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Evaluation of tomato genotypes for resistance against root-knot nematode *Meloidogyne incognita* (Kofoid and White) Chitwood race 2

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Abstract
The experimental result revealed that none of the genotype was found highly resistant against the root knot nematode, however three genotypes namely EC - 620394, EC – 620427 and EC – 617047 were recorded resistant having 1.1 to 2.0 root gall index. Ten genotypes exhibited moderately resistant reaction having root gall index between 2.1 to 3.0. Among the remaining genotypes, twenty were found susceptible showing root gall index between 3.1 to 4.0 and eighteen lines were found to be highly susceptible having root gall index between 4.1 to 5.0. Susceptible cultivars developed heavier root systems because of root galling compared to resistant cultivars. Similarly, resistant plants have shown more growth in shoot attributes conforms that the growth of root length, shoot length, fresh shoot weight and dry shoot weight is negatively correlated to the root knot index (r = -0.867, -0.917, -0.917, -0.925 respectively) while egg mass, fresh root weight and dry root weight, were positively correlated with root knot index (r = 0.723, 0.855, 0.761 respectively).

Keywords: Root knot nematode, genotypes, tomato, resistant, susceptible, gall index

Introduction
Tomato is grown worldwide and is a rich source of vitamins, minerals and organic acids. The richest source of lycopene one of the most powerful natural antioxidants in the diet is tomato and tomato derived products [10]. In India, tomato production per hectare is very low (214.5 q/ha), compared to the developed countries, and this can be attributed to several reasons. The most important among these is the vulnerability of tomato crop to various diseases including fungal, viral, bacterial and nematode diseases [3]. Unlike the other pathogens, nematodes give more problems because nematodes live in the soil and cannot be easily seen by farmers. They are only noticed when the population is widespread and yield reduction is high [8]. In order to reduce these losses, an estimated amount of US$500 million was spent on nematode control globally [6]. Estimation of 27.21% yield loss in tomato due to root knot nematode was reported [5]. More over the nematodes not only affect the health of the crop but also reduce its quality and productivity. The short life cycle of six to eight weeks enables root knot nematode populations to survive well in the presence of a suitable host and their populations build up to a maximum usually as crops reach maturity [14]. After root penetration and migration, they induce permanent feeding cells inside the vascular cylinder. Normal development of plants is impaired and distribution of hormones and minerals is altered. Root weight, as a result of nematode parasitism, increases whereas shoot weight declines, shifting the root-shoot balance [12]. The enormous economic damage to plants by nematode root feeding and interaction with other organisms renders the plants further vulnerable to other biotic and abiotic stresses [13]. Exploitation of resistance in crops is one of the most effective and ecofriendly components of integrated pest management and inclusion of this property ensures increased crop yield in the presence of nematode [7]. Nematode resistance in host plant is manifested by reduced rates of nematode reproduction and, consequently, lower nematode population densities in the crop rhizosphere than that of a susceptible one [9]. Host plant resistance has been prioritized over chemical, biological, cultural, and regulatory control components as a major goal for pest management because it provides an effective, sustainable and economical method for managing nematodes in both high and low value cropping systems. There is therefore, the need to identify sources of resistance in tomato cultivars for seed multiplication or breeding against root-knot nematode disease. Keeping the above background information in view the present study was undertaken to evaluate tomato genotypes for their reaction to root-knot nematodes (*Meloidogyne incognita* race -2) in pots on tomato.

Materials and Methods

51 tomato germplasm was screened in net house condition at the Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, during February – April, 2017 to investigate response of the germplasm against root knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood race 2. Fifty genotypes were collected from the Project coordinator AICRP on nematodes, ICAR New Delhi and one from local market. *M. incognita* race- 2 was selected as a test pathogen. To perform this experiment during the period of research, pure culture of *M. incognita* race- 2 was maintained on tomato roots in the net house. Extraction of nematode eggs was done by using modified method [4]. Juveniles were also extracted from infested tomato roots, using modified Baermann tray method [15]. Counting was done three times to obtain the mean number of juveniles. Potting medium used was comprised of soil, sand and vermicompost in 3:1:1 ratio. The required amount of media was sterilized by 10% formaldehyde solution to make the media free from nematodes. The potting media was ready to use after three weeks of sterilization. The earthen pots (6 ") were filled with sterilized soil @ 1000 cc pot. Sowing of tomato seeds was done. Three seeds were sown in each pot and only one plant per pot was allowed to grow after one week of germination. The inoculation was done at 3-4 leaves stage (15 days after sowing) @ one J_2 per cc of soil i.e. 1000 J_2 pot. For the inoculation three to four holes to a depth of 3-5 cm were made with the help of glass rod near the rhizosphere. The second stage juveniles (J_2) of *Meloidogyne incognita* @ 1000 J_2 plant per pot were released with the help of 10 ml pipette. Holes were subsequently covered with soil and pots were watered after inoculation.

The tomato plants were uprooted after 45 days of inoculation carefully to avoid the damage of roots and other plant parts. The observations on shoot length, root length, fresh root weight, dry root weight, fresh shoot weight, dry shoot weight, root knot index (0-5 scale), egg masses per plant were taken. After uprooting the roots were gently washed in tap water and made cut at the junction of the shoot and root. Observation on length (cm) of shoot and root, weight (g) of shoot and root were recorded thereafter. Roots were brought to the laboratory for further studies. Counting of galls and egg masses were carried in the laboratory under stereoscopic binocular microscope. After counting roots as well as shoots were kept in paper packets for drying in dry air oven at 45ºC for 4-5 days and then taken the dry weight. The degree of resistance was indicated by the root knot index and it was done as per Heald *et al.* [2]. The critical difference (CD) at 5% level of significance was worked out from the data recorded during experiment and compared according to Duncan's Multiple Range Test at 5% level of probability; the data was analyzed in CRD.

Results and Discussions

The experimental result revealed that the tomato accession EC - 620427 was yielded with the highest plant height of 51.06 cm while the lowest height of 22.2 cm was obtained from EC - 157568. It was also recorded that in reference to plant height 11 accessions were having no significant difference with EC - 620427 and 6 accessions had no significant difference with EC - 157568. Maximum fresh shoot weight (17.03 g) was recorded from EC - 620427 and the lowest weight (3.3g) was in EC-164334. In terms of fresh shoot weight 2 accessions were having no significant difference with EC - 620427 while 6 accessions had no significant difference with EC-164334. Fresh shoot weight of rest of the plants was significantly different from the heaviest and the lightest ones. It was observed that the tomato accession EC - 620427 was recorded for the maximum dry shoot weight, 3.13g and the lowest weight, 0.34g was obtained in tomato accession EC - 164334. It was also found that in reference to dry shoot weight no accessions were at par with EC - 620427 while 7 accessions had no significant difference with EC - 164334. Dry shoot weight of rest of the plants was significantly different from the heaviest and the lightest ones (Table.1).

Table 1: Evaluation of different tomato germplasms against root knot nematode

Germplasm	Shoot Parameters			Root Parameters			Root knot index	Egg mass	Reaction
	Shoot length	Fresh shoot weight	Dry shoot weight	Root length	Fresh root weight	Dry root weight			
EC-3176	31.47	5.80	0.73	4.86	3.13	0.60	5	23	HS
EC- 145057	26.27	5.46	0.63	4.20	2.90	0.43	5	25	HS
EC- 151568	31.60	5.20	0.63	4.87	3.30	0.45	5	21	HS
EC- 157568	22.27	4.20	0.47	4.50	3.00	0.47	5	26	HS
EC- 160885	30.60	3.80	0.38	4.80	2.80	0.40	5	19	HS
EC- 162601	31.20	4.80	0.67	4.80	2.40	0.33	4.4	13	HS
EC- 163605	35.37	6.00	0.77	5.16	1.60	0.21	4	18	S
EC- 164334	27.00	3.40	0.34	4.30	2.30	0.30	4.8	17	HS
EC- 164563	30.36	4.40	0.50	4.70	2.50	0.33	4.4	19	HS
EC- 164670	30.86	3.60	0.37	4.60	2.30	0.30	4.4	21	HS
EC- 164677	31.17	5.20	0.70	4.83	2.30	0.33	4.6	18	HS
EC- 164838	30.63	3.90	0.46	4.76	2.70	0.43	4.4	16	HS
EC- 164863	44.50	9.80	1.57	6.26	1.10	0.15	3	11	MR
EC- 165395	38.20	6.40	0.80	5.23	1.30	0.18	3.6	1	S
EC- 165690	39.33	8.10	0.87	5.40	1.70	0.25	3.8	15	S
EC- 165700	45.16	10.03	1.63	6.36	1.10	0.15	2.8	9	MR
EC- 249508	39.57	8.03	0.97	5.40	1.50	0.19	3.2	11	S
EC- 249514	29.07	5.16	0.56	4.50	2.40	0.33	4.8	18	HS
EC- 520078	46.26	10.20	1.72	6.10	0.66	0.13	3	8	MR
EC- 521067-B	45.30	10.76	1.78	6.40	1.10	0.13	2.8	9	MR
EC- 523851	33.83	8.66	1.16	5.70	2.13	0.27	3.6	17	S
EC- 528368	35.30	8.13	0.97	5.50	1.80	0.22	4	11	S
EC- 538153	23.50	3.63	0.47	4.10	2.60	0.38	4.2	18	HS

EC- 538156	33.53	6.83	0.80	5.10	2.30	0.37	4	23	S
EC- 549819	36.03	7.20	1.12	6.20	1.90	0.22	3.8	21	S
EC- 567305	40.63	7.06	1.04	6.00	2.30	0.30	4	40	S
EC- 617047	48.53	15.13	2.83	7.30	0.70	0.11	2	2	R
EC- 620343	39.26	9.36	1.47	5.90	2.10	0.25	3.2	5	S
EC- 620361	46.10	11.23	2.03	7.20	0.80	0.13	2.8	5	MR
EC- 620370	36.03	7.33	1.07	6.00	2.00	0.27	4	22	S
EC- 620372	30.63	5.16	0.70	5.30	2.90	0.47	4.4	35	HS
EC- 620373	42.40	9.73	1.33	6.20	1.70	0.27	3.4	7	S
EC-620382	40.70	8.80	1.23	6.30	1.70	0.25	4	13	S
EC- 620387	42.93	11.53	2.03	6.33	1.10	0.18	2.4	5	MR
EC- 620394	49.47	15.43	2.61	7.90	0.70	0.12	2	3	R
EC- 620395	37.20	8.10	1.10	5.60	1.90	0.23	3.8	13	S
EC- 620396	31.76	4.90	0.67	5.00	3.20	0.47	4.6	20	HS
EC- 620397	41.20	8.50	1.11	5.80	2.30	0.33	3.8	11	S
EC- 620401	47.23	13.90	2.26	6.80	1.30	0.17	2.6	7	MR
EC- 620406	46.43	14.30	2.32	7.20	1.10	0.15	2.8	5	MR
EC- 620410	32.26	5.90	0.73	5.50	5.00	0.90	5	19	HS
EC- 620417	42.20	9.73	1.58	6.30	2.20	0.28	3.2	6	S
EC- 620422	41.36	8.90	1.47	6.10	2.00	0.47	3.4	11	S
EC- 620427	51.07	17.03	3.13	7.00	0.60	0.12	2	2	R
EC- 620431	46.10	10.70	1.87	6.30	1.00	0.13	2.4	5	MR
EC- 620433	47.93	13.93	2.42	6.10	1.20	0.20	2.4	5	MR
EC- 631359	37.93	7.16	1.03	6.10	2.40	0.37	3.8	11	S
EC- 631369	28.30	5.43	0.74	4.70	2.60	0.42	4.4	10	HS
EC- 631376	34.23	6.30	0.87	5.50	1.80	0.30	3.8	15	S
EC- 631379	33.90	7.90	1.26	5.43	1.30	0.16	4	13	S
Check (Patharkuchi)	27.46	6.40	0.76	4.40	2.50	0.39	4.6	10	HS
Lsd(5%)	7.043	1.23	0.27	0.75	0.45	0.084	0.787	4.688	-
CV (%)	11.71	9.45	13.8	8.23	13.98	17.66	16.811	20.789	-

R=Resistant, MR= Moderately resistant, S= Susceptible and HS=Highly susceptible

With regard to root length, the tomato accession, EC- 620394 exhibited longest root length, 7.9 cm whereas the smallest root length 4.1 cm was recorded with the accession EC - 538153. It was also recorded that another 3 accessions and 12 accessions were statistically indifferent with the accessions EC - 620394 and EC - 538153 respectively. Root length of rest 33 accessions was statistically different from both the longest and smallest root. In respect to fresh root weight the accession EC - 620410 was observed to record the greatest fresh root weight, 5 g and the accession EC - 620427 was noted to have roots of smallest weight. It is further to mention that no accession was found to be statistically at par with the accession EC - 620410, five accessions were statistically at par with EC - 620427 and all other accessions were significantly different from both these two accessions. Performance trend of germplasms with regard to dry root weight of the plants was same as was noted in case of the fresh root weight. The greatest dry root weight 0.9g, the smallest dry root weight 0.11 g, were recorded for EC - 620410 and EC - 620427 respectively. No accession was at par with EC - 620410 while 13 were statistically indifferent with the accession EC - 620427. In reference to root-knot index, three germplasm were recorded resistant, 10 were moderately resistant and 20 germplasm were susceptible and 18 highly susceptible. However, interestingly six germplasm exhibited no statistically significant difference with the smallest value of root-knot index. It was further observed that egg mass in the roots of the germplasm EC- 165395 was lowest, 1 egg mass and this was statistically at par with no other germplasm. Maximum egg masses were obtained in the roots of germplasm EC - 567305 which was statistically at par with the same recorded for the 9 germplasm. The correlation of root knot index with both root and shoot attributes conforms that the growth of root length, shoot length, fresh shoot weight and dry shoot weight is negatively correlated to the root knot index (r = -0.867, -0.917, -0.917, -0.925 respectively) while egg mass, fresh root weight and dry root weight, were positively correlated with root knot index (r = 0.723, 0.855, 0.761 respectively) (Table. 2).

Table 2: Correlation between Root knot index and other parameters

Parameters	Root length	Shoot length	Fresh root weight	Fresh shoot weight	Dry root weight	Dry shoot weight	Egg mass
Root-knot index	-0.867 **	-0.917**	0.855**	-0.917**	0.761**	-0.925**	0.723**

** Significant at 1% level of significance

El- Sherif *et al.* (2007) [1] also reported that root knot nematode increases root weight for the most susceptible cultivar compared to resistant cultivar. Root weight of susceptible cultivar as a result of nematode parasitism increases whereas shoot weight declines shifting the root shoot balance [11].

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