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Short Communication

Combining Ability Estimates for Yield and its Contributing Traits in Tomato (*Lycopersicon esculentum*)

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ABSTRACT

Combining ability of eleven diverse breeding lines/varieties for yield and its contributing characters was evaluated trough a line × tester analysis. The results revealed that the variances due to lines effects were found significant for number of fruits per plant, days to 50% flowering and height of plant. Mean sum of squares due to testers effects were found significant for number of fruits per plant, average weight of fruits and height of plant. While the variances due to lines × testers effects, were highly significant for all the characters under study. In general, the parental line, M-3-1 and the tester 18-1-1 were found to be the best general combiner for yield per ha, yield per plant, number of fruits per plant, days to 50% flowering and plant height. For yield per ha, yield per plant and number of fruits per plant, the cross M-3-1 x 18-1-1 was the best combination. Analysis of variance for combining ability manifested the predominance of additive gene action for plant height and dominance gene action for yield per ha, yield per plant and number of branches per plant. While, both additive and non-additive gene actions were involved in the expression of number of fruits per plant, average weight of fruits and days to 50% flowering.

Key Words: Tomato; Combining ability; Gene action

INTRODUCTION

Combining ability has a prime importance in plant breeding since it provides information for the selection of parents and also provides information regarding the nature and magnitude of involved gene action. The knowledge of genetic structure and mode of inheritance of different characters helps breeders to employ suitable breeding methodology for their improvement (Kiani *et al.*, 2007). The concept of combining ability was introduced by Sprague and Tatum (1942). They stated that general combining ability (GCA) is average performance of a parent in a series of crosses and specific combining ability (SCA) designates those cases in which certain combinations perform relatively better or worse than would be expected on the basis of average performance of lines involved. The variance of GCA includes additive and additive × additive portions, while SCA includes non-additive genetic portion. Hence, combining ability, which is important in the development of breeding procedures is of notable use in crop hybridization either to exploit heterosis or to combine the favorable fixable genes. The main aim of the research work was to identify breeding lines/varieties having good combing ability effects for yield and its contributing characters viz., number of fruits per plant, average weight of fruits, days to 50% flowering, number of branches per plant and height of plant.

MATERIALS AND METHODS

The present study was carried out at Department of Horticulture, Mahatma Phule Agricultural University, Rahuri during Kharif, 2005. The parental material used in the line × tester model, were consisted of three lines and eight testers of tomato selected on the basis of diverse morphological and quantitative characteristics. All genotypes were evaluated in a randomized block design with three replications. There were 10 plants per replication spaced at 90 × 30 cm. The combining ability analysis was carried out following Kempthorne (1957). In case of height of plant and days to 50% flowering, as more compact growth habit and earliness were of interest, the lines/hybrids having negative GCA/SCA effects were considered as superior.

RESULTS AND DISCUSSION

Analysis of variance (Table I) showed that the variance due to lines effects was significant for number of fruits per plant, days to 50% flowering at 0.05 and height of plant at 0.01 probability level. Mean squares due to testers were significant for number of fruits per plant, average weight of fruits and height of plant. While variances due to lines × testers effects, were significant at 1% of probability for all the characters under study. The analysis of variance

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Table I. Analysis of variance for combining ability

Source of variation	DF	Mean Squares						
		Yield ha^{-1}	Yield $plant^{-1}$	No. of fruits $plant^{-1}$	Average fruit's weight	Days to 50% flowering	Plant height	No. of branches $plant^{-1}$
Replication	2	1.977	0.0007	1.926	10.359	0.172	7.375	0.210
Line effect	2	122.711	0.169	190.541*	1035.031	112.797*	972.186**	4.021
Tester effect	7	132.707	0.076	123.228*	1242.054*	59.804	373.098*	11.885
L × T effect	14	121.709**	0.041**	33.747**	340.083**	21.759**	93.045**	4.861**
Error	46	3.865	0.0022	1.128	4.552	1.702	4.541	0.447

*, ** Significant at 0.05 and 0.01 probability level, respectively.

Table II. Components of variation in tomato

Sources of variation	Yield ha^{-1}	Yield $plant^{-1}$	No. of fruits $plant^{-1}$	Average fruit's weight	Days to 50% flowering	Plant height	No. of branches $plant^{-1}$
GCA variance (σ^2 gca)	7.526	0.007	9.437	68.638	5.053	40.455	0.457
SCA variance (σ^2 sca)	39.387	0.023	10.857	111.386	6.279	29.307	1.483
σ^2 gca / σ^2 sca	0.191	0.304	0.869	0.616	0.805	1.38	0.308
Additive variance (σ^2 A)	15.053	0.014	18.874	137.276	10.106	80.91	0.914
Dominance variance (σ^2 D)	39.387	0.023	10.857	11.386	6.279	29.307	1.483
σ^2 A/ σ^2 D	0.382	0.616	1.7384	1.232	1.609	2.761	0.616

Table III. Estimates of GCA effects of parents

Sr. No.	Parents	Yield ha^{-1}	Yield $plant^{-1}$	No. of fruits $plant^{-1}$	Average fruit's weight	Days to 50% flowering	Plant height	No. of branches $plant^{-1}$
					Lines			
1	M-3-1	2.010 **	0.080**	2.521**	-3.730**	-2.125**	-6.937**	-0.290*
2	87-2	0.439	0.006	0.521*	-3.852**	-0.083	1.368**	-0.178
3	Floradade	-2.449**	-0.086**	-3.042**	7.582**	2.208**	5.570**	0.468**
	S. E. ±	0.385	0.009	0.221	0.498	0.349	0.462	0.131
	C. D. 5%	0.774	0.019	0.446	1.002	0.702	0.930	0.264
	C. D. 1%	1.033	0.025	0.595	1.337	0.938	1.241	0.353
					Testers			
4	COMLCR-7	-3.738**	-0.098**	-5.317**	21.981**	3.917**	0.637	-0.783**
5	COMLCR-9	-3.739**	0.028	2.687**	-10.330**	-1.750**	9.488**	1.727**
6	COMLCR-4	1.182	0.084**	4.659**	-10.704**	-2.528**	6.267**	0.848**
7	H-24	-0.269	-0.047**	1.204**	-11.162**	-1.750**	-10.327**	-0.665**
8	H_88	4.332**	0.027	-0.741*	3.983**	3.139**	0.747	1.141**
9	H_36	-4.330**	-0.138**	-4.831**	9.455**	-1.639**	-5.308**	0.078
10	H_86	0.567	0.005	-1.131**	2.029*	2.028**	2.711**	-0.710**
11	18-1-1	5.996**	0.139**	3.468**	-5.252**	-1.417*	-4.215**	-1.635**
	S. E. ±	0.628	0.015	0.362	0.813	0.570	0.754	0.214
	C. D. 5%	1.264	0.031	0.728	1.635	1.147	1.519	0.431
	C. D. 1%	1.687	0.041	0.972	2.183	1.531	2.027	0.576

*, ** Significant at 0.05 and 0.01 probability level, respectively

for combining ability revealed that the SCA variances were greater than GCA variances for all of the studied characters (Table II) except height of plant. For plant height, the GCA variance was greater than SCA variance and consequently the ratio of additive variance (σ^2 A) to dominance variance (σ^2 D) was greater than unity suggesting the predominance of additive gene action for its inheritance (Sharma, 2004). Therefore, selection among the segregating generations would be effective for improving plant height in tomato. Furthermore, the greater values of dominance variance (σ^2 D) than additive variance (σ^2 A) and consequently the ratio of σ^2 A/σ^2 D less than unity, indicated the predominance of dominance gene action for yield per ha, yield per plant and number of branches per plant. These results suggested that breeding of F_1 tomato hybrids would be a suitable breeding strategy to exploit heterosis for these traits. Dominance gene action for these traits has been reported (Srivastava *et al*., 1998; Dhaliwal *et al*., 2000; Thakur & Joshi, 2000; Bhatt *et al.,* 2001). While, the greater values of additive variance (σ^2 A) than dominance variance (σ^2 D) and greater SCA effects than GCA effects revealed the involvement of both additive and non-additive gene actions in the inheritance of number of fruits per plant, average weight of fruits and days to 50% flowering. Rai *et al.* (1997) and Dhaliwal *et al.* (2000) also observed both additive and non-additive gene action for these characters.

As regards to the estimates of GCA effects of parents (Table III), among the lines, M-3-1 exhibited significant positive GCA effects for yield per ha, yield per plant and number of fruit per plants and significant negative effects for days to 50% flowering and height of plant. Significant positive GCA effects were also exhibited by the parent 87-2 for number of fruits per plant and Floradade for average weight of fruits and number of branches per plant. While

Table IV. Estimates of SCA effects of hybrids

Crosses	Yield ha^{-1}	Yield plant^{-1}	No. of fruits plant^{-1}	Average fruit's weight	Days to 50% flowering	Plant height	No. of branches plant^{-1}
1 x 4	-3.213**	-0.116**	-2.306**	-7.441**	-2.542**	3.642**	0.169
1 x 5	-4.252**	0.037	0.863	0.543	0.125	-2.433	0.602
1 x 6	-6.322**	-0.090**	1.677*	-7.779**	0.903	1.565	-0.599
1 x 7	5.930**	0.134**	1.443*	5.362**	0.125	-5.062**	-0.203
1 x 8	-0.024	-0.048	1.477*	-10.807**	1.236	1.308	-0.589
1 x 9	2.764*	0.043	-1.383*	7.612**	-1.319	-2.414	-0.219
1 x 10	-6.269**	-0.222**	-6.193**	10.411**	-2.319*	-0.433	0.069
1 x 11	**11.387****	**0.262****	**4.422****	2.099	3.792**	3.827**	0.771*
2 x 4	6.148**	0.137**	3.516**	-13.585**	-1.250	0.670	-0.109
2 x 5	-0.813	-0.085**	-0.995	0.439	2.417*	4.039**	1.077**
2 x 6	6.359**	0.015	-0.247	2.270	**-3.139****	**-12.183****	-1.934**
2 x 7	-6.081**	-0.168**	-2.321**	-1.059	1.417	3.520**	0.380
2 x 8	-0.608	-0.035	-4.047**	17.756**	-2.139*	2.447	-0.644
2 x 9	2.254*	0.117**	2.300**	-2.455	1.306	-0.275	-0.054
2 x 10	0.915	0.116**	2.753**	-2.120	2.972**	2.929*	1.401**
2 x 11	-8.173**	-0.097**	-0.959	-1.245	-1.583	-1.147	-0.117
3 x 4	-2.935**	-0.021	-1.210	**21.027****	3.792**	-4.312**	-0.059
3 x 5	5.065**	0.049	0.132	-0.982	-2.542*	-1.606	-1.679**
3 x 6	-0.036	0.075**	-1.430*	5.509**	2.236*	10.618**	**2.533****
3 x 7	0.151	0.034	0.879	-4.303**	-1.542	1.542	-0.177
3 x 8	0.632	0.083**	2.570**	-6.949**	0.903	-3.755**	1.233**
3 x 9	-5.018**	-0.160**	-0.917	-5.157**	0.014	2.689*	0.273
3 x 10	5.354**	0.105**	3.440**	-8.291**	-0.653	-2.496	-1.469**
3 x 11	-3.214**	-0.165**	-3.462**	-0.853	-2.208*	-2.680*	-0.654
S. E. ±	1.087	0.026	0.626	1.407	0.987	1.307	0.371
C. D. 5%	2.189	0.053	1.261	2.833	1.987	2.630	0.747
C. D. 1%	2.922	0.071	1.683	3.781	2.652	3.511	0.997

*, ** Significant at 0.05 and 0.01 probability level, respectively

among the testers, 18-1-1 recorded significant positive GCA effects for yield per ha, yield per plant and number of fruits per plant and significant negative effects for days to 50% flowering and height of plant. Significant positive GCA effects were also recorded by the parent H-88 for yield per ha; COMLCR-4 for yield per plant; COMLCR-4, COMLCR-9 and H-24 for number of fruits per plant; COMLCR-7, H-36, H-88 and H-86 for average weight of fruits and COMLCR-9, H-88 and COMLCR-4 for number of branches per plant. In addition to 18-1-1, significant negative GCA effects were produced by the testers COMLCR-4, COMLCR-9, H-24 and H-36 for days to 50% flowering and H-24and H-36 for height of plant.

Based on the results obtained for SCA effects (Table IV), the hybrid M-3-1 × 18-1-1 was the best combination for yield per ha, yield per plant and number of fruits per plant. While the hybrids Floradade × COMLCR-7, 87-2 × COMLCR-4, 87-2 × COMLCR-4 and Floradade × COMLCR-4 were found to be the best combinations for average weight of fruits, days to 50% flowering, height of plant and number of branches per plant, respectively.

CONCLUSION

Considering performance of parents and their behavior in a series of crosses, the parents M-3-1 and 18-1-1 were found to be the best general combiner for yield per ha, yield per plant, number of fruits per plant, days to 50% flowering and plant height. For yield per ha, yield per plant and number of fruits per plant, the best combination was M-3-1 × 18-1-1, which can further be exploited for isolating superior segregants.

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