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Reaction of wild *Solanum* rootstocks and tomato scions against root knot nematode (*Meloidogyne incognita* kofoid and white)

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ABSTRACT : Root-knot nematodes (*Meloidogyne incognita)* are responsible for severe crop loss in tomato and grafting with resistant rootstocks may be effective strategy for managing this disease. Hence, the study was carried out to identify the resistant *Solanum* rootstocks for grafting of tomato against root knot nematode. Eight wild *Solanum* rootstocks and two tomato hybrids were screened against root-knot nematode. The experiment was conducted in a Completely Randomized Block Design with three replications. The seedlings of the wild *Solanum* rootstocks and tomato hybrids were maintained in pots filled with sterilized soil under glasshouse condition and inoculated with *Meloidogyne incognita* @ two second stage juveniles per gram of soil after 15 days of planting. Leaf samples were also taken from all the plants at different days after inoculation and analyzed for the biochemical parameters using spectophotometric methods. Results revealed that the *S. sisymbrifolium, Physalis peruviana* and *S. torvum* showed highest level of expression of phenolics and defense related enzymes *viz.*, peroxidases, polyphenol oxidases, phenyl alanine ammonia lyase and acid phosphatase than the susceptible tomato scion such as US-618. TNAU tomato hybrid CO-3 showed moderately resistant reaction. These rootstocks can be used as resistant source to root knot nematode in tomato grafting technology.

KEY **W**ORDS :Biochemical parameters, Root-knot nematode, *Solanum* rootstocks, Tomato

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Tomato (*Solanum lycopersicum* L.) is one of the most popular and widely used vegetable crop in the world. In India, tomato is grown in 9.33 lakhs ha with a total production of 193.77 lakh tonnes (India Stat, 2013). The incidence of root knot nematode was observed to be high in areas where tomato is cultivated intensively. Root knot nematodes (*Meloidogyne* spp.) have been recorded to cause yield losses ranging from 39.7 to 46.92 per cent in tomato production (Darekar and Mhase, 1988). Khan *et al.* (2000) listed several nematodes that are associated with vegetable crops. Among them the most serious one which cause more damage was *M. incognita*. The disease is expressed by gall formation in the root system and ultimately the plant becomes weak due to interruption in nutrient uptake from the soil and at severe infection the plants may die.

It is a sedentary endoparasite nematode which penetrates the feeder roots and feed on the vascular tissue. A number of wild *Solanum* species are resistant to soil borne diseases like root knot nematode, but attempt to incorporate this resistance is not been successful. One method to circumvent this problem is to graft the

susceptible scion on to resistant rootstocks. Grafting on suitable rootstocks improves the resistance to soil-borne diseases *viz*., Fusarium wilt, bacterial wilt, Verticillium wilt and root knot nematode (Rivard *et al*., 2010). But, very scanty reports exist on the screening of wild *Solanum* species against root knot nematode. Hence, the present study aimed at evaluation of eight wild *Solanum* rootstocks to pathogenic potential of root knot nematode *M. incognita* and to identify resistant rootstocks against root knot nematode for grafting in tomato.

RESEARCH PROCEDURE

Pot culture experiment was conducted under glasshouse condition at the Department of Nematology, TNAU, Coimbatore during 2012-2013. The wild *solanum* species *viz*., *Solanum torvum*, *S. xanthocarpum*, *S. incanum*, *S. aethiopicum*, *S. sisymbrifolium*, *S. viarum*, *Physalis peruviana*, *S. violaceum* and Tomato F_1 hybrids, TNAU Tomato Hybrid CO-3 and US-618 were used for screening. Seedlings were raised in protrays and then thirty day- old healthy seedlings were transplanted into pots containing two and half kilogram of sterilized pot mixture (Red soil: Sand: FYM in 2:2:1 ratio) for artificial inoculation.

The nematode inoculum (J_2) was placed in 2cm depth near the rhizosphere and covered with sterile sand. Each pot was inoculated with J_2 of *M. incognita* at the rate of two juvenile (J_2) / g of soil on 15 days after planting. The experiment was laid out in a Completely Randomized Block Design with three replications. Number of galls per 10 g of root, number of egg masses and females per g of root were determined at the end of experiment (Table 1). The enzymes *viz*., peroxidase, polyphenol oxidase, phenylalanine ammonia lyase and acid phosphatase activity in the roots were estimated in wild *Solanum* rootstocks and tomato scions by following the procedure of Srivastava (1987). Observations were taken at 0, 1, 2, 3, 4 and 5 days after inoculation (DAI), peak value attained at 4 DAI for all these four biochemical parameters which are presented in Table 2. All the statistical analysis was done using AGRES Version 7.01 software.

RESEARCH ANALYSIS AND REASONING

All the rootstocks and scions developed characteristic galls caused by *M. incognita*. Among the rootstocks and scions, significant differences were noticed on number of galls per 10 g of root, number of egg masses per g of root and number of females per g of root. *S. sisymbrifolium* (4.45, 1.30 and 1.70) followed by *Physalis peruviana* (4.87, 1.43 and 1.87) and *S. torvum* (5.51, 1.87 and 2.10) recorded the lowest number of galls, number of egg masses and number of females per g of root, respectively and showed resistant reaction (Table 1). This is due to the host status for the invading parasite. Sherly (2011) reported similar results in *S. torvum. S. incanum* followed by *S. aethiopicum* and scion (TNAU tomato hybrid CO-3) showed moderately resistant

Table 1 : Response of wild *Solanum* rootstocks and tomato scions to *Meloidogyne incognita*

Treatments	No. of galls / 10 g root	No. of egg masses / g root	No. of females / g root	Degree of resistance
Solanum torvum	5.51	1.87	2.10	R
Solanum xanthocarpum	44.57	6.83	31.63	S
Solanum incanum	23.53	4.23	14.77	MR
Solanum aethiopicum	25.80	4.70	17.83	MR
Solanum sisymbrifolium	4.45	1.30	1.70	R
Solanum viarum	57.23	8.23	44.90	S
Physalis peruviana	4.87	1.43	1.87	R
Solanum violaceum	108.83	30.60	90.33	HS
TNAU Tomato hybrid CO-3	28.67	5.57	22.10	MR
US-618	113.60	32.90	96.17	HS
S.E.±	1.03	0.64	1.26	
C.D. (P=0.05)	2.16	1.32	2.62	

R – Resistant, MR- Moderately resistant, S – Susceptible, HS – Highly susceptible

reaction and *S. xanthocarpum* and *S. viarum* showed susceptible reaction. Rootstock *S. violaceum* and scion (US-618) exhibited highly susceptible reaction as rhizosphere of these species favoured maximum population build up in terms of number of galls, number of egg mass and number of females per g of root and maximum root damage due to gall formation. Similar results were reported by Mattos *et al*. (2011) in *Solanum* species.

Among the various enzymes, peroxidase is considered as one of the important disease resistant enzyme due to its role in catalyzing and condensation process of phenolic compounds into lignin. Peroxidase content varied significantly among the *Solanum* wild species and tomato hybrids, which ranged from 0.95 to 4.76 changes in OD min^{-1} g^{-1}. The highest peroxidase activity was recorded in the wild species *S. sisymbrifolium* (4.76 changes in OD min^{-1} g^{-1}) followed by *Physalis peruviana* (4.12 changes in OD min g^{-1}) and *S. torvum* (3.25 changes in OD min^{-1} g^{-1}). The lowest enzyme activity was recorded by the scion (US-618) with 0.95 changes in OD min^{-1} g^{-1} (Table 2). These findings fall in line with the reports of Indu Rani *et al*. (2008) and Sundharaiya (2008) in tomato.

Polyphenol oxidase (PPO) oxidizes the phenols to highly toxic quinones and hence is considered to play an important role in pest and disease resistance, particularly those affecting the tissues. Polyphenol oxidase varied significantly among the *Solanum* wild species and tomato hybrids, which ranged from 1.04 to 4.87 changes in OD min^{-1} g^{-1}. Among the eight wild species and two tomato hybrids, *S. sisymbrifolium* recorded the highest polyphenol oxidase activity of 4.87 changes in OD min^{-1} g^{-1} of roots followed by *Physalis perviana* (4.27 changes in OD min^{-1} g^{-1}) and *S. torvum* (3.42 changes in OD min^{-1} g^{-1}) (Table 2). The role of PPO in respiration impairing *M. incognita* resistance had been well documented by several workers (Indu Rani *et al.*, 2008 and Sherly, 2011).

Phenylalanine ammonia lyase (PAL) is the most important enzymes in the synthesis of phenolics, phytoalexin and lignin. Hence, it is considered as the most important enzyme in disease resistance. The highest PAL activity was recorded in the wild species *S. sisymbrifolium* (17.14 nmol of trans cinnamic acid min^{-1} g^{-1} of roots) followed by *Physalis peruviana* (16.41 nmol of trans cinnamic acid min^{-1} g^{-1} of roots) and *S. torvum* (15.21 nmol of trans cinnamic acid min^{-1} g^{-1} of roots). The lowest enzyme activity was recorded by the scion (US-618) with 6.37 nmol of trans cinnamic acid min^{-1} g^{-1} of roots (Table 2). The activity levels of phenylalanine ammonia lyase and anionic peroxidase induced early resistance response to many other pathogens and also increased in resistant tomato cultivars after nematode inoculation (Rajesekar *et al*., 1997).

Acid phosphatase is yet another important enzyme closely related to nematode resistance. Increase in acid phosphatase activity in the roots was found to be a resistant mechanism to *M. incognita*. In the present study, the highest acid phosphatase activity was recorded

Table 2 : Enzyme activity in wild *Solanum* rootstocks and tomato scions against *M. incognita*

Treatments	Peroxidase (changes in OD min^{-1} g^{-1} of roots)	Polyphenol oxidase (changes in OD min^{-1} g^{-1} of roots)	Phenylalanine ammonium lyase (nmol of trans cinnamic acid min^{-1} g^{-1} of roots)	Acid phosphatase (mmoles p-nitrophenol min^{-1} mg^{-1} protein of roots)
Solanum torvum	3.25	3.42	15.21	119.82
Solanum xanthocarpum	2.24	2.32	11.68	96.34
Solanum incanum	2.72	3.04	13.31	113.21
Solanum aethiopicum	2.58	2.89	12.64	104.42
Solanum sisymbrifolium	4.76	4.87	17.14	134.65
Solanum viarum	2.05	2.12	10.38	92.54
Physalis peruviana	4.12	4.27	16.41	130.32
Solanum violaceum	0.96	1.09	7.87	69.54
TNAU Tomato hybrid CO-3	2.48	2.68	12.42	101.52
US-618	0.95	1.04	6.37	65.96
S.E.±	0.44	0.30	1.26	10.41
C.D. (P=0.05)	0.92	0.62	2.64	21.71

by *S. sisymbrifolium* (134.65 *m*moles p-nitrophenol min^{-1} mg^{-1} protein) followed by *Physalis peruviana* (130.32 *m*moles p-nitrophenol min^{-1} mg^{-1} protein) and *S. torvum* (119.82 *m*moles p-nitrophenol min^{-1} mg^{-1} protein). The lowest activity was observed on tomato hybrid US-618 (65.96 *m*moles p-nitrophenol min^{-1} mg^{-1} protein) (Table 2). *M. incognita* incidence showed significant negative association with acid phosphatase activity. These findings fall in line with reports of Sherly (2011) in brinjal.

Conclusion :

This study indicated that the preliminary evaluation of *Solanum* wild rootstocks exhibited significant differential response to *M. incognita*. Three rootstocks *S. sisymbrifolium, Physalis peruviana* and *S. torvum* were rated as resistant against *M. incognita* under artificial screening. *S. incanum* and *S. aethiopicum* were moderately resistant reaction and can be used for grafting in tomato which could be developed into a valuable crop management tool to reduce the deleterious effect of root knot nematodes on tomato. Root knot nematode is the main problem in tomato cultivation worldwide and is well known that grafting tomato with *Solanum* wild species can provide best solution to soil borne diseases. These rootstocks are further used to assess the graft compatibility with tomato scions. Once the compatibility between rootstocks and scions achieved, grafting is considered to part of an integrated approach to control soil borne diseases.

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