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Evaluation of F_1 hybrids of tomato (*Solanum lycopersicum* L.) and mechanism of resistance against root knot nematode (*Meliodogyne incognita*)

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Abstract
Tomato is mostly affected by root knot nematode (*Meliodogyne incognita*) which primarily produces root galls in the root system and cause 32 to 40% yield losses. Development of hybrids with nematode resistance as well as high yielding is very much needed to combat the effect. The present study is aimed to screen the F_1 hybrids and its parents of tomato along with susceptible (PKM 1) and resistant check hybrid (Hisar Lalit) based on the nematode multiplication and induction of defence related enzymes by the resistant plant due to nematode attack. Six F_1 hybrids and their parents are screened, among them, two F_1 hybrids Akra Abha×HN2 and LE 812×HN2 are found to be resistant with root knot index of 1.60 and 1.80 respectively. The resistant mechanisms are also supported with highest induction of defence enzymes *viz.,* phenol, peroxidase, polyphenol oxidase and IAA oxidase activities in the hybrids Akra Abha×HN2 and LE 812×HN2 compared to susceptible check (PKM 1) and on par with resistant check hybrid (Hisar Lalit).

Keywords: Tomato, root knot nematode, resistance, susceptible and defence enzymes

Introduction
Tomato (*Solanum lycopersicum* L.) is an important fruit vegetable and second most important crop 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. In many countries, it is considered as "poor man's orange" because of its attractive appearance and nutritive value (Meena and Bahadur, 2015) [9]. The plant parasitic nematodes play a lead role in bringing down the productivity of the crop. Among the phytonematodes, root knot nematode (*Meloidogyne* spp.) are reported to cause severe infestation and in particularly, the 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) [7]. The root knot nematode, *M. incognita* is a soil-dwelling, microscopic nematode that feeds exclusively on the cytoplasm of living plant cells. Disease symptoms on infected plants include the presence of galls on roots, which may increase susceptibility to secondary pathogens such as Fusarium wilt (Kyndt *et al.,* 2013) [8]. The present management strategies include use of chemical nematicides as one of the primary means of control and other strategies include crop rotations which have some limitations. However, the use of nematicides has detrimental effects on environment and human health (Noling and Becker, 1994) [10]. Therefore, there is a need to develop an alternative, environmental friendly management tactics for plant-parasitic nematodes. The use of root knot nematode resistant tomato cultivars is an alternative for nematode management as their use does not require any major adaptations in regular farming practices. Naturally occurring host resistance against *Meliodogyne* spp. has been found in many crops and related wild species (Sasser and Freckman, 1987) [12]. The main aim of the present study is artificial screening of tomato F_1 hybrids and its parents and also to analyse defence enzymes activities against *M. incognita*.

Materials and Methods
The screening of F_1 hybrids and its parents against resistance to *M. incognita* in tomato was carried at the College Orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore – 3. The experimental material consisting of six F_1 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 susceptible check cv. PKM -1 and 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.

Pure culture maintenance

The susceptible tomato cv. PKM -1 seeds obtained from Department of Vegetable Crops, Tamil Nadu Agricultural University, Coimbatore was used for maintenance of *M.incognita* pure culture.

Tomato seeds were sown in portrays and 25 days old seedlings were transplanted in earthern pots filled with sterilized potting mixture. Later, the method of Sasser *et al.*, (1957) [13] was followed for inoculating nematodes. Infested roots from pure culture were cut into small pieces of about 2 cm long and placed in 0.5% sodium hypochlorite (NaOCl) solution. The container was shaken for about 3 minutes to dissolve the gelatinous matrix and freeing the eggs from the eggmass and incubated for 48 h under room temperature. The inoculum concentration was adjusted to a known number by addition of water. A hole was made two centimetres near rhizosphere of plant and the nematode inoculum was released at the rate of two juvenile (J2)/g of soil after 15 days of transplanting.

Sixty days after inoculation, seedlings were uprooted carefully with minimum root disturbance and washed gently with water to remove the adhering soil particles and observations like root length (cm), dry root weight (g), number of galls/plant, number of eggmasses/g root, number of eggs/eggmass and also number of females/g root were recorded. The reactions of tomato genotypes were assessed based on root knot index given by Heald *et al.*, (1989) [4] as index 1: no galls as highly resistant, 2: 1-25% root galls as resistant, 3: 26-50% root galls as moderately resistant, 4: 51-75% root galls as susceptible, 5: 76-100% root galls Highly susceptible.

Biochemical characters of resistance

In resistant plant, defence enzymes has been accumulated and activated during nematode infestation. The root samples were analysed 45 days after inoculation of nematode. In view of the above mentioned criteria some of the biochemical characters like total phenols (µg/g) (Bray and Thrope, 1954) [2], peroxidase (ΔA/min/g) (Srivastava, 1987) [14], polyphenol oxidase (ΔA/min/g) (Srivastava, 1987) [14], IAA oxidase (µg/ 100mg) (Sadasivam and Manickam, 1997) [11] were analysed.

Result and Discussion

Susceptibility or resistance of a plant to root knot nematode depends on the penetration ability of nematode juveniles followed by formation of galls in the roots (Chen and Dickson, 2004) [3]. The galls formation is determined by the genetic make-up of the individual hybrid (Jacquet *et al.*, 2005) [6]. In the present study, 7 parents 6 hybrids and 2 checks were screened for *M. incognita* which varied in their resistance to *M. incognita*. Among the screened hybrids Arka Abha×HN2 recorded lowest values for all the characters *viz.*, soil nematode population (1043.20), number of females/g roots (7.85), number of eggmass per/g roots (12.08), number of eggs/eggmass (94.78) and root weight (1.34 g) and highest root length (29.20 cm) as resistant plants exhibit highest root length and lowest root weight (Table 1) and these results are in accordance with the investigations made by Indu Rani *et al.* (2009) [5]. It also recorded as resistant with the lowest root knot index (1.60) which is on par with the resistant check Hisar Lalit (1.60). The results of LE 812×HN2 was also similar to hybrid Arka Abha which also recorded lowest values for all the above characters studied with lowest root knot index of (1.80) which is also registered as resistant. Whereas the hybrids IC249503×HN2 and CLN2123A×HN2 with root knot index of 2.20 and 2.80 are registered as moderately resistant. While Hisar Arun×HN2 and LE 812×IIHR 2868 registered as susceptible with higher values of all the above characters (Table 1).

Similarly, in case of parents, HN2 and IIHR2868 registered lowest values for soil nematode population (936.20 and 1040.20), number of females/g roots (8.93 and 9.80), number of eggmass/g roots (10.21 and 13.35), number of eggs/eggmass (96.08 and 100.00), and root weight (1.31 and 2.32 g) and highest root length (30.15 and 22.62 cm) and with root knot index (2.00 and 2.40) respectively. The results obtained are in accordance with the observations made by Sujatha *et al.* (2017) [15]. Therefore both the parents are categorised as resistant. While the remaining parents *viz.*, IC249503, LE 812, Arka Abha, CLN 2123A, Hisar Arun registered higher values for above characters studied. Hence they are registered as susceptible (Table 1).

Induction of defence related enzymes against nematode

The above mentioned root knot nematode resistant characters were also supported by the biochemical analysis. Accumulation of phenolic compounds can be considered as a defence mechanism of plants. Increase in Phenols content as a resistance mechanism of plants against nematode infestation was reported as early by Acedo and Rodhe (1971) [1]. Peroxidases and polyphenol oxidases are important enzymes which actively take part in the oxidation of phenolic compounds. The hybrid Arka Abha recorded the highest total phenol content (118.28), peroxidase activity (3.29), polyphenol oxidase activity (3.84) and IAA Oxidase activity (83.64) which is also an important characters associated with resistance (Table 2). Increase in defence enzymes activities like peroxidase activity and polyphenol oxidase activity in resistant genotypes was also reported by Kalaiarasan (2009) [7]. The resistant check Hisar Lalit exhibited 125.52, 3.36, 3.70 and 87.64 of total phenols, peroxidase activity, polyphenol oxidase activity and IAA Oxidase activity respectively where the results were similar to Arka Abha (Fig. 1 & Fig. 2). The hybrid LE 812×HN2 also registered the values next to Arka Abha indicating resistance where as the other hybrids IC249503×HN2 and CLN2123A×HN2, Hisar Arun×HN2 and LE 812×IIHR 2868 recorded lowest changes in defence enzyme activities.

Similar trend was observed in case of parents, HN2 and IIHR2868 recorded the highest total phenols (117.80 and 113.74), peroxidase activity (3.28 and 2.33), polyphenol oxidase activity (3.63 and 3.61) and IAA Oxidase activity (72.22 and 71.08) where the results were similar to resistant check Hisar Lalit indicating resistance. The other parents IC249503, LE 812, Arka Abha, CLN 2123A, Hisar Arun recorded lowest changes in defence enzyme activities indicating susceptibility nature (Table 2). The results indicated that the resistant genotypes exhibits highest defence related enzyme activities compared to susceptible genotypes as a resistance mechanism. Similar results regarding to changes in defence enzyme activities were also obtained by Sundharaiya *et al.* (2018) [16] and Indu Rani *et al.* (2009) [5].

Table 1: *Per se* performance of tomato parents and hybrids for nematode resistance

Parents and hybrids	Final soil nematode population (200cc)	No. of females/g root	No. of eggmasses /g root	No. of eggs/ eggmass	Root length (cm)	Root weight (g)	Root knot index	Reaction
IC249503	3052.80	18.03	16.77	172.73	11.89	3.57	5.00	HS
CLN2123A	2599.60	15.91	15.50	158.30	19.36	2.45	3.80	S
Hisar Arun	2619.40	13.22	15.10	126.49	21.21	2.24	4.00	S
LE 812	2740.00	14.58	18.28	183.74	18.87	3.16	5.00	HS
Arka Abha	3224.20	17.54	18.36	175.68	14.50	3.92	5.00	HS
HN2	936.20	8.93	10.21	96.08	30.15	1.31	1.60	R
IIHR2868	1040.20	9.80	13.35	100.00	22.62	2.32	1.80	R
IC249503× HN2	1096.60	9.92	13.13	115.46	27.86	1.43	2.20	MR
CLN2123A× HN2	1221.80	12.10	13.71	115.48	27.68	2.12	2.80	MR
Hisar Arun× HN2	1301.00	14.85	14.18	123.61	26.92	2.49	3.40	S
LE 812× HN2	1049.00	8.57	12.52	99.33	28.35	1.38	1.80	R
LE 812× IIHR2868	1580.60	11.99	15.08	135.48	26.48	2.39	3.60	S
ArkaAbha× HN2	1043.20	7.85	12.08	94.78	29.20	1.34	1.60	R
PKM 1	4802.80	20.44	26.92	174.60	21.52	4.29	5.00	HS
Hisar Lalit	510.00	4.68	5.90	71.19	34.01	2.14	1.60	R
SE(d)	118.38	1.04	1.71	18.52	1.90	0.11	-	-
CD (0.05)	236.80	2.08	0.85	9.26	3.81	0.22	-	-

Table 2: *Per se* performance of tomato parents and hybrids for biochemical basis of resistance

Parents and hybrids	Total phenols (µg/g)	Peroxidase (ΔA/min/g)	Polyphenol oxidase (ΔA/min/g)	IAA oxidase (µg/100mg)
IC249503	54.62	1.50	1.75	26.27
CLN2123A)	77.46	1.67	2.32	38.58
L4 (Hisar Arun)	67.90	1.55	2.13	37.78
L7 (LE 812)	64.50	1.38	2.08	32.38
L10(Arka Abha)	53.32	1.16	2.12	23.71
T3 (HN2)	117.80	3.28	3.63	72.22
T2 (IIHR2868)	113.74	2.33	3.61	71.08
IC249503 × HN2	111.26	2.72	3.49	81.36
CLN2123A × HN2	101.18	2.69	3.15	78.92
Hisar Arun × HN2	98.52	2.63	2.91	73.02
LE 812× HN2	116.98	3.26	3.78	81.46
LE 812× IIHR2868	97.76	2.61	3.07	75.72
Arka Abha× HN2	118.28	3.29	3.84	83.64
PKM 1	47.26	1.00	0.97	32.08
Hisar Lalit	125.52	3.36	3.70	87.64
SE(d)	3.58	0.18	0.18	6.57
CD (0.05)	7.17	0.36	0.36	3.28

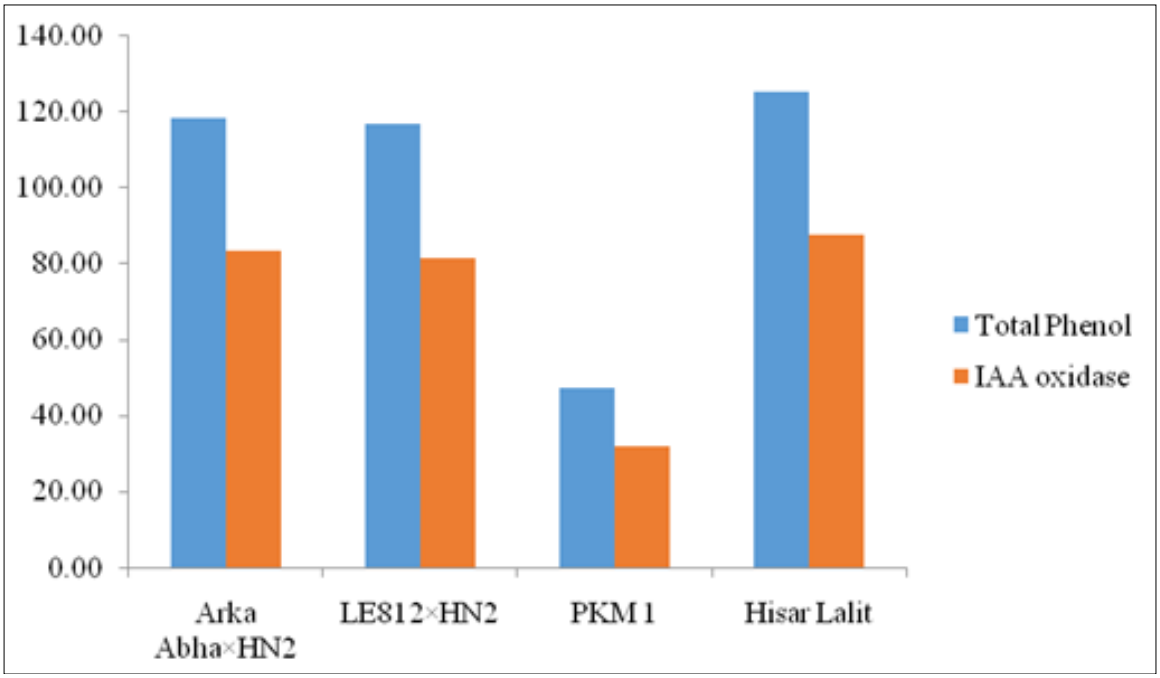

Fig 1: Total phenol and IAA oxidase activity in resistant hybrids tomato against *M. incognita*

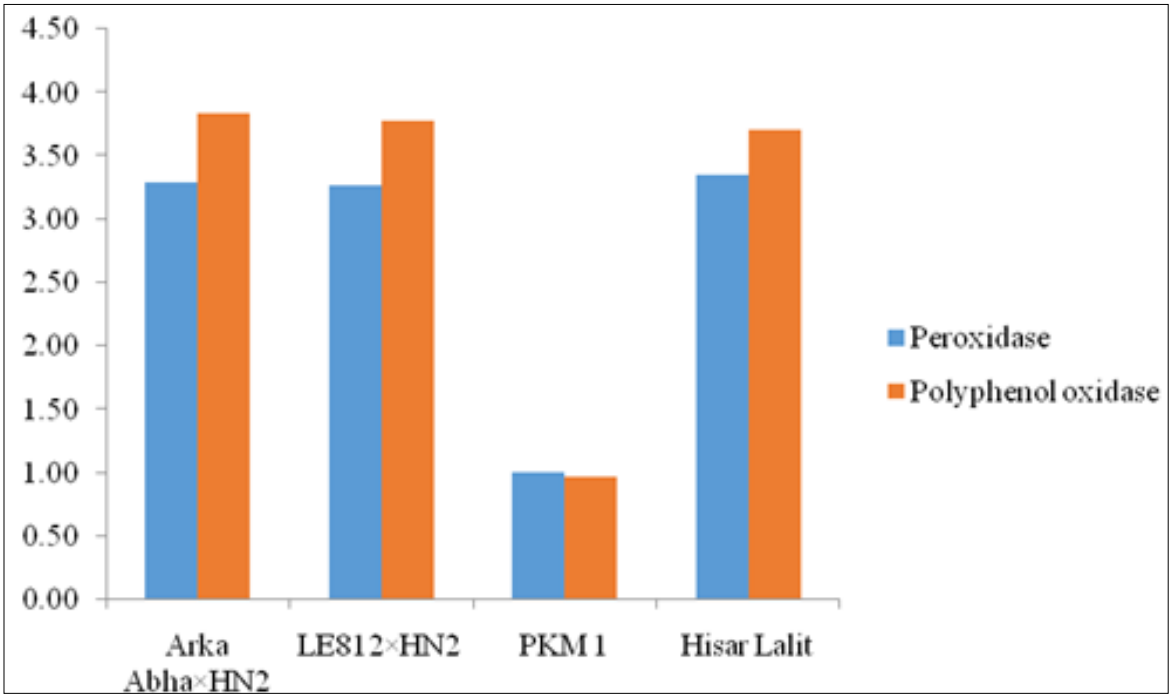

Fig 2: Peroxidase and Polyphenol oxidase activity in resistant hybrids against *M. incognita*

Conclusion

In the present study, it can be concluded that artificial screening of F_1 hybrids along with parents has shown that two hybrids *viz.*, Akra Abha×HN2 and LE 812×HN2 were found to be resistant and two hybrids *viz.*, IC 249503×HN2 and CLN 2123A×HN2 as moderately resistant. Whereas the other two hybrids *viz.*, Hisar Arun×HN2 and LE 812×IIHR 2868 were found to be susceptible based on the gall index (root knot index). These observations are also supplemented with induction of related defence enzymes due to root knot nematode attack which showed that resistant ones recorded highest enzymes activities 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.

Reference

1. Acedo JR, Rohde RA. Histochemical root pathology of *Brassica oleracea* var. *capitata* L. Infected by *Pratylenchus penetrans* (Cobb) Filipjev and Schuurmans Stekhoven. J Nematol. 1971; 3:62-68.
2. Bray HG, Thrope WV. Analysis of phenolic compounds of interest in metabolism. Meth. Bio chem. Anal. 1954; 1:27-52.
3. Chen ZX, Chen SY, Dickson DW. Nematology Advances and Perspectives Nematode Management and Utilisation, Tsinghua University Press, China. 2004; 2:63.
4. Heald CM. Bruton BD, Davis RM. Influence of *Glomus intraradices* and soil phosphorus on M. incognita infecting Cucumis melo. J Nematol. 1989; 21:69-73.
5. Indu Rani CI, Veeraragavathatham I. Evaluation of 14 Tomato genotypes for yield and root knot nematode resistance parameters. Pest Tech. 2009; 3(1):76-80.
6. Jacquet M, Bongiovanni M, Martinez M, Verschave P, Wajnberg E, Castagnone Sereno P. Variation in resistance to the root knot nematode, *Meloidogyne incognita* in tomato genotypes bearing the Mi gene. Pl. Pathol. 2005; 54:93-99.
7. Kalaiarasan P. Biochemical markers for identification of root knot nematode (*Meloidogyne incognita*) resistance in tomato. Karnataka J of Agric. Sci. 2009; 22(3):471-475.
8. Kyndt T, Vieira P, Gheysen G, De Almeida Engler J. Nematode feeding sites: unique organs in plant roots. Planta. 2013; 238:807-818.
9. Meena OP, Bahadur V. Genetic Associations analysis for fruit yield and its contributing traits of indeterminate tomato (*Solanum lycopersicum* L.) germplasm under open field condition. J Agric. Sci. 2015; 7(3):148-163.
10. Noling JW, Becker JO. The challenge of research and extension to define and implement alternatives to methyl bromide. J Nematology. 1994; 26:573-586.
11. Sadasivam S, Manickam A. *Biochemical methods* (2nd edn), New age International (P) Ltd Publishers, New Delhi, India, 1997, 112-113.
12. Sasser JN, Freckman DW. A world perspective on nematology: The role of the society. In: Veech, J. A, Dickson, D.W, editors. Vistas on Nematology. Hyattsville, MD: (U.S.A) Society of Nematology, 1987, 7-14.
13. Sasser JN, Powers HR, Lucas GB. Effect of root knot nematodes on the expression of black shank resistance in tobacco. Physio. Path. 1957; 43:483.
14. Srivastava SK. Peroxidase and polyphenol oxidase in *Brassica juncea* plants infected with *Macrophomina phaseolina* (Tassi.) Goid and their implication in disease resistance. J Phyto. Path. 1987; 120:249-254.
15. Sujatha R, Irene Vethamoni P, Manivannan N, Sivakumar M. Screening of Tomato genotypes for root knot nematode (*Meloidogyne incognita* Kofoid and White. Chitwood). Int. J Curr. Microbiol. App. Sci. 2017; 6(3):1525-1533.
16. Sundharaiya K, Jansirani P, Karuthamani M. Studies on challenge inoculation for combined resistance to tomato leaf curl virus and root knot nematode in Tomato (*Solanum lycopersicum* L.). Int. J Curr. Microbiol. App. Sci. 2018; 6:179-188.