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Impact Assessment of Neem Products against Root-Knot Nematode, Meloidogyne incognita on Tomato

Shyam Babu Gautam[1], Ramesh Chand[1], Subhash Chandra[1], Dhirendra Pratap Singh[2], S.N. Rahul[1]* and Pankaj Kumar[3]

[1]Department of Plant Pathology, Acharya Narendra Deva University of Agricultural& Technology, Kumarganj, Ayodhya 224229, Utter Pradesh, India
[2]Zonal Agriculture Research Center, Maharajganj, Acharya Narendra Deva University of Agricultural& Technology, Kumarganj, Ayodhya 224229, Utter Pradesh, India
[3]Department of Entomology, Acharya Narendra Deva University of Agricultural& Technology, Kumarganj, Ayodhya 224229, Utter Pradesh, India

Abstract

Neem, Azadirachta indica belongs to family Meliaceae is native to India, Bangladesh, Thailand, Nepal and Pakistan grown well in tropical and sub-tropical regions. It is well known fact that neem plant parts have immense medicinal value and great potential in lowering down various plant infections. To exploit the impact of neem based formulations on multiplication of root-knot nematode, Meloidogyne incognita and growth of tomato cv. SL-120 was investigated under pot condition. The observations on the root weight, shoot weight, gall per plant and eggs per plant, eggs/plant, J2 population in soil, J2 population in soil, eggs per egg mass initial population, Total nematode population and their nematode multiplication factor showed that the various neem formulations used in the experiments i.e. Ethanol neem leaf extract @ 5% and 7.5%, Neem leaf extract@ 5% and 7.5%, Neem leaf compost@ 5% and 7.5%, Achook@ 5% and 7.5% and Neem cake @ 5% and 7.5 percent doses decreased the gall formation, egg formation, soil and root population and nematode multiplication factor parameters while a positive impact on tomato plant growth parameters i.e. root weight, shoot weight and total nematode population was observed. The root-drip treatments are more effective comparison to the soil application in experiments. The higher dose of neem formulations was observed to be more effective as compared to the lower dose i.e. 5.0 and 7.5 % of neem formulations on the reproduction parameters of the Meloidogyne incognita and the growth parameters of tomato plants.

Keywords: *Tomato, Solanum Lycopersicum, Juveniles, Neem products, Meloidogyne incognita, Nematode Management, Eco-friendly Nematode Management and Impact assessment of Neem Products.*

Introduction

Tomato (*Solanum Lycopersicum* L.) is one of the most popularly and extensively grown vegetable crop, in India. The fruits of tomato are generally considered as poor man's apple due to it's shape and nutritional value. In India, tomato crop is cultivated in 0.831 million hectares with 21.18 million tones of production with a average of 26.4 t ha-1 productivity. India is the second largest tomato producer and occupies second position amongst the vegetable crops in terms of production. Among the major biotic factors that affect the tomato production, root-knot nematode, *Meloidogyne incognita* is the most serious pest causing considerable yield loss in all parts of India. Root-knot nematode causes an annual loss of approximately 27.24% in tomato in India [1]. However, the current level of productivity and quality are constrained by the direct interference of plant parasitic nematodes on the plant root system besides several pests and diseases. Due to environmental concerns and increased regulations on use of chemical fumigants, more management strategies for management of root-knot (*Meloidogyne* spp.) nematodes are currently being investigated [2]. Some plant extract were evaluated for their nematicidal potentials in controlling *M. incognita* infesting tomato [3]. Symptoms of root-knot nematode include galling on root, stunted growth, wilting and a decline

*Corresponding Author: S.N. Rahul
E-mail Address: - sagar4499@gmail.com
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in yield of the crop pesticides [4]. It is considered to be the most destructive pathogen in many crops root-knot nematodes can cause great damage to the major crop losses in yield. It is complicated to guess yield suppression caused by plant parasitic nematodes due to wide spacious species [5]. The tested plat extracts' have significantly inhibited the total number of nematode juveniles, numbers of the galls and egg-masses, as well as the total number of root-knot nematodes in soil. Neem leaf powder could be used as a nematicide for nematodes control as a replacement for synthetic nematicides [6].

Method and Material

Root-knot nematode, *Meloidogyne incognita* infected tomato plants were procured and maintained in cage house of the department of plant pathology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P) During the *Rabi* session of the year 2018-19 and 2019-20 . The second stage juveniles for experimentation were procured from the single egg mass of *Meloidogyne* spp. infected tomato plants roots and kept in 10 centimeter diameter Petri plate for 72 hours at 25^0c for hatching. The species identification was done using female perennial pattern and other morphological parameters such as stylet morphology, male head form, larval length and the race was identified as *M. incognita* and race-1 using the host differential test as given by [7]. The culture of *M. incognita* race-1 was inoculating on Tomato cv. SL-120 seedlings in sterilized soil with active second stage juveniles (J_2) hatched from a single egg mass and maintained in pots. In order to investigate the impact of neem products such as ethanol neem leaf extract @ 5% and 7.5%, Neem leaf extract @ 5% and 7.5%, Neem leaf compost @ 5% and 7.5%, Achook @ 5% and 7.5%, and Neem cake @ 5% and 7.5% in the management of *M. incognita* on tomato plant, a total of eleven treatments were prepared in 2X2 Meter Micro plots and 3-5 leaf stage tomato seedlings were transplanted and inoculated with freshly hatched J_2 of *M. incognita @ 4.0 larvae/ gram of soil.* After transplanting tomato seedlings were left for growth. All the treatments were replicated four times. The observations recorded during the year of 2018-19 and 2019-20 are presented in the table-01 and table-02. The plants after 60 days of growth period harvested and observations on the number of galls/plants, egg/ plants, egg mass/ plant, root weight, shoot weight, gall index, initial nematode population, total J_2 population in soil, total J_2 population in root, total multiplication factor and plant growth parameters were recorded.

Result and Discussion

The statistical analysis of the observations recorded for studying the impact assessment of neem products against root-knot nematode, *Meloidogyne incognita* on tomato revealed that the fresh plant weight increased by 70.17, 58.50, 27.87, 23.33, 20.09, 11.99, 52.35, 46.51, 39.70 and 32.41percent during *Rabi* session of 2018-19 while during *Rabi* session 2019-20 the magnitude of increase in the plant weight was observed 7.50,65.61,30.12, 26.97,18.13,8.35,53.31,47.63 and 36.75 per cent in ENLE @ 7.5 %, ENLE @ 5 %, Achook @ 7.5 %, Achook @ 5%, NC @ 7.5 %, NC @ 5%, NLE @ 7.5%, NLE @ 5%, LC @ 7.5%, LC @ 5% treatment respectively over the untreated check. The increase in plant weight may be attributed to the impact of neem products incorporated in the soil which after decomposition may have liberated the chemical compounds like Azadirachtin, Nimbolinin-A, Nimbin, Quercetin, Nimbin, Sitosterol, Salannin, gedunin and Polyphenolic flavonoids. These chemical compounds are reported to be responsible for the reduction of various plant infections. These observations are Sufficiently proven by the reports showing their antibiotic and inhibitory reactions of these compounds [8 & 9]. All the treatment was observed to be the significantly different from each other. Similarly, the general increase in root and plant height and number of leaves could be attributed to the fact that incorporation of soil with botanicals provides organic matter to the plant and therefore additional nutrient that improved the growth and yield of the tomato plant. The observations recorded where neem products was applied *i.e.* ENLE @ 7.5 %, ENLE @ 5 %, Achook @ 7.5 %, Achook @ 5%, NC @ 7.5 %, NC @ 5%, NLE @ 7.5%, NLE @ 5%, LC @ 7.5%, LC @ 5% have also reduced the gall formation and nematode population in soil and root, egg population and the nematode multiplication in comparison to the inoculated or untreated check . The gall index was reduced up to 3 and 4 as compared to 5 in check with the J_2 population in soil by 68.51, 62.72, 29.97, 26.19, 22.41, 18.89, 58.69, 53.14, 45.08 and 37.78 in *Rabi* session 2018-19 and 65.11, 59.17, 38.50, 34.62, 22.99, 19.37, 55.03, 51.93, 46.25 and 43.92 percent in *Rabi* session 2019-20, nematode population in root reduced by 59.45, 53.79, 34.61, 32.08, 24.49, 18.22, 49.17, 44.37, 41.58 and 39.23 percent in 2018-19 and 57.50, 53.19, 36.14, 29.83, 22.16, 17.22, 47.65, 45.01, 42.11 and 38.78 percent in 2019-20, egg population by 81.73, 74.34, 39.32, 35.96, 29.29, 22.96, 62.01, 56.07,

Table No. 1: Impact assessment of neem products on plant growth and multiplication of root-knot nematode, *Meloidogyne incognita* in tomato under micro plot condition during *Rabi* Session 2018-2019.

Observations are the mean of four replicates

Treatment	Fresh Plant Weight (gms/Plant)	Gall Index	Egg/ Plant*	Soil J_2*	Root Population	Multiplication Factor
ENLE @ 7.5%	262.50	3	3.26	1.25	116.25	1.93
ENLE @ 5%	244.50	4	4.58	1.48	132.50	2.31
Achook @ 7.5%	197.25	5	10.83	2.78	187.50	3.49
Achook @ 5%	190.25	4	11.43	2.93	194.75	3.63
NC @ 7.5%	185.25	5	12.62	3.08	216.50	3.88
NC @ 5%	172.75	4	13.75	3.22	234.50	4.27
NLE @ 7.5%	235.00	4	6.78	1.64	145.75	2.47
NLE @ 5%	226.00	3	7.48	1.86	159.50	2.66
LC @ 7.5%	215.50	4	8.73	2.18	167.50	2.92
LC @ 5%	204.25	3	9.56	2.47	174.25	3.11
UC	154.25	5	17.85	3.97	286.75	5.72
C.D. Value @ 5%	7.28		2.56	0.32	6.21	0.19

Table No. 2: Impact assessment of neem products on plant growth and multiplication of root-knot nematode, *Meloidogyne incognita* in tomato under micro plot condition during *Rabi* Session of 2019-20.

Observations are the mean of four replicates

Treatment	Fresh Plant Weight (gms/Plant)	Gall Index	Egg/ Plant*	Soil J_2*	Root Population	Multiplication Factor
ENLE @ 7.5%	275.00	3	2.96	1.35	123.75	2.01
ENLE @ 5%	262.50	4	3.68	1.58	137.25	2.41
Achook @ 7.5%	206.25	4	11.63	2.38	187.25	3.58
Achook @ 5%	201.25	3	12.97	2.53	205.75	3.89
NC @ 7.5%	187.25	4	14.32	2.98	228.25	3.86
NC @ 5%	171.75	4	15.75	3.12	242.75	4.25
NLE @ 7.5%	243.00	3	4.78	1.74	153.50	2.58
NLE @ 5%	234.00	4	6.68	1.86	161.25	2.71
LC @ 7.5%	222.50	5	7.93	2.08	169.75	3.09
LC @ 5%	216.75	3	9.86	2.17	179.50	3.30
UC	158.50	5	19.35	3.87	293.25	5.70
C.D. Value @ 5%	4.08		0.37	0.22	5.66	0.24

51.09 and 46.44 percent in 2018-19 and 84.70, 80.98, 39.89, 32.97, 25.99, 18.60, 75.29, 65.47, 59.01 and 49.04 percent in 2019-20 *Rabi* session. The nematode multiplication factor was observed to be reduced by 66.25, 59.61, 38.98, 36.53, 32.16, 25.34, 52.09, 53.33, 48.95 and 45.62 percent in 2018-19 and 64.73, 57.71, 37.19, 31.75, 32.28, 25.43, 54.73, 52.45, 45.78 and 42.10 percent in 2019-20 *Rabi* session in ENLE @ 7.5 %, ENLE @5 %, Achook @ 7.5 %, Achook @ 5%, NC @ 7.5 %, NC @ 5%, NLE @ 7.5%, NLE @ 5%, LC @ 7.5%, LC @ 5% treatments respectively as compared to the check. The reduction in the gall formation and the nematode reproduction parameters may be due to the fact that neem, *Azadiracta indica* is known to have more than 140 compounds, present in its different parts such as leaves, flowers, seeds, fruits, roots, and bark. When these plant parts are added to the soil and left for decomposition releases various chemical compounds like Azadirachtin, Nimbolinin-A, Nimbin, Quercetin, Nimbin, Sitosterol, Salannin, gedunin. Polyphenolic flavonoids extracted from fresh leaves of neem, Querestien and sitosterol shows Antifungal [10] antibacterial activities of neem in plant are reported. Many investigators have confirmed anti-inflammatory, antiarthritic, antipyretic, hypoglycemic, antigastric ulcer, antifungal, antibacterial, and antitumour activities of neem originated phytochemicals [11, 12, 13, 14, 15 & 16]. These chemical compounds also known to minimize various plant infections when added in

Table No. 3: Pooled Impact assessment of neem products on plant growth and multiplication of root-knot nematode, *Meloidogyne incognita* in tomato under micro plot condition during *Rabi* Session of 2018-19 and 2019-20.

Observations are the mean of four replicates

Treatment	Fresh Plant Weight (Gms/Plant)	Egg/ Plant*	Soil J_2*	Root Population	Multiplication Factor
ENLE @ 7.5%	268.75	3.11	1.30	120.00	1.97
ENLE @ 5%	253.50	4.13	1.53	134.87	2.36
Achook @ 7.5%	201.75	11.23	2.58	187.37	3.53
Achook @ 5%	195.75	12.20	2.73	200.25	3.76
NC @ 7.5%	186.25	13.47	3.03	222.37	3.87
NC @ 5%	172.25	14.75	3.17	238.62	4.26
NLE @ 7.5%	239.00	5.78	1.69	149.62	2.52
NLE @ 5%	230.00	7.08	1.86	160.37	2.68
LC @ 7.5%	219.00	8.33	2.13	168.62	3.05
LC @ 5%	210.50	9.71	2.32	176.87	3.20
UC	156.38	18.60	3.92	290.00	5.71
C.D. Value @ 5%	4.18	0.34	0.19	4.99	0.21

@ENLE= Ethanol Neem Leaf Extract, NLE= Neem Leaf Extract, NLC= Neem Leaf Compost, NC= Neem Cake, UC= Untreated Check

***Figures are in thousand**

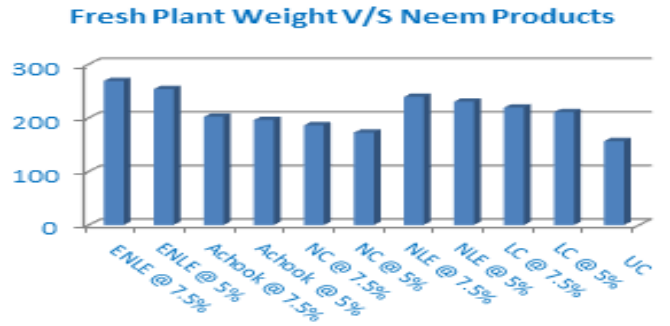

Figure A: Fresh weight per plant (In grams)

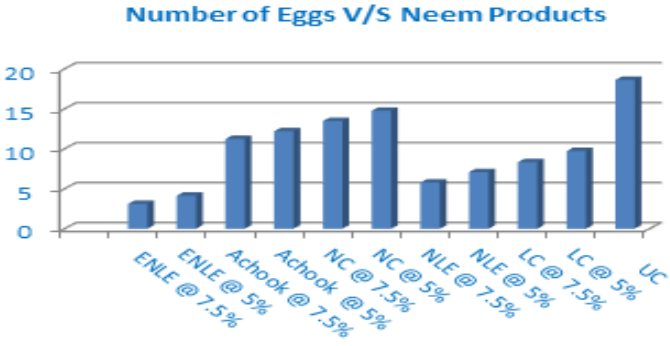

Figure B: Number of eggs/ plant (In thousands)

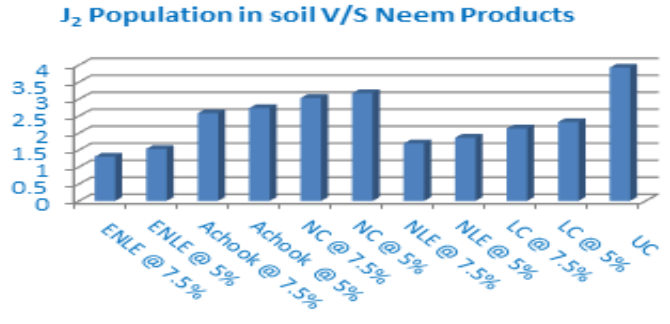

Figure C: Number of soil J2 (In thousands)

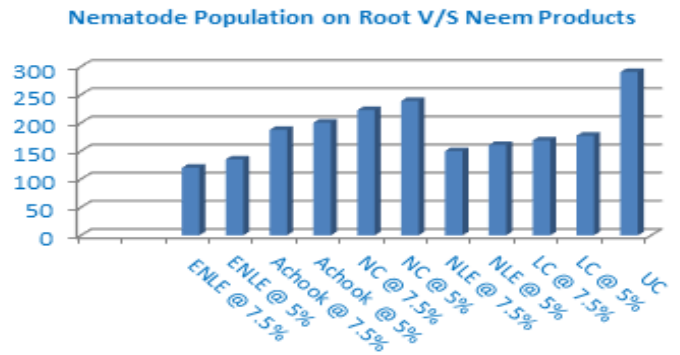

Figure D: Nematode Population on root

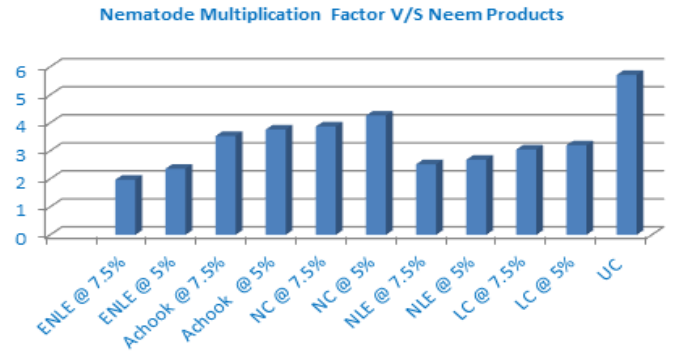

Figure D: Nematode Multiplication Factor

Figure A, B,C,D and E are the Pooled Data of Impact assessment of Neem Products on Nematode Multiplication.

the soil. Neem products are found to significantly reduce nematode population multiplication rate under pot condition in tomato crop. The highest reduction in nematode multiplication in comparison to the inoculated check was observed in carbofuran treated check (1.99) followed by the Achook @ 5%

(2.19), neem cake @ 5% (2.50), neem leaf compost (2.68), neem leaf compost (2.68), vermi compost (3.14) and 3.38 in neem leaf with decomposer with the minimum reduction 4.50 observed in inoculated check respectively in ascending order. The percentage decrease in nematode multiplication factor was observed maximum (55.77) in Carbofuran treated check followed by 51.33% in Achook, 44.44% in neem cake, 40.44% in neem leaf compost, 30.22 in vermi compost and minimum 24.88% in neem leaf with organic decomposer treatment in comparison to the inoculated check. Similar trends in the reduction of hatching of *Meloidogyne incognita* eggs and larval penetration was also observed when neem plant parts products was added to the soil under pot condition [17&18]. The Aqueous extracts of neem plant products like neem cake, fresh neem leaf and neem seed (each @ 2.5, 5.0, 10.0 and 100%) have also found to be effective in reducing the hatching of *M. incognita* significantly [19,20,21&22]

Conclusion

The investigation carried out at the main experimental site of the department of plant pathology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P) during the year 2018-19 and 2019-20.The use of neem originated formulations for soil application significantly improved the plant growth in terms of the fresh plant weight and reduced the gall index, nematode population in soil and plant root, egg population and the overall reduction in the nematode multiplication factor. The highest impact of neem products was observed to be found in treatment where ethanol neem leaf extract was added in the soil followed by neem leaf extract, neem leaf compost and achook with the minimum impact observed in the neem cake treatment. The highest increase in the fresh plant weight was observed 70.17 and 73.50 % in 2018-19 and 2019-20 season and the nematode population in soil (68.51 and 65.11 %), root population (59.45 and 57.50 %), egg population (81.73 and 84.70 %) and the nematode multiplication factor was found to be reduced by 66.25 and 64.73 percent in Rabi season of 2018-19 and 2019-20 respectively in ethanol neem leaf extract treatment with the lowest impact observed in neem cake.

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