HETEROSIS STUDIES FOR EARLINESS, YIELD AND EARLY BLIGHT RESISTANCE IN TOMATO (*SOLANUM LYCOPERSICUM* L.)

MV Bharathkumar[1]*, AT Sadashiva, TH Singh and MK Shivaprasad[1]

Indian Institute of Horticultural Research, Bengaluru-560 089, India

Key words: Heterosis, Earliness, Early blight, Resistance, Tomato

Abstract

Line (6 lines) × **T**ester (3 testers) analysis in tomato genotypes revealed that the hybrids IIHR977 × IIHR2890 and IIHR2891 × IIHR2853 were best heterotic hybrids for early fruit maturity over both the commercial checks. Whereas hybrids, namely, IIHR1816 × IIHR2852, IIHR1816 × IIHR2890, IIHR2848 × IIHR2853, IIHR2850 × IIHR2852, IIHR2891 × IIHR2852 and IIHR2892 × IIHR2890 exhibited significant heterosis for early blight resistance and yield per hectare over Abhinav. IIHR1816 × IIHR2853 and IIHR1816 × IIHR2852 that exhibited highest significant heterosis of 68.96 and 52.93%, respectively over check Abhinav along with highest significant desirable heterosis of –59.97% for early blight PDI can be recommended for further evaluation.

Introduction

Tomato (*Solanum lycopersicum* L., 2n = 24) being cultivated throughout the world owing to its wide climatic adaptability, versatile nature in culinary usage and high nutritive value. Hence, innumerable number of tomato varieties are available worldwide. Development of new tomato varieties or hybrids is a never-ending process due to changing preferences of the consumers and new challenges arising because of various biotic and abiotic stresses. Among biotic stresses, early blight disease caused by *Alternaria solani* is a major one which in severe cases known to cause complete defoliation of crop grown in regions with heavy rainfall, high humidity and moderate to high temperatures of 24 - 29°C (Rotem and Reichert 1964). Development of early blight resistant tomato genotypes using wild relatives has been attempted, but such resistant genotypes were found to be late in bearing (Barrat and Richards 1944) coupled with their poor yields (Foolad *et al.* 2002).

Heterosis is a natural phenomenon whereby hybrid offspring from genetically diverse individuals show phenotypic superiority over its parents with respect to traits such as growth rate, reproductive success, resistance, quality and yield (Shull 1948). Hedrick and Booth (1968) were first to report heterosis in tomato for higher yield and more number of fruits per plant. Heterosis in tomato was observed in the form of improved vigour, growth and development, earliness in maturity, enhanced quality and increased productivity (Yordanov 1983). Hence, the present investigation has been taken up to exploit the advantage of heterosis for early blight resistance, yield and yield attributing traits.

Materials and Methods

Materials comprised of 9 genotypes, namely IIHR 977, IIHR 1816, IIHR 2848, IIHR 2850, IIHR 2891, IIHR 2892, IIHR 2852, IIHR 2853 and IIHR 2890 were selected according to their diversity for various traits. Among these, the parental lines IIHR 977 and IIHR 1816 were found to be resistant, whereas**,** the parents IIHR 2850, IIHR 2890 and IIHR 2891 were moderately

---

*Author for correspondence: <bharathkumarmv809@gmail.com>. [1]Department of Vegetable Science, CCS HAU, Hisar-125 004, India.

resistant. These nine parental lines were crossed in Line × Tester fashion comprising six lines and three testers at experimental plot (Block-8), Division of vegetable crops, Indian Institute of Horticultural Research (IIHR), Hesaraghatta, Bengaluru during *rabi* of 2013 - 2014. Evaluation of hybrids for resistance to early blight, yield and yield attributing parameters in tomato along with the parents, resistant (Arka Rakshak) and susceptible (Abhinav) checks for early blight was performed during summer 2014 in RBD with three replications. Each entry in a replication was represented by 40 plants spaced 100 cm apart between rows and 45 cm within row. Crop was raised by following package of practices recommended by IIHR for tomato crop (excluding the fungicidal spray).

Five fruits in random were selected from each replication to record average fruit weight (g). The observations were recorded on five randomly selected plants in each replication for days to 50 per cent flowering, days to first fruit maturity, plant height (cm), number of primary branches, flower clusters per plant**,** fruits per cluster, fruit set per cent. Yield per hectare was obtained by conversion of yield obtained by 40 plants in each replication to hectare by considering the spacing given. The observation on reaction of entries against early blight pathogen was recorded by using detached leaf assay on the basis of per cent disease index (PDI) using the detached leaf assay by employing 0 - 4 scale developed by Devananthan and Ramanujam (1995). The test genotypes were then grouped into five categories like immune, highly resistant, resistant, moderately resistant, susceptible and highly susceptible based on PDI (Mckinney 1923). Data were analysed to know the heterosis per cent using statistical package WINDOSTAT version 8.0 and significance of the heterosis over better parent and standard checks was determined at 5 and 1% probability. Heterosis values in negative direction were considered as desirable for the characters like days to 50 per cent flowering, days to first fruit maturity and PDI of early blight disease.

Results and Discussion

Analysis of variance for ten characters (Table 1) related to fruit yield revealed that mean sum of squares for parents and hybrids were significant for the traits like days to 50 per cent flowering, plant height, flower clusters per plant, days to first fruit maturity, PDI for early blight and yield per hectare indicates presence of heterosis for these characters. Variance due to lines (females) was significant for all the traits except number of branches and yield per hectare. While the male parents were significant for traits like plant height, number of branches, flower clusters per plant, average fruit weight and PDI claiming the presence of sufficient variation among the male and female parents for most of the characters. Heterosis expressed by hybrids over better parent, standard check 1 (Arka Rakshak) and standard check 2 (Abhinav) is presented (Tables 2 and 3). The range of *per se* performance, range of heterosis over better parent (BP) and standard checks (SC), number of crosses with significant heterosis in desirable direction and two best heterotic hybrids over BP and SC are presented (Table 4).

For days to 50 per cent flowering, heterosis (%) varied from −15.96 to 5.62 over better parent, −15.05 to 1.08 over standard check Arka Rakshak (SC 1) and −11.24 to 5.62 over standard check Abhinav (SC 2). Out of 18 hybrids, negative heterosis for days to 50 per cent flowering is observed in 8, 16 and 8 hybrids over better parent, standard checks 1 and 2, respectively. IIHR2891×IIHR2852 showed maximum heterosis over better parent (−15.96), SC 1 (−15.05) and SC 2 (−11.24) for days to 50 per cent flowering. These results are in conformity with the findings of Chauhan *et al*. (2014), Negi *et al*. (2012), Joshi and Thakur (2004). Heterosis range of −10.94 to 15.35 over better parent, −12.04 to 8.76 over SC 1 and −17.61 to 1.86 over SC 2 was reported for plant height. Significant heterosis for this trait was observed in 3 and 2 hybrids over better and SC 1. The IIHR2848 × IIHR2853 exhibited maximum heterosis of 15.35 and 8.76 over better parent

Table 1. ANOVA for various studied characters.

Sl. No.	Source	Replication	Parents	Lines	Tester	Line × tester	Parent vs. hybrids	Crosses	Error
	Degrees of freedom	2	8	5	2	1	1	17	52
1	Days to 50 % flowering	1.81	5.42**	7.95**	1.44	0.67	18**	4.08**	0.88
2	Plant height (cm)	21.92	175.74**	118.57**	282.18**	248.75**	1036.49**	80.16**	13.18
3	Number of branches	4.26**	0.81 *	0.49	2.01 **	0.0018	0.06	1.03 **	0.30
4	Flower clusters per plant	28.56*	211.83**	280.73**	144.66**	1.67	45.58*	144.16**	7.57
5	Fruits per cluster	2.64**	0.46**	0.576**	0.40444	0.01185	0.04	0.36**	0.14
6	Fruit set per cent	148.05*	171.64**	228.68**	114.11	1.51	91.02	88.83*	45.12
7	Average fruit weight	1180.04	5752.71**	5720.95**	4546.52**	8323.89**	1824.62	2552.56**	485.10
8	Days to first fruit maturity	0.60	23.54**	24.93**	6.78	50.07**	16.69*	11.20**	3.00
9	PDI	0.09	304.54**	429.42**	126.35**	36.52	267.55**	542.35	20.47
10	Yield per hectare	52.836	90.18	13.593	101.895	449.685 **	27085.25**	483.27**	44.544

*, ** $p < 0.05$ and 0.01, respectively.

Table 2. Heterosis (%) for yield attributing traits.

Crosses	Days to 50 % flowering			Plant height			Number of branches			Flower clusters per plant			Fruits per cluster		
	Heterosis % over			Heterosis % over			Heterosis % over			Heterosis % over			Heterosis % over		
	BP	SC-1	SC-2	BP	SC-1	SC-2	BP	SC-1	SC-2	BP	SC-1	SC-2	BP	SC-1	SC-2
IIHR 977 × 2852	−4.6	−10.75**	−6.74*	6.43	0.5	−5.87	13.66	13.53	18.40*	17.36**	8.42	42.26**	−1.46	−9.04	−9.04
IIHR 977 × 2853	5.62*	1.08	5.62*	1.16	8.16*	1.3	17.79*	17.65*	22.70**	−6.3	−7.82	20.95**	21.95	−3.85	−3.85
IIHR 977 × 2890	−1.14	−6.45*	−2.25	7.08	−9.05*	−14.82**	4.85	27.06**	32.52**	33.40**	−4.45	25.38**	19.51	−5.77	−5.77
IIHR 1816 × 2852	−3.53	−11.83**	−7.87**	6.95	1	−5.41	10.71	9.41	14.11	10.43*	2.02	33.86**	−22.92*	−28.85**	−28.85**
IIHR 1816 × 2853	−7.87**	−11.83**	−7.87**	−10.94**	−4.78	−10.81**	−4.19	−5.88	−1.84	−5.27	−6.81	22.28**	−8.51	−17.31	−17.31
IIHR 1816 × 2890	−5.68*	−10.75**	−6.74*	4.99	−12.04**	−17.61**	−11.65	7.06	11.66	7.35	−13.34**	13.70*	−21.28*	−28.85**	−28.85**
IIHR 2848 × 2852	0	−8.60**	−4.49	7.27	1.29	−5.13	−9.23	5.88	10.43	−9.92	−16.78**	9.2	−27.08**	−32.69**	−32.69**
IIHR 2848 × 2853	−3.37	−7.53**	−3.37	1.72	8.76*	1.86	−21.33**	−8.24	−4.29	−22.81**	−24.06**	−0.35	−15.79	−38.46**	−38.46**
IIHR 2848 × 2890	−2.27	−7.53**	−3.37	15.35**	1	−5.41	−1.46	19.41*	24.54**	−30.20**	−50.00**	−34.39**	−1.79	−26.35**	−26.35**
IIHR 2850 × 2852	−12.63*	−10.75**	−6.74*	12.01**	5.77	−0.93	2.3	4.71	9.2	3.28	−4.58	25.20**	−18.75	−25.00*	−25.00**
IIHR 2850 × 2853	−10.53*	−8.60**	−4.49	−10.01**	−3.78	−9.88**	0.57	2.94	7.36	−11.08*	−12.51**	14.79*	−13.16	−36.54**	−36.54**
IIHR 2850 × 2890	−8.42*	−6.45*	−2.25	4.45	−8.66*	−14.45**	−27.18**	−11.76	−7.98	−18.84**	−29.45**	−7.43	2.56	−23.08*	−23.08*
IIHR 2891 × 2852	−15.96*	−15.05**	−11.24**	3.8	2.79	−3.73	−5.59	4.41	8.9	−21.55**	−11.46*	16.18*	−5.61	−11.06	−11.06
IIHR 2891 × 2853	−12.77*	−11.83**	−7.87**	−2.47	4.28	−2.33	4.26	15.29	20.25*	−20.24**	−9.97	18.13**	−24.49*	−28.85**	−28.85**
IIHR 2891 × 2890	−8.51**	−7.53**	−3.37	−2.63	−3.58	−9.69**	−24.27**	−8.24	−4.29	−8.48*	3.3	35.54**	−14.29	−19.23*	−19.23*
IIHR 2892 × 2852	−2.35	−10.75**	−6.74*	9.17*	3.08	−3.45	1.15	3.53	7.98	−14.15**	−9.64*	18.57**	−12.5	−19.23*	−19.23*
IIHR 2892 × 2853	2.25	−2.15	2.25	−10.29**	−4.08	−10.16**	0	2.35	6.75	−3.65	1.42	33.07**	−4.88	−25.00**	−25.00**
IIHR 2892 × IHR 2890	−2.27	−7.53**	−3.37	1.69	−9.05*	−14.82**	−11.17	7.65	12.27	−0.06	5.19	38.02**	4.88	−17.31	−17.31
SEm±	0.55			2.10			0.32			1.59			0.22		
CD at 5%	1.56			6.0229			0.9133			4.5667			0.6243		
CD at 1%	2.09			8.0861			1.2261			6.131			0.8382		

*, ** p < 0.05 and 0.01, respectively . BP = Better parent, SC-1 = Standard check 1 (Arka Rakshak), SC-2 = Standard check 2 (Abhinav).

Table 3. Heterosis (%) for yield attributing traits, yield and early blight PDI.

Crosses	Days to first fruit maturity Heterosis % over			Fruit set per cent Heterosis % over			Average fruit weight Heterosis % over			Percent Disease Index Heterosis % over			Yield per hectare Heterosis % over		
	BP	SC-1	SC-2	BP	SC-1	SC-2	BP	SC-1	SC-2	BP	SC-1	SC-2	BP	SC-1	SC-2
IIHR 977× IIHR 2852	0	−4.81 *	−6.32 **	4.11	−0.7	1.03	−20.31	−2.93	17.26	4.69	57.03 **	−26.66**	60.92 **	−39.27**	−7.7
IIHR 977× IIHR 2853	0	−7.49**	−8.95**	−4	−9.66	−8.09	−24.73	5.11	26.96	−22.89 *	7.14	−49.96**	39.65 *	−26.94**	11.03
IIHR 977× IIHR 2890	0	−9.63**	−11.05**	−11.46	−5.87	−4.23	−36.43 *	−22.57	−6.47	−20	−14.29	−59.97**	48.05 *	−35.06**	−1.3
IIHR 1816× IIHR 2852	−3.37	−8.02**	−9.47**	−5.22	−5.33	−3.68	−12.07	16.07	40.2	−42.86**	−14.29	−59.97**	166.61**	0.63	52.93**
IIHR 1816× IIHR 2853	−3.37	−8.02**	−9.47**	−5.89	−6.01	−4.37	−3.2	35.18	63.29**	−38.31**	−14.29	−59.97**	112.53**	11.18	68.96**
IIHR 1816× IIHR 2890	−1.12	−5.88 *	−7.37**	−11.54	−5.95	−4.31	13.92	50.38**	81.65**	−20	−14.29	−59.97**	118.71**	−4.06	45.80**
IIHR 2848× IIHR 2852	−7.25**	−4.28	−5.79 *	7.01	2.24	4.02	−34.95**	23.96	49.73 *	0	57.03**	−26.66**	90.50**	−28.10**	9.27
IIHR 2848× IIHR 2853	−3.11	0	−1.58	1.87	−2.68	−0.98	−1.61	87.50**	126.48**	−4.48	50.00**	−29.94**	63.74**	−14.34	30.18 *
IIHR 2848× IIHR 2890	−3.11	0	−1.58	−8.62	−2.85	−1.15	−47.18**	0.65	21.57	−23.03**	20.86	−43.55**	56.74**	−31.24**	4.49
IIHR 2850× IIHR 2852	−2.13	−1.6	−3.16	1.6	−2.09	−0.38	−21.12 *	35.2	63.31**	−28.57**	7.14	−49.96**	157.45**	−2.83	47.67**
IIHR 2850× IIHR 2853	−1.6	−1.07	−2.63	−12.31	−15.49	−14.01	−25.61 *	27.51	54.03 *	−7.59	28.40 *	−40.03**	52.07**	−20.45*	20.9
IIHR 2850× IIHR 2890	−8.51**	−8.02**	−9.47**	−13.5	−8.04	−6.43	−56.81**	−25.97	−10.58	40.00**	50.00**	−29.94**	70.60**	−25.17**	13.72
IIHR 2891× IIHR 2852	−2.81	−7.49**	−8.95**	−8.03	−12.27	−10.74	−2.76	−14.29	3.53	23.77**	85.66**	−13.29 *	121.62**	−16.35 *	27.12 *
IIHR 2891× IIHR 2853	−4.49	−9.09**	−10.53**	−20.38	−31.97**	−30.79**	−33.70 *	−7.42	11.83	38.80**	92.86**	−9.93	110.22**	9.98	67.13**
IIHR 2891× IIHR 2890	−2.25	−6.95**	−8.42**	−33.95**	−29.77**	−28.55**	21.74	−11.85	6.47	−15.88	7.14	−49.96**	71.28**	−24.87**	14.18
IIHR 2892× IIHR 2852	−6.45**	−6.95**	−8.42**	−15.58	−3.35	−1.67	−2.75	12.88	36.35	15.33 *	114.11**	0	155.31**	−3.54	46.58**
IIHR 2892× IIHR 2853	−6.99**	−7.49**	−8.95**	−23.42**	−12.33	−10.8	−19.44	12.5	35.89	26.96**	135.71**	10.09	75.91**	−7.97	39.86**
IIHR 2892× IIHR 2890	−6.45**	−6.95**	−8.42**	−15.98	−3.8	−2.13	−13.31	0.62	21.54	−15.42 *	57.03**	−26.66**	146.47**	8.11	64.30 **
SEm±	1.00			3.89			12.75			2.62			4.44		
CD at 5%	2.88			11.15			36.55			7.50			12.72		
CD at 1%	3.86			14.96			49.07			10.07			17.08		

*, ** p < 0.05 and 0.01, respectively. BP = Better parent, SC-1 = Standard check 1 (Arka Rakshak), SC-2 = Standard check 2 (Abhinav).

Table 4. Range of heterosis and best heterotic hybrids.

Character	Mean range	Heterosis (%) range over			Number of crosses with significant heterosis in desirable direction over			Best heterotic hybrids over		
		BP	SC 1	SC 2	BP	SC 1	SC 2	BP	SC 1	SC 2
Days to 50 % flowering	26.33 - 31.33	−15.96 - 5.62	−15.05 - 1.08	−11.24 - 5.62	8	16	8	IIHR2891×IIHR2852 (−15.96) IIHR2891×IIHR2853 (−12.77)	IIHR2891xIIHR2852 (−15.05) IIHR2891xIIHR2853 (−11.83)	IIHR2891xIIHR2852 (−11.24) IIHR2891xIIHR2853 (−7.87)
Plant height (cm)	73.67 - 91.08	−10.94 − 15.35	−12.04 - 8.76	−17.61 - 1.86	3	2	0	IIHR2848×IIHR2890 (15.35) IIHR2850×IIHR2852 (12.01)	IIHR2848xIIHR2853 (8.76) IIHR977xIIHR2853 (8.16)	-
Number of branches	5 - 6.77	−27.18 − 17.79	−11.76 - 27.06	−7.98 - 32.52	1	3	5	IIHR977×IIHR2853 (17.79)	IIHR977xIIHR2890 (27.06) IIHR2848xIIHR2890 (19.41)	IIHR977xIIHR2890 (32.52) IIHR2848xIIHR2890 (24.54)
Flower clusters per plant	24.73 - 53.63	−30.20 - 33.40	−50.00 - 8.42	−34.39 - 42.26	3	0	14	IIHR977xIIHR2890 (33.40) IIHR977xIIHR2852 (17.36)	-	IIHR977xIIHR2852 (42.26) IIHR2892xIIHR2890 (38.02)
Fruits per cluster	2.13 - 3.33	−27.08 - 21.95	−38.46 - −3.85	−38.46 - −3.85	0	0	0	-	-	-
Fruit set per cent (%)	40.17 - 60.37	−33.95 − −1.6	−31.97 - 2.24	−30.79 - 4.02	0	0	0	-	-	-
Average fruit weight (g)	76.77 - 194.44	−56.81 - 21.74	−25.97 - 87.50	−10.58 - 126.48	0	2	6	-	IIHR2848xIIHR2853 (87.50) IIHR1816xIIHR2890 (50.38)	IIHR2848xIIHR2853 (126.48) IIHR1816xIIHR2890 (81.65)
Days to first fruit maturity	56.33 - 62.33	−8.51 - 0	−9.63 - 0	−11.05 - −1.58	5	13	14	IIHR2850xIIHR2890 (−8.51) IIHR2848xIIHR2852 (−7.25)	IIHR977xIIHR2890 (−9.63) IIHR2891xIIHR2853 (−9.09)	IIHR977xIIHR2890 (−11.05) IIHR2891xIIHR2853 (−10.53)
PDI (%)	25 - 68.75	−42.86 − 40.00	−14.29 - 135.71	−59.97 - 10.09	6	0	15	IIHR1816xIIHR2852 (−42.86) IIHR1816xIIHR2853 (−38.31)	-	IIHR977xIIHR2890 (−59.97) IIHR1816xIIHR2852 (−59.97)
Yield (t/ha)	48.38 - 88.56	39.65 - 166.61	−39.27 - 11.18	−7.7 - 68.96	18	0	10	IIHR1816xIIHR2852 (166.61) IIHR2850xIIHR2852 (157.45)	-	IIHR1816xIIHR2853 (68.96) IIHR2891xIIHR2853 (67.13)

and SC1, respectively. For the vegetative character number of branches, range of heterosis varied from −27.18 to 17.79 over better parent, −11.76 to 27.06 over SC1 and −7.98 to 32.52 over SC2. Only hybrid IIHR977×IIHR2853 showed significant heterosis of 17.79% over better parent and 3 hybrids exhibited significant heterosis over SC1 with IIHR977×IIHR2890 (27.06) expressing maximum heterosis. Hybrid IIHR977×IIHR2890 exhibited maximum heterosis of 32.52% among the 5 hybrids that exhibited significant heterosis for number of branches. The results obtained in positive direction for plant height and number of branches is in accordance with the results of Usha (2011) and Angadi *et al*. (2012). The magnitude of heterosis for flower clusters per plant varied between −30.20 to 33.40 over better parent, −50 to 8.42 over SC1 and −34.39 to 42.26 over SC2. Significant heterosis in desirable direction was observed in 3 hybrids over better parent with the maximum heterosis of 33.40% in IIHR977×IIHR2890 and in 14 hybrids over SC2 with IIHR977×IIHR2852 (42.26%) exhibiting maximum significant heterosis. The extent of heterosis for fruits per cluster varied between −27.08 and 21.95, −38.46 to −3.85 and −38.46 to −3.85 over the better parent, SC1 and SC2, respectively. Whereas the heterosis ranged between −33.95 to 1.6, −31.97 to 2.24 and −30.79 to 4.02 over better parent, SC1 and SC2, respectively for fruit set per cent. None of the hybrid combinations expressed significant heterosis over better parent, SC1 or SC2 for fruits per cluster and fruit set per cent.

Heterosis for average fruit weight ranged between −6.81 and 21.74, −25.97 to 87.50 and −10.58 to 126.48 over better parent, SC 1 and SC 2, respectively with 2 hybrids showing significant positive heterosis over SC1 and 6 hybrids with significant heterosis in desirable direction over SC2. The IIHR2848×IIHR2853 showed highest significant standard heterosis of 87.50 and 126.48% over SC1 and SC2, respectively. For days to first fruit maturity, heterosis range of −8.51 to 0, −9.63 to 0 and −11.05 to −1.58 was observed over better parent, SC1 and SC2, respectively. Five hybrids showed significant heterosis in desirable direction over better parent with IIHR2850×IIHR2890 (−8.51) exhibiting highly significant heterosis, whereas IIHR977×IIHR2890 showed highest significant heterosis over SC1 (−9.63) and SC2 (−11.05) for days to first fruit maturity. The results obtained for average fruit weight and days to first fruit maturity are in line with the findings of Chauhan *et al*. (2014). For the trait per cent disease index (PDI) heterosis range of −42.86 to 40.00, −14.29 to 135.71 and −59.97 to 10.09 was observed over better parent, SC1 and SC2, respectively. Out of 18 hybrids, six exhibited significant heterosis in desirable direction over better parent with IIHR1816 × IIHR2852 (−42.86) being the maximum, whereas 15 hybrids showed significant desirable heterosis over SC 2 with IIHR977×IIHR2890 (−59.97) exhibiting maximum heterosis. Heterosis for early blight resistance has also been reported by Rao *et al*. (2007). The extent of heterosis for yield per hectare ranged between 39.65 to 166.61, −39.27 to 11.18 and −7.7 to 68.96 over better parent, SC1 and SC2, respectively. Among all 18 hybrids that had shown heterosis over better parent and 10 hybrids that exhibited significant heterosis over SC2, the combination IIHR1816×IIHR2852 found to be the best heterotic one with heterosis per cent of 166.61 and 68.96 over better parent and SC2, respectively. While none of the hybrids recorded significant heterosis in desirable direction over SC1. Positive significant heterosis for fruit yield has been reported by Rao *et al*. (2007), Yadav *et al*. (2013), Amaefula *et al*. (2014), Chauhan *et al*. (2014).

Hybrids IIHR1816 × IIHR2852, IIHR1816 × IIHR2853, IIHR1816 × IIHR2890, IIHR2848 × IIHR2853, IIHR2850 × IIHR2852, IIHR2891 × IIHR2852 and IIHR2892 × IIHR2890 exhibited significant heterosis for early blight resistance and yield per hectare in desirable direction over the standard commercial check (SC2) Abhinav. IIHR1816 × IIHR2852, IIHR1816 × IIHR2853 can be recommended for further evaluation in different locations for yield and different isolates of *Alternaria solani* for early blight resistance.

References

Amaefula C, Agbo CU and Nwofia GE 2014. Hybrid vigour and genetic control of some quantitative traits of tomato (*Solanum lycopersicum* L.). Open J. Gen. **4**: 30-39.

Angadi A, Dharmatti PR and Angadi P 2012. Heterosis for productivity related traits in tomato. Asian J. Hort. **7**(1): 94-97.

Barrat RW and Richards MC 1944. Physiological maturity in relation to Alternaria blight in tomato. Phytopathology **34**: 997.

Chauhan VBS, Raj Kumar, Behera TK and Yadav RK 2014. Studies on heterosis for yield and its attributing traits in tomato (*Solanum lycopersicum* L.). International J. Agri. Envi. Biotech. **7**(1): 95-100.

Devananthan M and Ramanujam K 1995. Evaluation of fungicides for the management of early blight of tomato caused by *Alternaria solani*. Madras Agri. J. **82**: 228-229.

Foolad MR, Subbiah P and Ghangas GS 2002. Parent-offspring correlation estimate of heritability for early blight resistance in tomato, *Lycopersicon esculentum* Mill. Euphytica **126**: 291-297.

Hedrick UP and Booth NO 1968. Mendelian characters in tomato. Proceedings of American Soc. Hort. Sci. **5**: 19-24.

Joshi A and Thakur MC 2004. Evaluation of diallel progenies for yield and its contributing traits in tomato. Hort. J. **17**: 145-153.

McKinney HH 1923. Influence of soil temperature and moisture on infection of wheat seedlings by *Helminthosporium sativium*. J. Agri. Res. **26**: 195-217.

Negi PK, Sharma RR and Raj Kumar 2012. Heterosis and inbreeding depression in tomato under low temperature regime. Ind. J. Hort. **69**(3): 443-445.

Rao ES, Munshi AD, Balraj singh and Raj kumar 2007. Studies on heterosis and combining ability for yield and resistance to early blight in tomato. Ind. J. Hort. **64**(3)**:** 331-334.

Rotem J and Reichert I 1964. Dew - A principal moisture factor enabling early blight epidemics in a semiarid region of Israel. Pl. Dis. Rep. **48**: 211-215.

Shull, G.H. 1948. What is heterosis? Genetics **33**: 439-446.

Usha A. 2011. Line × tester analysis for yield, yield attributing characters and bacterial wilt disease resistance in tomato (*Solanum lycopersicum* Mill.). M.Sc. (Agri.) Thesis, UAS, Dharwad, India.

Yadav SK, Singh BK, Baranwal DK and Solankey SS 2013. Genetic study of heterosis for yield and quality components in tomato (*Solanum lycopersicum*). African J. Agri. Res. **8**(44): 5585-5591.

Yordanov M 1983. Heterosis in tomato. Theor. Appl. Gen. **6**: 189-219.