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Effect of Soil Amendments with Botanical Leaves on Root-Knot Nematode (*Meloidogyne incognita*) of Cowpea (*Vigna unguiculata* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Cowpea (*Vigna unguiculata* L. Walp) is a earliest crop which is a member of the Phaseoleae tribe of the Leguminosae Family widely known as Lobia, which is a better alternative source for protein, minerals etc., as compared to other legumes. Root-knot nematodes (*Meloidogyne incognita*) cause a major loss in cowpea production by hindering nutrient and water uptake. Leaf waste of marigold, rose, calotropis, euphorbia, neem and castor as botanical amendments were experimented under field conditions during *kharif* 2021 for their effectiveness against the root knot nematodes, rhizobium nodule and growth parameters. Field studies were conducted in randomized blocks with six treatments and three replications. Among the composts, the treatment Neem leaf compost remarkably increased the Plant height at 90 DAS (293 cm), root length at 90 DAS (29.16cm), rhizobium nodules (5), and significantly decreased the root weight at 90 DAS (3.5 gm) and root knots in the root system of cowpea at 90 DAS (10.67). The weight of the roots decreased because of a decrease in the number of root knot in cowpea compared to other composts and control T_0.

Keywords: Cowpea; rhizobium; botanical amendments; root-knot nematode; neem leaf compost.

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1. INTRODUCTION

"Cowpea *(Vigna unguiculata* L. Walp) is a member of the Phaseoleae tribe of the Leguminosae Family which is known as southern pea, blackeye pea, crowder pea, lobia, yard long bean, and frijole. Cowpea is an important dietary legume and an essential component of cultivation systems in drier regions of the tropics covering parts of Asia, southern Europe, Africa, southern USA" [1].

Cowpea is a better alternative source for protein as compared to other pulses. Dry cowpea seed contains between 20- 25% protein. On average, cowpea grain contains 5055 mg/kg phosphorus, 38.1 mg/kg Zinc, 53.2 mg/kg iron, 14,890 mg/kg potassium, 1915 mg/kg magnesium and 826 mg/kg calcium [2]. The total carbohydrate content of the seed varies between 50-60%, while the fat percentage varies from 1-1.4% [3,4].

"Nigeria is the world's largest producer and represents for 2.5 million tons of cereal production out of an estimated 4.9 million hectares" [5]. "Cowpea was cultivated on 12.5 million hectares (31 million acres) and produced of 3 million metric tonnes globally. In India, cowpea is cultivated on an area of 3.9 million hectares with an output of 2.21 million tonnes. The highest producing states in India are Uttar Pradesh, West Bengal and Odisha" [6].

Cowpea productivity is greatly affected by a number of biotic factors such as fungi, bacteria, viruses, nematodes and parasitic flowering plants [7]. Economically loss causing cowpea diseases are seed and seedling rot, collar rot, scab, rust, leaf spot, powdery mildew, bacterial blight, bean common mosaic, cowpea chlorotic mottle, root-knot and striga caused by fungal bacterial, viral, nematodes and parasitic higher plants. Although cowpea is vulnerable to root knot nematode and suffer from massive infections that have caused a serious economic downturn in the crop production [8].

Root-knot nematodes (RKN) are microscopic sedentary endoparasitic worms which rely on the induction of a permanent feeding site into living roots for completion of their life cycle. Root-knot nematodes are involved in the development of specialized feeding structures known as "Giantcells". The secondary Juvenile stage (J2) is the infective stage of the nematode. The J2 larvae enter the host roots and undergo three successive moults to become adult females or males. Many of the major root-knot nematode species, including *Meloidogyne incognita*, reproduce by obligatory mitotic parthenogenesis [9]. Root-knot nematode (*Meloidogyne* spp*.)* induce symptoms like development of chlorosis on leaves, root galling, stunted growth and excessive branching of the root.

Root knot nematodes belongs to the genus Meloidogyne are the most important group of RKN can parasitize over 3000 plant species, resulting in an estimated harvest loss of $ 100 billion a year [10,11]. About 50-80% loss in vegetable crops can be caused by root-knot nematode. In India, about 39.7 to 46.0% yield loss caused by *Meloidogyne* spp., as a result, number of tactics were adopted to bring out plant parasitic nematode population below marginal level.

Now a days, management of plant parasitic nematodes by utilising conventional nematicides has decreased globally because many existing synthetic pesticides are inherently toxic to non-target organisms and persist in the nature. Recognising that root-knot nematodes have a wide range of hosts, this also limits the usefulness of cultural control tactics like green manures, cover crops, and crop rotations [12,13].

Amending the soil with the composts exponentially reduce the root galling of *Meloidogyne* spp. Keeping in view the following objectives were taken:

- To study the effect of soil amendments with botanical leaves on plant growth parameters of cowpea.
- To study the effect of soil amendments with botanical leaves on the number of root-knot nematode *(Meloidogyne incognita)* galls in cowpea roots.

2. MATERIALS AND METHODS

A field trail was conducted in nematode infected soil in courtyard beside the Department of Plant Pathology, SHUATS, Prayagraj, UP during *kharif* season in the year 2021. Before plot preparation, 500 gm of soil was collected from different places of infested field and processed in laboratory by using cobbs decanting and sieving technique followed by modified Baermann funnel technique to count the nematode population. The experiment was laid out after the confirmation of

the experimental field contain 2 larvae of nematode per gm of soil. The chosen field was ploughed, the soil was pulverized and then entire site was divided into sub-plots and defined in the randomized block design with six treatments viz Leaves of Marigold, Rose, Calotropis, Euphorbia, Neem and Castor @ 10 t/ha. Every treatment was replicated three times with plot size of 3 × 2 m^2 each and local seed variety was sown with a spacing of 45 × 30 cm. The plant growth parameters and Root knot count in root system of cowpea was recorded at 60, 75 and 90 days following sowing of the crop. The records have been statistically analyzed.

At 60 days after sowing the root knots in the roots of cowpea were observed. The galled roots were separated and cleaned with sterile water. A gall was placed on the sterile slide using sterile forceps and torn using a sterile needle and microscopically examined.

Eggs, 3rd stage juvenile and female Meloidogyne were recognized when seen under microscope. Mature females are swollen, melon like shape, 0.3-1.4 mm, with prolonged neck at anterior end, forms perineal patterns, short stylet with well-developed basal knobs, eggs were laid in gelatinous matrix outside the body, tail absent. Males are vermiform, motile,1.5-2.0 mm long, basal knobs; oesophageal glands overlap intestine ventrally; tail elongate conoid with pointed tip.

3. RESULTS AND DISCUSSION

The result shown in Table 1 disclosed that all the treatments were statistically significant and decreased the number of root knots count in the roots of cowpea when compared with control. Among the botanical amendments used, the treatment T_5- Neem leaf compost significantly decreased the number of root knots (23), (12) and (11) at 60, 75 and 90 DAS respectively in root system of cowpea [Plate 3]. The treatments (T_1, T_5) are not significant from each other at 90 DAS. Similar findings have been described in which amending of neem leaf compost has been found effective against *Meloidogyne* spp. under field conditions.

The result shown in Table 1 disclosed that all the treatments were statistically significant and decreased the number of root nodules in the root system of cowpea when compared with control. Among the botanical amendments used, the treatment T_5- Neem leaf compost significantly decreased the number of rhizobium nodules (29), (9) and (5) at 60, 75 and 90 DAS respectively in cowpea [Plate 3]. The treatments (T_1, T_5, T_3), (T_3, T_4), (T_4, T_6, T_2) and (T_6, T_2, T_0) are not significant from each other at 90 DAS. Similar findings have been described where amending of neem leaf compost has found effective against *Meloidogyne* spp. under field conditions.

Plate 1. Microscopic view of female *M. incognita*

Plate 2. Microscopic view of larva *M. incognita*

The result shown in Table 2 disclosed that all the treatments were statistically significant and increased the plant height of cowpea when compared with control. Among the botanical amendments used, the treatment T_5- Neem leaves compost significantly increased the number of plant height (201.11 cm), (262.9 cm) and (293 cm) at 60, 75 and 90 DAS respectively in cowpea. The treatments (T_1, T_3) are not significant from each other at 90 DAS. Similar findings have been described where amending of neem leaf compost has been found effective against *Meloidogyne* spp. under field conditions.

The result shown in Table 2 disclosed that all the treatments were statistically significant and increased the root length in the root system of cowpea as compared to control. Among the botanical amendments used, the treatment T_5- Neem leaves compost significantly increased the root length (14.3), (19.16) and (29.16) at 60, 75 and 90 DAS respectively in root system of cowpea. The treatments (T_3, T_4) (T_4, T_6) are not significant from each other at 90 DAS. Similar findings have been described where amending of neem leaf compost has been found effective against *Meloidogyne* spp. under field conditions.

The result shown in Table 2 disclosed that all the treatments were statistically significant and decreased the root weight of cowpea when compared with control. Among the botanical amendments used, the treatment T_5- Neem leaf compost significantly decreased the root weight (2.21 gm), (2.29 gm) and (3.5 gm) at 60, 75 and 90 DAS respectively in cowpea. The treatments (T_3, T_6) are not significant from each other at 90 DAS. Similar findings have been described where amending of neem leaf compost has been found effective against *Meloidogyne* spp. under field conditions.

Table 1. Effect of botanical soil amendments on count of root knots in root system of cowpea

Tr. No.	Treatments	No. of Root Knots			No. of Rhizobium nodules		
		60 DAS	75 DAS	90 DAS	60 DAS	75 DAS	90 DAS
T_0	Control (Untreated check)	87	147.33	199	4	1	0.3
T_1	Marigold leaf compost	24.67	14.67	11	13.33	8	5
T_2	Rose leaf compost	52.33	49	59	4.67	3	1.33
T_3	Calotropis leaf compost	28	19	21	11.67	6	4
T_4	Euphorbia leaf compost	42.33	20	41	11	4.67	3
T_5	Neem leaf compost	23	12	11	29.33	9	5
T_6	Castor leaf compost	34.67	19.67	30	10	4	1.67
S. E (d) ±		0.90	0.98	0.76	1.06	0.77	0.82
C. D (0.05)		1.96	2.14	1.67	2.32	1.69	1.79

Plate 3. Root galls in the root system of cowpea at 90 DAS

Table 2. Effect of botanical soil amendments on plant height, root length and root weight of cowpea

Tr. No.	Plant height (cm)			Root length (cm)			Root weight (gm)		
	60 DAS	75 DAS	90 DAS	60 DAS	75 DAS	90 DAS	60 DAS	75 DAS	90 DAS
T_0	155.57	207.64	236.57	8.83	13	18.5	6.74	12.74	19.5
T_1	196.33	258.33	288	11.83	16.83	25.16	2.4	3.2	4.7
T_2	171.33	231.8	260.89	9.33	15	20	4.9	5.67	10.18
T_3	183.57	256.47	287.89	10.16	16	23.16	3.79	3.65	7.67
T_4	175.47	248.33	273.33	10.67	16	22.33	4.89	5.66	5.67
T_5	201.23	263	293	14.33	19.16	29.16	2.21	2.29	3.5
T_6	172.87	240	269.89	9.67	15.5	21.33	3.84	4.23	7.9
S. E(d) ±	1.01	1.17	0.95	0.37	0.61	0.55	0.39	0.42	0.47
C.D(0.05)	2.26	2.56	2.08	0.81	1.34	1.21	0.84	0.91	1.03

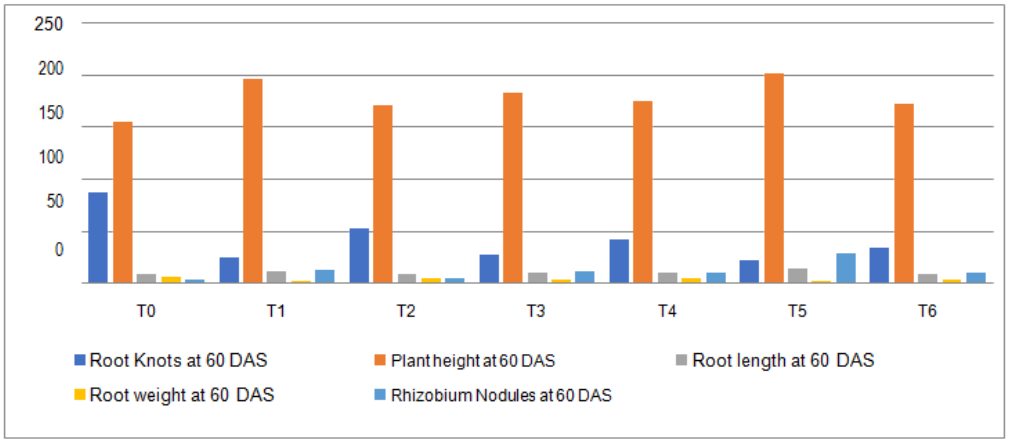

Fig. 1. Effect of botanical soil amendments on number of root knots, plant height, root length, root weight and rhizobium nodule in root system of cowpea at 60 DAS

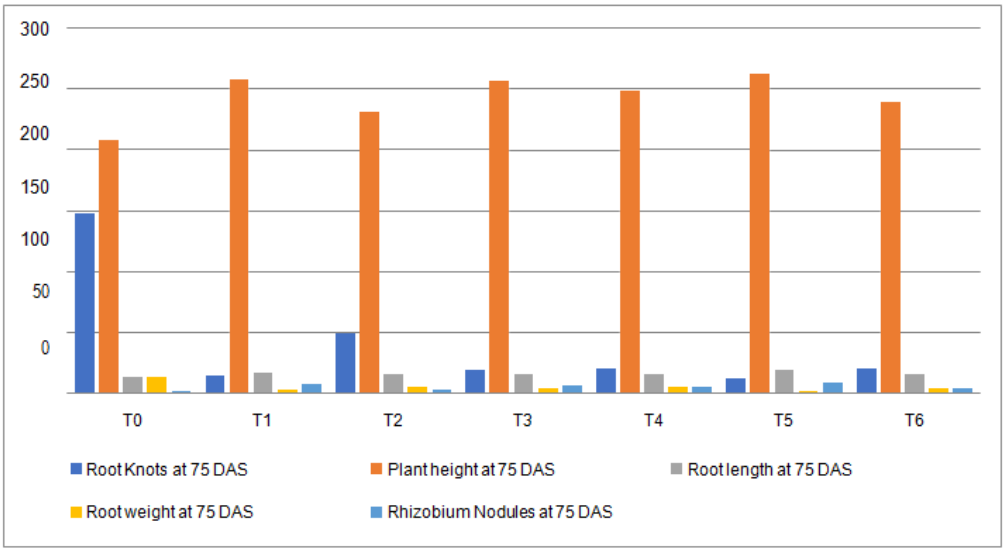

Fig. 2. Effect of botanical soil amendments on number of root knots, plant height, root length, root weight and rhizobium nodule in root system of cowpea at 75 DAS

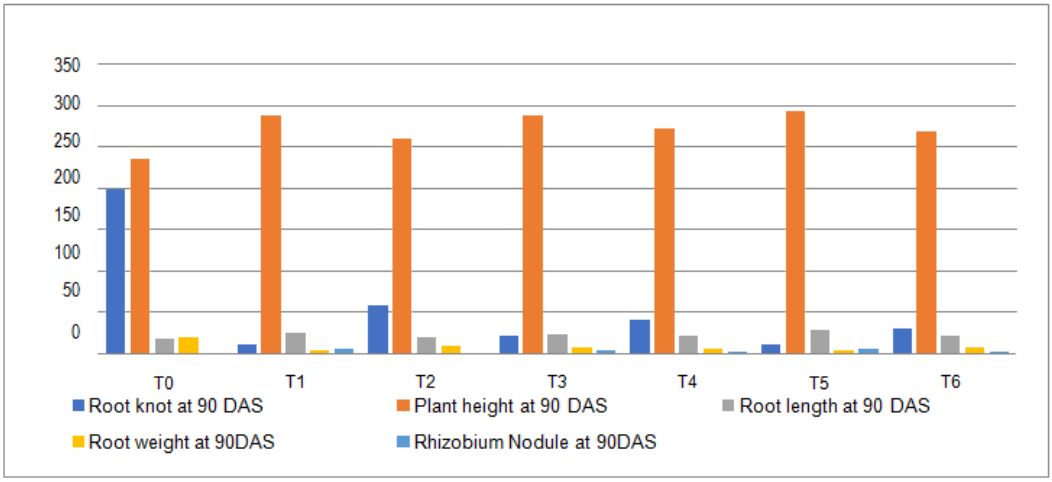

Fig. 3. Effect of botanical soil amendments on number of root knots, plant height, root length, root weight and rhizobium nodule in root system of cowpea at 90 DAS

The probable reason for such findings may be because of inhibitory effect of botanicals leaf amendment compost due to the nutritional source and antagonistic chemicals produced by them. It is possible that application of neem leaf amendment promoted plant growth. The results of the present investigation agreed with the observation made by Atungwu et al. [14], chimbekujwo et al. [15], Resha and rani [16], Hussain et al. [17], Moosavi [18] have shown that application of neem leaf amendment compost is effective against *Meloidogyne* spp. under field conditions. The neem leaf compost has nematicidal effects on nematodes in the soil are may be due to the interaction of the compost with the roots thereby dissolving the proteins. Amending of the neem leaf compost had a remarkable effect on both nematode larvae population and root galls after harvest. The extract of neem leaves is found to be toxic to *Meloidogyne* spp. population due to the metabolites (Azadirachtin) present in the leaves. It is possible that application of neem leaf amendment promoted plant growth. Cookey et al. [19] reported that neem contains nutrients which enhance the plant development. Izuogu et al. [20] reported that the no. of Nodules are inversely proportional to the number of galls. Highest number of nodules were observed in soil amended with neem leaves as compost.

Also, the results obtained proved that application of organic amendments could be eco-friendly substitute for chemicals in management of root-knot nematodes of cowpea. The results of the present investigation agreed with the observation made by Akhtar et al. (1999) Control of plant-parasitic nematodes can be by release of nemato-toxic compounds from botanicals amendment.

4. CONCLUSION

In current investigation based on observation, it was determined that management of the root knots present in the root system of cowpea with neem leaf compost (11) was remarkable in comparison to control (199). Hence from present research it can be concluded that neem leaf compost can be used to reduce the root knot count effectively and to improve the plant growth of cowpea [Fig. 3].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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