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Combining ability among bacterial wilt resistant genotypes for certain biochemical parameters affecting fruit quality in tomato *(Lycopersicon esculentum Mill.)*

Puja Rattan and Vidyasagar*

Department of Vegetable Science & Floriculture, CSK HPKV Palampur, (H.P.)
**Division of Vegetable Science & Floriculture, FOA, Main Campus, Chatha, SKUAST-Jammu INDIA*

ABSTRACT : The present investigation on combing ability for certain biochemical parameters was carried out in a set of 28 F_1 hybrids of tomato from a line X tester method involving 7 lines and 4 testers, which were resistant to bacterial wilt. Among lines, BL-342 in 2003 and 2005 exhibited highest General Combining Ability (GCA) for total soluble solids (TSS). For ascorbic acid, BL-333 in both proved to be best general combiner, For total sugars and reducing sugars CLN-2116 was the best general combiner in 2005, while for non reducing sugars, Rodade in 2003 and BL-333 in 2005 exhibited best general combing ability. CLN 2123 was top ranker for titrable acidity in 2005. EC-392698 was top ranking tester for TSS and ascorbic acid during both years of study and for total sugars and reducing sugars during 2005. For non reducing sugars Hawaii-7998 in both years and for titrable acidity, PTOM 9802 exhibited highest GCA. Best specific combination as depicted by its Specific Combining Ability (SCA) was BT-18 X H-7998 in 2003 and CLN-2026 X EC-191536 in 2005 for TSS, CLN-2026 X EC-191536 both in 2003 and 2005 for ascorbic acid and CLN-2123 X EC-191536 in 2005 both for total sugars and reducing sugars. For non reducing sugars BT-18 X EC-392698 in 2003, BL-342 X EC-392698 in 2005 were top rankers, while for titrable acidity top rankers were CLN-2116 X EC-392698 in 2003 and CLN-2026 X EC-392698 in 2005.

Keywords : Tomato, combining ability, bacterial wilt, biochemical parameters, quality.

INTRODUCTION

Tomato is one of the most popular and widely grown vegetables in the world. It is very well known for its outstanding nutritive value. Per capita fresh tomato consumption is expected to increase in the light of availability of antioxidants in tomato fruits. Tomato is an important crop in the processing industry. It is widely employed in canning, made into soups, pickes, ketchups, sauces and juices etc.

Fruits having high total soluble solids (TSS) and optimum sugars and acidity are the most desirable for processing industry. In India quality breeding needs to be given priority in tomato improvement programmes. Hybrid breeding can result in terrific gains in production and quality. The presence of heterosis indicates the ability of parents to combine well in hybrids. The ability of parents to combine well is due to complex interaction among genes which cannot be judged by mere yield performance of fruits. This information is provided by General Combing Ability (GCA) and Specific Combining Ability (SCA) of genotypes and their hybrid combinations.

Bacterial wilt is an important problem in mid hills of Himachal Pradesh and more than 40% yield losses occur due to this disease. So this study was conducted, using bacterial wilt resistant tomato lines to find out combining ability for certain biochemical traits such as total soluble solids (TSS), ascorbic acid, titrable acidity and total sugars, reducing sugars and non reducing sugars.

MATERIAL AND METHODS

The present study entitled, "Line *x* tester analysis involving bacterial wilt resistant genotypes across environments" was carried out at CSK HPKV, Palampur during summer-rainy season of 2003 and 2005.The location is situated at 32°6′ N latitude and 76°3′ E longitudes at an elevation of 1290. 8 m above mean sea level, with very high rainfall.

The experimental material comprised of F_1 population, developed by crossing 7 lines of tomato viz., BT-18 (L1), Rodade (L2), BL-342 (L3), BL-333 (L4), CLN-2123 (L5), CLN-2116 (L6), and CLN-2026 (L7) with 4 testers, namely EC-191536 (T1), PTOM-9802 (T2), Hawaii-7998 (T3) and EC-392698 (T4). The experimental material was grown in Randomized Block Design keeping three replications during summer rainy season at the Vegetable Research Farm of the Department of Vegetable Science and Floriculture, CSK HPKV, Palampur. Each F_1 and parent was grown in a single row of 3.15m length. The plants were placed at 75cm row to row and 45cm plant to plant. Thus, there were 7 plants in each entry per replication.

For recording the data of the characters under study, a random sample of 10 fruits per entry per replication was drawn from 3rd to 4th picking. The data was analyzed for line x tester analysis as per the method given by Kempthorne (1957).

RESULTS AND DISCUSSION

The results of analysis of variance are presented in table 1. The 'F' test revealed that the differences among treatments were highly significant for all the characters in 2005 and except total sugars and reducing sugars in 2003. Partitioning of variance due to treatments into lines, testers and lines x testers interactions revealed significant mean squares due to lines as well as testers for all the traits except total sugars, reducing sugars and titrable acidity in 2003, while it was significant for all the traits in 2005. Mean squares due to line x tester were significant for all the traits in 2005 and except total sugars and reducing sugars in 2003.

The estimates of general combining ability (GCA) effects with corresponding standard errors of lines and testers are presented in table 2. Good general combining lines having positive significant general combining ability (GCA) effects for total soluble solids were BL-342 in 2003 and BL-342 and CLN-2116 in 2005, while among testers, only EC-392698 had significant positive general combining ability effects for total soluble solids in 2003 and 2005. For ascorbic acid, line BL-333 in 2003 and 2005 and testers EC-392698 and Hawaii-7998 in 2003 and PTOM-9802 in 2005 showed good general combining ability effects. The lines CLN-2116 and CLN-2026 in 2005 and testers EC-392698 and PTOM 9802 has significant positive general combining ability effects for total sugars indicating their good general combining ability. For reducing sugars, among lines only CLN-2116 and among testers, EC-392698 and PTOM-9802 showed good general combining ability in 2005. Lines Rodade and BL-333 in 2003 and BL-333, CLN-2026, CLN-2116 and CLN-2123 in 2005 and tester Hawaii-7998 in 2003 revealed good general combining ability for non reducing sugars. For higher titrable acidity, the line CLN-2123 and tester PTOM-9802 in 2005 showed significant positive general combining ability. Thus these lines and testers can be very well utilized for hybrid production.

Specific combining ability effects (SCA) of different crosses are given in table 3. Higher total soluble solids add to the quality of fruit and result in recovery of processed products. For higher total soluble solids, 7 cross combinations in 2003 and 6 in 2005 revealed positive specific combining ability effects indicating their good specific combining ability. Out of these BT-18 x Hawaii-7998 (poor x average) in 2003 and CLN-2026 x Ec-191536 (average x poor) in 2005 top ranked for higher total soluble solids. CLN-2026 x EC-191536 (average x average) in 2003 as well as in 2005 had highest specific combining ability effects for ascorbic acid.

Sugars and organic acids are the important constituents of flavor and edible quality of tomato fruits (Lower and Thompson, 1967). High sugars contribute to sweetness and aroma in fruit (Kalloo, 1988). For total sugars and reducing sugars, CLN-2123 × EC-191536 (average × poor) in 2005, ranked first among 8 cross combinations showing positive significant specific combining ability effects. For non reducing sugars, amongst 11 cross combinations revealing positive significant specific combining ability effect, BT-18 × EC-392698 (poor × poor) had highest specific combining ability effects.

Fruit acidity affects flavor and taste of fresh fruits as well as the finished products (Raina *et al*. 1980). Keeping higher acidity as desirable, the cross combinations CLN-2116 × EC-392698 (average x poor) had maximum positive specific combining ability effect among 11 cross combinations revealing positive specific combining ability effects.

Majority of cross combinations exhibiting desirable specific combining ability effects, had atleast one of the parents as good or average general combiner. Similar views have also been expressed by Chadha et al., 2001, Makesh 2003 and Sharma, 2003. But some cross combination like BT-18 × EC-392698 having both the parents as poor general combiners have also been observed, these observations corroborate the findings of Lonkar and Borikar, 1988, Sharma, 1998, and Sharma 2003, who commented that the superiority of hybrids need not necessary have parents showing high general combining ability effects only. Usually the high estimates of specific combining ability effects are obtained from crosses involving diverse parents. The better performance of the cross having poor x poor general combiners as parents suggests that high magnitude of non additive component was responsible for the superiority of the pertinent cross combination. This preponderance of non additive gene action is appreciable magnitude lead the credence to the already well established practice of exploitation of hybrid vigor in tomato.

Table 1 : Analysis of variance for combining ability during 2003 (P1) and 2005 (P2) at Palampur.

Traits	df	Replication 2	Crosses 27	Lines 6	Testers 3	Line X Tester 18	Error 54
Total soluble solids	P1	0.36	1.18*	2.14*	0.63*	0.96*	0.12
	P2	0.04	1.88*	2.87*	1.11*	1.71*	0.12
Ascorbic acid	P1	0.584	59.011*	57.985*	82.592*	55.423*	14.957
	P2	5.858	55.887*	86.594*	74.788*	42.502*	7.37
Total sugars	P1	0.0225	0.793	0.706	0.447	0.879	0.7
	P2	0.339*	0.741*	0.582*	1.424*	0.681*	0.0395
Reducing sugars	P1	0.0295	0.909	0.969	0.682	0.928	0.711
	P2	0.327*	0.723*	0.389*	1.693*	0.673*	0.04
Non reducing sugars	P1	0.0062*	0.0572*	0.0922*	0.068*	0.0437*	0.0006
	P2	0.0006	0.0183*	0.0329*	0.0203*	0.0132*	0.00033
Titrable acidity	P1	0.0012	0.0086*	0.0069	0.0045	0.0098*	0.005
	P2	0.0297*	0.0176*	0.0218*	0.0281*	0.0144*	0.0032

* When tested against mean squares due to error,
@ When tested against mean squares due to line X tester interaction

Table 2 : Estimates of general combing ability effects of lines (L) and testers(T) in F_1 during 2003 (P1), 2005 (P2).

Traits	Total soluble solids		Ascorbic acid		Total sugars		Reducing sugars		Non reducing sugars		Titrable acidity	
	P1	**P2**	**P1**	**P2**	**P1**	**P2**	**P1**	**P2**	**P1**	**P2**	**P1**	**P2**
L1	-0.34*	-0.54*	1.17	-0.2	-	0.08	-	0.1	-0.01	-0.02*	-	-0.08*
L2	-0.28*	0.07	0.83	-0.11	-	-0.22*	-	-0.15*	0.17*	-0.07*	-	-0.04*
L3	0.90*	0.87*	-1.52	-3.62*	-	-0.34*	-	-0.25*	-0.09*	-0.06*	-	0.03
L4	0.08	-0.18	4.13*	4.80*	-	0.03	-	-0.02	0.03*	0.05*	-	0.02
L5	-0.21*	0.24*	-2.11	-2.42*	-	0	-	-0.02	0.01	0.02*	-	0.04*
L6	-0.07	-0.03	-1.3	0.73	-	0.32*	-	0.29*	-0.03*	0.04*	-	0
L7	-0.08	-0.44*	-1.2	0.82	-	0.12*	-	0.07	-0.09*	0.05*	-	0.02
SE(gi)+	0.1	0.1	1.12	0.78	-	0.06	-	0.06	0.007	0.005	-	0.02
SE(gi-gj)+	0.14	0.14	1.57	1.11	-	0.08	-	0.08	0.009	0.007	-	0.02
+ CD	0.28	0.28	3.15	2.21	-	0.1	-	0.1	0.02	0.014	-	0.06
T1	-0.19*	-0.32*	-1.12	0.17	-	-0.14*	-	-0.15*	-0.03*	0.01*	-	0.02
T2	-0.04	0.01	-2.22*	-2.61*	-	0.15*	-	0.19*	-0.01*	-0.04*	-	0.04*
T3	0	0.12	1.53	1.36*	-	-0.29*	-	-0.32*	0.08*	0.03*	-	-0.03*
T4	0.23*	0.20*	1.81*	1.42*	-	0.28*	-	0.28*	-0.05*	0	-	-0.03*
SE(gi)+	0.08	0.08	0.84	0.59	-	0.04	-	0.04	0.005	0.004	-	0.01
SE(gi-gj)+	0.11	0.11	1.19	0.84	-	0.06	-	0.06	0.008	0.006	-	0.02
CD	0.21	0.21	2.38	1.67	-	0.12	-	0.12	0.016	0.012	-	0.03

* When tested against mean squares due to error

Table 3 : Estimates of specific combining ability (SCA) during 2003 (P1), 2005 (P2).

Treatments	years	Total soluble Solids(%)	Ascorbic acid (mg/100g)	Total Sugars (%)	Reducing Sugars (%)	Non-Reducing Sugars (%)	Titrable acidity (%)
	P1	-0.38	-5.10*	-	-	-0.07*	0.05*
L_1 X T_1	P2	-0.59*	-2.24	-0.74*	-0.72*	-0.01	-0.04
	P1	0.04	4.38	-	-	-0.19*	0.01
L_1 X T_2	P2	-0.02	3.90*	-0.32*	-0.28*	0.04*	-0.05
	P1	0.90*	2.77	-	-	-0.01	0.05*
L_1 X T_3	P2	0.90*	1.05	0.41*	0.42*	-0.01	0.10*
	P1	-0.56*	-2.05	-	-	0.27*	-0.11*
L_1 X T_4	P2	-0.28	-2.71	0.01	0.02	-0.01	-0.02
	P1	0.06	-4.04	-	-	0.03*	0.02
L_2 X T_1	P2	0.53*	-6.03*	-0.32*	-0.25*	-0.08*	-0.03
	P1	-0.25	0.96	-	-	0.04*	0.02
L_2 X T_2	P2	-0.36	0.84	0.53*	0.50*	0.03*	0.09*
	P1	0.04	1.70	-	-	0.09*	0.02
L_2 X T_3	P2	-0.07	4.29*	-0.09	-0.02	0.11*	0.01
	P1	0.14	3.29	-	-	-0.16*	-0.05*
L_2 X T_4	P2	-0.09	0.90	-0.12	-0.05	-0.07*	-0.07*
	P1	-0.39	1.97	-	-	-0.14*	-0.03*
L_3 X T_1	P2	-1.00*	-1.40	0.12	0.01	0.12*	0.05
	P1	0.40*	-3.77	-	-	-0.09*	-0.03*
L_3 X T_2	P2	0.60*	-0.82	-0.88*	-0.87*	-0.01	-0.01
	P1	-0.44*	-1.53	-	-	0.00	0.03*
L_3 X T_3	P2	0.13	-1.83	0.50*	0.56*	-0.07*	-0.02
	P1	0.43*	3.33	-	-	-0.05*	0.04*
L_3 X T_4	P2	0.27	4.05*	0.26*	0.30*	-0.04*	-0.03
	P1	0.17	2.37	-	-	-0.13*	-0.02
L_4 X T_1	P2	0.39	2.02	0.01	0.00	0.02*	-0.04
	P1	0.42*	3.20	-	-	0.14*	0.04*
L_4 X T_2	P2	0.29	2.61	0.18	0.15	0.03*	0.05
	P1	-0.41*	-2.75	-	-	-0.04*	0.00
L_4 X T_3	P2	-0.12	-2.47	-0.10	-0.04	-0.06*	0.04
	P1	-0.18	-2.81	-	-	0.04*	0.01
L_4 X T_4	P2	-0.57*	-2.16	-0.09	-0.11	0.01	-0.06
	P1	-0.08	-2.47	-	-	0.08*	0.03*
L_5 X T_1	P2	-0.50*	-3.35*	0.64*	0.61*	0.03*	-0.07*
	P1	-0.69*	-1.42	-	-	0.08*	-0.09*
L_5 X T_2	P2	-0.66*	0.20	0.25*	0.27*	-0.11*	-0.05
	P1	0.07	4.27	-	-	-0.07*	0.03*
L_5 X T_3	P2	-0.14	0.68	-0.88*	-0.91*	0.02*	0.04
	P1	0.70*	-0.39	-	-	-0.08*	0.04*
L_5 X T_4	P2	1.31*	2.47	0.09	0.03	0.06*	0.06
	P1	-0.25	-0.36	-	-	-0.05*	-0.05*
L_6 X T_1	P2	-0.37	-3.51*	-0.22	-0.13	-0.08*	0.07*
	P1	0.57*	4.75*	-	-	0.03*	0.06*

(Cont...)

Treatments	years	Total soluble Solids(%)	Ascorbic acid (mg/100g)	Total Sugars (%)	Reducing Sugars (%)	Non-Reducing Sugars (%)	Titrable acidity (%)
L_6 X T_2	P2	0.27	-1.10	0.09	0.05	0.04*	-0.05
	P1	-0.51*	-0.56	-	-	-0.04*	-0.08*
L_6 X T_3	P2	-0.37	-1.73	0.16	0.15	0.01	0.00
	P1	0.19	-3.82	-	-	0.06*	0.07*
L_6 X T_4	P2	0.47*	-0.68	-0.04	-0.07	0.03*	-0.02
	P1	0.86*	7.63*	-	-	0.01	0.00
L_7 X T_1	P2	1.55*	7.49*	0.50*	0.49*	0.01	-0.09*
	P1	-0.48*	-6.17*	-	-	-0.01	0.00
L_7 X T_2	P2	-0.11	-5.63*	-0.39*	-0.38*	-0.01	0.04
	P1	0.34	-3.89	-	-	0.08*	-0.04*
L_7 X T_3	P2	-0.32	0.03	0.01	0.01	-0.01	-0.06*
	P1	-0.72*	2.44	-	-	-0.08*	0.04*
L_7 X T_4	P2	-1.11*	-1.88	-0.11	-0.12	0.01	0.10*
	P1	0.20	2.33	-	-	0.01	0.01
SE (S_{ij})	P2	0.20	1.57	0.12	0.12	0.01	0.03
	P1	0.28	3.15	-	-	0.02	0.06
SE (S_{ij}-s_{kl})	P2	0.28	2.21	0.16	0.16	0.01	0.05
	P1	0.56	6.30	-	-	0.04	0.12
CD(5%)	P2	0.56	4.42	0.32	0.33	0.03	0.09

* When tested against mean squares due to error

REFERENCES

Chadha, S., Kumar, J. and Vidyasagar. (2001). Combining ability over environments in tomato. *Indian Journal of Agriciultural Research* **35**(3)**:** 171-175.

Kalloo, G. (1988). Vegetable Breeding. CRC press. Inc. Boca Raton, Florida 239pp.

Lonkar, S.G. and Borikar, S.T. (1988). Combining ability studies with positional male sterile lines in tomato. *Journal of Maharashtra Agricultural University* **13:** 261-262.

Lower, R.L. and Thompson, A.E. (1967). Inheritance of acidity and solids content of small fruited tomatoes. Proceedings of American Society of Horticultural Science **91:** 486-494.

Makesh, S., Puddan, M., Banu, M.R. and Ramaswamy, N. (2003) Heterosis for some important qualitative traits in tomato (*Lycopersicon esculentum* Mill.). *Research on Crops* **4**(2)**:** 235-239.

Raina, B.L., Kalra, C.L., Teotia, M.S., Nandpuri, K.S., Kanwar, J.S. and Singh, S. (1980). Studies on suitability of tomato varieties for canning. *Vegetable Science* **7:** 60-66.

Sharma, P. (1998). Genetic analysis of fruit yield components and bacterial wilt resistance in tomato (*Lycopersicon esculentum* Mill.). Ph. D. Thesis, Himachal Pradesh Krishi Vishvavidayalaya, Palampur, India.

Sharma, R. (2003). Heterosis and combining ability studies in tomato (*Lycopersicon esculentum* Mill.). M. Sc. Thesis, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India.