 8	3.74	-3.85**	-6.53**	-5.16**	34.33	8.95**	22.56**	9.67**
3 X 9	3.94	-4.36**	-6.75**	-7.45**	26.11	1.59	8.79**	10.10**
4 X 5	3.87	-3.73**	-10.35**	-4.65**	34.40	14.66**	37.02**	8.33**
4 X 6	4.15	3.23**	1.43**	-4.34**	33.41	4.40*	7.77**	11.26**
4 X 7	4.32	7.46**	1.49**	-4.48**	30.61	-8.35**	-2.53	10.79**
4 X 8	3.99	2.57**	1.10**	-5.18**	37.50	19.04**	24.37**	10.81**
4 X 9	4.31	7.21**	3.44**	-4.25**	29.61	-1.30	13.23**	11.23**
5 X 6	4.26	1.91**	-3.29**	-4.85**	26.12	-18.37**	0.06	13.94**
5 X 7	4.32	-4.21**	-5.47**	-3.63**	24.31	-27.21**	8.30**	10.87**
5 X 8	3.69	-5.14**	-13.38**	-5.60**	28.61	-9.17**	13.28**	8.07**
5 X 9	4.20	-3.00**	-6.25**	-4.37**	23.71	6.32**	11.55**	7.14**
6 X 7	4.31	3.03**	-0.88**	3.72**	36.70	9.88**	13.25**	9.10**
6 X 8	3.5	-13.88**	-16.98**	-5.47**	34.39	7.46**	10.40**	9.56
6 X 9	4.27	2.23**	0.43**	-7.25**	28.70	-10.31**	5.71**	10.43**
7 X 8	4.09	5.14**	-2.62**	-4.24**	37.61	14.62**	19.18**	12.55**
7 X 9	4.18	-3.46**	-5.43**	-5.34**	28.30	-15.26**	2.70	8.85**
8 X 9	3.86	-0.01	-6.08**	-6.04**	27.61	-12.34**	4.97*	10.09**
S.E+		0.17	0.14	0.11		1.98	1.66	1.36
C.D at 5 %		0.336	0.277	0.215		3.920	3.286	2.670
C.D. at 1 %		0.444	0.366	0.283		5.181	4.344	3.503

* Significant at 5% probability level; ** Significant at 1% probability level

Table 3. Performance of parents, their F_1s, percentage of heterosis over better parent (BP), mid parent (MP) and inbreeding depression (ID) for shelf life seed weight per fruit

Characters	Self life (days)				Seed weight per fruit (mg)			
	Mean	BP	MP	ID	Mean	BP	MP	ID
Parents								
1. Sel-18	12.33				430.00			
2. Pusa Ruby	16.33				510.00			
3. Pusa Early Dwarf	21.66				361.00			
4. Money maker	18.33				310.00			
5. Marglobe	22.67				545.67			
6. NT-3	16.33				380.00			
7. Hisar Arun	13.00				340.67			
8. Punjab Chhuhara	27.33				296.67			
9. HS-101	17.67				335.00			
Hybrids								
1 x 2	11.00	-32.63**	-23.26**	-42.42**	535.00	-3.92	12.77**	12.08
1 x 3	14.00	-33.84**	-15.67**	9.30**	455.00	5.81	15.04**	12.09
1 x 4	14.67	-36.60**	-4.35*	-50.00**	370.00	-13.95**	0.00	12.07
1 x 5	13.00	-42.65**	-25.71**	-46.15**	483.00	-11.37**	-0.99	12.01
1 x 6	9.33	-42.86**	-34.88**	-39.29**	478.00	11.16**	18.02**	11.92
1 x 7	18.33	41.00**	44.74**	36.36**	460.00	6.97	19.38**	12.03
1 x 8	20.67	-24.36**	4.20**	40.32**	349.00	0.18	-3.94	12.17
1 x 8	20.67	-24.36**	4.20*	40.32**	349.00	0.18	-3.94	12.17
1 x 9	18.00	1.86	20.00**	11.11**	367.00	-14.65**	4.05	11.94
2 x 3	20.00	-7.66**	5.28**	40.00**	402.00	-21.17**	-7.69*	12.12
2 x 4	24.00	30.93**	38.46**	18.06**	409.67	-19.67**	-0.08	12.02
2 x 5	20.00	11.78**	2.56	6.67**	560.00	2.75	6.09*	12.06
2 x 6	24.00	46.96**	46.96**	36.11**	467.00	-8.43*	4.94	11.70
2 x 7	19.00	16.35**	29.55**	5.26**	396.00	-22.35**	-6.90*	11.96
2 x 8	20.00	-26.82**	-8.40**	0.00	418.00	-18.03**	3.64	11.76
2 x 9	11.00	-37.74**	-35.29**	-57.58**	428.00	-16.07	1.30	11.82
3 x 4	20.00	-7.67**	0.02	16.67**	378.00	8.00**	12.67**	12.00
3 x 5	17.33	-27.55**	-21.79**	9.62**	561.00	2.93	23.75**	12.08
3 x 6	20.00	-7.66**	5.28**	25.00**	403.00	6.05	8.77*	11.94
3 x 7	17.00	-21.51**	1.90	5.88**	391.00	11.71**	11.45**	11.54
3 x 8	19.00	-30.48**	-22.44**	19.30**	393.00	12.28**	19.51**	12.24
3 x 9	17.00	-21.51**	13.54**	-31.37**	384.00	9.71*	10.34**	11.77
4 x 5	16.00	-29.42**	21.95**	18.75**	419.00	-23.11**	-2.06	11.98
4 x 6	19.00	3.65	9.62**	21.05**	428.67	12.80**	24.25**	11.96
4 x 7	16.00	-12.71**	2.13	-12.50**	365.00	7.35**	12.19**	11.95
4 x 8	24.00	-12.18**	5.11**	25.00**	348.67	12.47**	14.95**	38.06*
4 x 9	11.00	-39.98**	-38.89**	-54.55**	365.44	9.08*	13.32**	11.87
5 x 6	12.33	-45.61**	-36.75**	-21.62**	443.67	-18.59**	-4.14	11.98
5 x 7	11.33	-50.02**	-36.45**	-32.35**	470.33	-13.70**	6.13	11.94
5 x 8	12.00	-56.09**	-52.00**	5.56**	438.33	-19.57**	4.08	12.06
5 x 9	7.33	-67.66**	-63.64**	-4.55**	445.00	-18.34**	1.06	11.80
6 x 7	15.00	-8.14**	2.77	6.67**	404.00	6.31	12.12**	12.03
6 x 8	17.00	4.10*	-22.14**	-7.84**	359.22	-5.46	6.17	12.34
6 x 9	23.33	32.03**	37.25**	17.14**	391.67	3.07	9.56**	12.34
7 x 8	26.67	-2.41	32.23**	43.75**	369.67	8.72*	16.09**	12.35
7 x 9	14.33	-18.90**	6.52**	58.14**	384.33	13.03**	13.76**	12.14
8 x 9	11.00	-59.75**	-51.11**	9.09**	349.00	4.17	10.50**	12.13
S.E		1.89	1.66	1.65		3.85	3.31	16.61
C.D. at 5%		3.74	3.28	3.23		7.62	6.55	32.55
C.D. at 1%		3.74	4.34	4.25		10.07	8.66	42.78

* Significant at 5% probability level; ** Significant at 1% probability level

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COMBINING ABILITY IN WINTER SORGHUM

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ABSTRACT

The nature of gene action through combining ability analysis for grain yield and its components was studied in 5 X 5 diallel cross of sorghum. Estimates of *gca* and *sca* indicated the influence of both additive and non additive gene action for the inheritance of grain yield, stem girth and plant height. The cultivar SPV-462 was the best general combiner for all the traits under study. The best specified crosses *viz.*, SPV-462 X M35- 1, SPV-472 X Moti, SPV-913 X M35-1 and M35-1 X Moti for grain yield resulted from non-additive gene action could be utilised in heterosis breeding programme.

KEY WORDS : Sorghum, Combining Ability, GCA, SCA

Genetic information about the combining ability of parents and the nature of gene action involved in the inheritance of a trait would be of immense value to breeders in the choice of suitable parents and to identify potential crosses of practical use. As limited variability existed among the winter genotypes of sorghum (*Sorghum bicolor* (L.) Moench) the investigation has been taken up with kharif and winter genotypes to produce better recombinants and evaluate the nature and extent of gene action controlling the inheritance of yield and its components.

MATERIALS AND METHODS

The material comprises of five improved genotypes *vis.*, SPV- 462, SPV-472, SPV-913, *Kharif* genotype), M35-1 and Moti (winter genotypes). A diallel cross (excluding reciprocals) among these genotypes were made during winter. The resulting ten crosses along with their parents were sown at Agricultural Research Station, Madhira during winter 1989 in a randomised complete block design replicated thrice. Each entry was represented by a single row of 5m length with 45m X 15m of spacing. All the recommended package of practices were adopted. Data were recorded on five randomly selected plants in each entry on plant height, stem girth, leaf area, panicle length, panicle girth and yield/plant. The combining ability analysis was carried out following the procedure of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) for six characters revealed significant differences between the genotypes, indicating wide diversity in the