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## Heterosis studies on plant defence enzymes for root knot nematode resistance in tomato (*Solanum lycopersicum* L.) F<sub>1</sub> hybrids

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**Abstract**

The main aim of the present investigation was to study the heterosis of plant defence enzymes in six tomato hybrids that are bred in Line x Tester fashion. Exploitation of hybrid vigour through heterosis breeding by considering the induction of plant defence enzymes like total phenols, peroxidase, IAA oxidase and acid phosphatase in roots can be utilized. It was found that heterosis was appreciable in all the hybrids but it was more in the two hybrids viz., Arka Abha×HN2 and E812×HN2 for all the defence enzymes studied. These crosses can be selected for the exploitation of hybrid vigour and commercial utilization under root knot nematode infested areas.

**Keywords:** Heterosis, tomato, plant defence enzymes, root knot nematode

**Introduction**

Tomato (*Solanum lycopersicum* L.) is an important economic fruit vegetable after potato throughout the world because of its wider adaptability, high yielding potential and suitability for a variety of uses in fresh as well as processed food industries. The crop is severely affected by various biotic stresses. Among them, the phytonematodes particularly southern root knot nematode, *M. incognita* (Kofoid & White) Chitwood is a major constraint for production of tomato in tropical and subtropical countries like India (Kalaiarasan, 2009) [3] which causes 32 to 40% yield losses (Anwar and McKenry, 2010) [1]. Development of F<sub>1</sub> hybrids with high yield and quality as well as with resistance will be a boon to tomato growers for maximum production.

In resistant plants there will be induction and accumulation of defence enzymes during nematode infestation. These defence enzymes act as barriers and restrict the growth of nematode multiplication in the host cell. Therefore the knowledge on the induction of plant defence enzymes is an important prerequisite. With this background, an attempt has been made to estimate the magnitude of heterosis for yield and defence enzymes.

**Materials and methods**

The present study was carried out at the College Orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The experimental material consisting of six F<sub>1</sub> hybrids viz., IC249503×HN2, CLN 2123A×HN2, Hisar Arun×HN2, LE 812×IIHR 2868, LE 812×HN2 and Akra Abha×HN2 and their parents IC 249503, CLN 2123A, Hisar Arun, LE 812, Akra Abha, IIHR 2868, HN2 along with standard resistant check hybrid Hisar Lalit. The experiment was conducted in a completely randomized design with five replications. The basic seeds of the line × tester mating were produced in the vegetable research field, HC&RI, Coimbatore – 3.

**Result and discussion**

The *per se* performance of parents and hybrids are presented in Table 1. The heterosis per cent estimated for yield and plant defence enzymes over mid, better parent and check hybrid are given in Tables 2 and 3. The evaluation of the parents and hybrids was done based on their *per se* performance and heterosis.

With respect to yield per plant, the parent Hisar Arun recorded the highest yield followed by Arka Abha and LE812. All the hybrids registered positive and significant heterotic values for yield over their respective mid parental, better parental and check hybrid values except LE812×IIHR2868 which is not significant over better parent. Heterosis for yield in tomato was

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reported by Rasheed *et al.*, 2018 [4]. Highest significant and positive heterosis over the mid and better parent is observed in LE 812×HN2 followed by Arka Abha×HN2 whereas over check it is reported in Hisar Arun×HN2 followed by Arka Abha×HN2 and LE 812×HN2. The highest heterotic values in these hybrids are due to their highest per se performances for yield. Yield is a complex character which is influenced by various characters and heterosis for yield is the consequence of relationship between all those component characters Williams (1959) [6].

The total phenol content among the parents was highest in HN2 followed by IIHR 2868. Among the hybrids highest mean values are registered in Arka Abha×HN2 which is on par with the resistant check hybrid Hisar Lalit followed by LE 812×HN2 for this trait. All the hybrids exhibited significant negative heterosis over the check hybrid except Arka Abha×HN2 and it recorded highest value for total phenols. The highest heterotic value is recorded by Arka Abha×HN2 followed by IC249503×HN2 and LE 812×HN2 over mid parent and over better also Arka Abha×HN2 recorded highest. The hybrid mean was higher than the parental mean implying more degree of resistance in hybrids than parents. The similar results were obtained by Sankari (2000) [5] for total phenol content against TLCV resistance.

The highest polyphenol oxidase activity, which is one of the important resistant traits is recorded in HN2 followed by IIHR 2868 among the parents. Among the hybrids, Arka Abha×HN2 followed by LE 812×HN2 recorded highest values. These two hybrids exhibited highest positive heterosis

over the mid, betterparent and check hybrid. The results are in accordance with the Sundharaiya *et al.*, (2018) [7]. In this case also the hybrid mean exceeded the parental mean.

The highest peroxidase activity is also an important trait to be studied for root knot nematode resistance and highest value for this trait is recorded in HN2 among the parents and in hybrids, Arka Abha×HN2 followed by LE 812×HN2 exhibited highest peroxidase activity which are close to check hybrid Hisar Lalit. The cross Arka Abha×HN2 followed by LE 812×IIHR2868 recorded highest value over mid parent whereas over better parent LE 812×IIHR2868 followed by Arka Abha×HN2 recorded highest value. All the hybrids showed negative heterotic values over check hybrid and lowest negative value is recorded in Arka Abha×HN2. In this case also the hybrid mean exceeded the parental mean indicating more peroxidase activity in hybrids.

The highest IAA oxidase activity among the parents is recorded by HN2 followed by IIHR 2868 and in hybrids, it is recorded in Arka Abha×HN2 followed by LE 812×HN2. These two hybrids exhibited highest positive heterosis over the bestparent whereas they exhibited negative heterosis over check hybrid.

The highest Acid phosphatase activity among the parents is recorded by HN2 followed by IIHR 2868 and in hybridsit is recorded in Arka Abha×HN2. It exhibited highest positive heterosis over the mid and best parent whereas negative heterosis over check hybrid. These highest heterotic values are followed by LE 812×HN2 in all the three types of heterosis.

**Table 1:** *Per se* performance of parents and hybrids under pot culture

Parents and hybrids	Yield /plant (g)	Total phenols (µg/g)	Polyphenol oxidase (ΔA/g/min)	Peroxidase (ΔA/g/min)	IAA oxidase (µg/100 mg)	Acid phosphatase (mmoles of <i>p</i> - nitrophenol/min/mg)
IC249503	844.56	54.62	1.75	1.50	26.27	72.60
CLN2123A	806.64	77.46	2.32	1.67	38.58	76.51
Hisar arun	1181.38	67.90	2.13	1.55	37.78	77.23
LE 812	945.48	64.50	2.08	1.38	32.38	70.76
Arka Abha	1008.00	53.32	2.12	1.16	23.71	74.20
HN 2	923.98	117.80	3.63	3.28	72.22	84.31
IIHR2868	986.61	113.74	3.61	2.33	71.08	82.62
Mean	956.67	78.48	2.52	1.84	43.15	76.89
IC249503×HN2	1221.55	111.26	3.49	2.72	81.36	81.32
CLN2123A×HN2	1124.74	101.18	3.15	2.69	78.92	80.32
Hisar Arun×HN2	1348.00	98.52	2.91	2.63	73.02	78.46
LE812×HN2	1324.77	116.98	3.78	3.26	81.46	83.25
LE812×IIHR2868	1114.83	97.76	3.07	2.61	75.72	79.21
Arka Abha ×HN2	1342.80	118.28	3.84	3.29	83.64	85.23
Mean	1246.12	107.33	3.37	2.87	79.02	81.30
PKM 1	707.22	47.26	0.97	1.00	32.08	69.25
Hisar Lalit	867.29	125.52	3.70	3.36	87.64	86.23
Grand mean	1049.85	91.07	2.84	2.30	59.72	78.77
SeD	87.66	3.59	0.18	0.18	2.26	3.29
CD (0.05)	175.35	7.18	0.36	0.37	4.51	6.58
CD (0.01)	233.22	9.55	0.48	0.49	6.00	8.75

**Table 2:** Heterosis percent for yield per plant (g), total phenols (µg/g) and polyphenol oxidase (ΔA/g/min)

Hybrids	Yield per plant			Total phenols			Polyphenol oxidase		
	di	dii	diii	Di	Dii	diii	di	dii	diii
IC249503 × HN2	38.14**	32.21**	40.85**	29.06**	-5.55	-11.36**	29.93**	-3.75	-5.78**
CLN2123A × HN2	29.98**	21.73*	29.69**	3.64	-14.11**	-19.39**	5.99	-13.13**	-14.96**
Hisar Arun × HN2	28.05**	14.10	55.43**	6.11	-16.37**	-21.51**	1.18	-19.75**	-21.44**
LE812 × HN2	41.73**	40.12**	52.75**	28.34**	-0.70	-6.80*	32.54**	4.25	2.05*
LE812 × IIHR2868	15.40	13.00	28.54**	9.69*	-14.05**	-22.12**	8.05*	-14.89**	-17.01**
Arka Abha × HN2	39.01**	33.21**	54.83**	38.24**	0.41	-5.77	33.70**	5.90	3.67

\* Significant at 5 per cent level \*\* Significant at 1 per cent level

**Table 3:** Heterosis percent for peroxidase ( $\Delta A/g/min$ ), IAA oxidase ( $\mu g/100mg$ ) and acid phosphatase (mmoles of *p*-nitrophenol/min/mg)

Hybrids	Peroxidase			IAA oxidase			Acid phosphatase		
	di	dii	diii	Di	dii	diii	di	dii	diii
IC249503 × HN2	13.95*	-16.97**	-18.95**	65.22**	12.66**	-7.17*	3.65**	-3.55*	-5.69
CLN2123A × HN2	8.69	-17.95**	-19.90**	42.45**	9.28**	-9.95**	-0.11**	-4.73	-6.85*
Hisar Arun × HN2	8.90	-19.72**	-21.63**	32.76**	1.11**	-16.68**	-2.86**	-6.94*	-9.01**
LE812 × HN2	40.09**	-0.37	-2.74	55.75**	12.79**	-7.05*	7.37**	-1.26*	-3.46
LE812 × IHR2868	40.52**	12.03	-22.29**	46.38**	6.53**	-13.60**	3.29**	-4.13	-8.14**
Arka Abha × HN2	48.47**	0.43	-1.97	74.38**	15.81**	-4.56	7.54**	1.09**	-1.16

\* Significant at 5 per cent level \*\* Significant at 1 per cent level

### Conclusion

Heterosis studies on plant defence enzymes for root knot nematode resistance has shown that two hybrids *viz.*, Akra Abha×HN2 and LE 812×HN2 recorded highest heterotic values for enzymes activities and also yield compared to the others. The hybrids with resistance can be helpful to the farming communities as they reduce the economic losses caused by root knot nematode infested tomato fields. These two hybrids have to be further studied for their stability in yield and quality traits under different locations.

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