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Effect of Compost on Root-knot Nematode (*Meloidogyne* spp.) and Rhizobium Nodulation of Cowpea (*Vigna unguiculata* L. Walp)

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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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ABSTRACT

Cowpea (*Vigna unguiculata* L. Walp) is an ancient crop widely known as Lobia, Vegetable crop, Black-eyed peas. Cowpea is used as pulse, fodder, vegetable, and green manure crop. It is known to suffer from many diseases and pests. Nematodes cause a severe damage to cowpea production leading to economic losses. Among the nematodes, root-knot nematodes (*Meloidogyne* spp.) cause severe damage to the cowpea crop. Farmyard manure, spent mushroom compost, leaf waste of marigold, neem, lantana, rose, berseem and drumstick were tested under field conditions during *Rabi* 2020-2021 for their efficacy against the root knot nematodes and growth parameters. Field experiment was carried out in randomized block design (RBD) with six treatments and four replications. Among the botanicals amendment, the treatment T_6- farmyard manure @ 8t/ha + spent mushroom compost @ 8t/ha + drumstick leaf waste @ 8t/ha significantly increased the plant height at 60 DAS (85.91 cm), shoot weight (111.37gm), root length (17.31 cm), root weight (3.37 gm), rhizobium nodules (26) and significantly decreased the number of root knots in the root system of cowpea at 60 DAS (41). Root weight reduced due to less number of root knots in the roots of cowpea as compared to other botanicals amendment and control T_0.

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1. INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp), belongs to the family Fabaceae, which is widely grown in the tropical and sub-tropical regions of west Africa [1]. It is the appropriate mixture of proteins, minerals. On an average, cowpea seed contains 20-25% protein, 53.2 mg/kg iron (Fe), 38.1 mg/kg zinc (Zn), 826 mg/kg Calcium (Ca), 1915 mg/kg magnesium (MG), 14,890 mg/kg potassium (K) and 5055 mg/kg phosphorus (P) [2]. The total carbohydrate content of seed ranges from 50-60%, while the percentage of fat ranges from 1-1.4% [3-4]. The estimated world-wide area under cowpea production is over 14.5 million hectares with over 6.5 million tonnes annual production and per hectare production comes to 387 kg [5]. The estimated area in India is around 23,012 ha with production quantity of about 1,33,587 tonnes and productivity accounting to 5.8 t/ha in India. The leading states in India are Uttar Pradesh, West Bengal and Odisha [6]. Like all other legumes, cowpea has nodules on roots. There occurs *Rhizobium* spp. in the nodules which are nitrogen fixing bacteria that aid legumes to perform well in nitrogen deficient soil thereby enabling fertility restoration and hence could be used in amelioration of food security problems in area prone to drought [7]. Root-knot nematodes (RKN) are sedentary endo-parasites and is among the most damaging agricultural pests, attacking wide range of crops [8]. Out of 106 described species of RKN 95% infestations are caused by *Meloidogyne incognita, Meloidogyne javanica, Meloidogyne hapla, Meloidogyne arenaria* [9-10]. The root-knot nematode accounts for 20-90% loss in cowpea. The species *Meloidogyne incognita* and *Meloidogyne javanica* are frequently prevalent in cowpea fields [11]. Symptoms of damage by root knot nematode (*Meloidogyne* spp.) include development of chlorosis on leaves, stunted growth, presence of root galls, excessive branching of the root and reduced root functioning of root systems [12]. Heavy infestation of cowpea by *Meloidogyne* spp. leads to early senescence of the crop [13]. Incorporation of botanicals amendment along with spent mushroom compost are cowpea. Most of the botanical's amendment are powerful and do not have dangerous outcomes on people and useful soil micro-organisms.

2. MATERIALS AND METHODS

An experiment was conducted in nematode infested soil at the courtyard of Department of Plant Pathology, SHUATS, Prayagraj, Uttar Pradesh during *Rabi* season in the year 2020-2021. The soil sample was collected from the infested field and processed in laboratory by following cobbs decanting and sieving technique followed by modified Baermann funnel technique to estimate the nematode population. Before laying out the experiment it was assured that the experimental field possess 2 larvae/gm of soil.

The selected field was dug up and the soil become pulverized and then whole location was divided into sub-plots and specified in randomized block design with six treatments *viz*, farmyard manure @ 8 t/ha, spent mushroom compost @ 8 t/ha was used as basal application. These were incorporated into the soil by forming specific ridges according to the crop spacing and covered by thin layer of soil. The field was irrigated for seven days at regular intervals to enhance the decomposition process. After seven days, plant waste of marigold, neem, lantana, rose, berseem and drumstick @ 8 t/ha each was incorporated into the ridges where, farmyard manure and spent mushroom compost was incorporated initially. Irrigation was given at regular intervals to decompose the plant materials in the soil. Each treatment was replicated four times with plot size of 2.5 × 1 m^2 each and local variety seeds were sown with a spacing of 40 × 30 cm. Root knots in the root system, rhizobium nodules and plant growth parameters of cowpea were recorded at 30, 45, 60 days after sowing of the crop. The records have been subjected to the statistical analysis.

At 60 days after sowing the root knots in the root system of cowpea were identified. The galled roots were removed and washed thoroughly with sterile water. A gall was placed on the sterile slide using sterile forceps and teared using a sterile needle and examined under microscope. Eggs and female *Meloidogyne* were identified when observed under microscope (Plate 1-2). Mature females were swollen, melon like with elongate neck at anterior end, eggs laid in gelatinous matrix outside the body, tail absent.

Plate 1. Microscopic view of eggs and female *Meloidogyne*

Plate 2. Microscopic view of larvae of *Meloidogyne*

Second stage juveniles (J2) were vermiform, 280-500 µm long, stylet slender, about 10 µm long with rounded basal knobs; oesophageal glands overlap intestine ventrally; tail elongate conoid with pointed tip.

3. RESULTS

The result presented in Table 1 revealed that all the treatments were statistically significant and decreased the number of root knots in the roots of cowpea as compared to control. Among the botanical's amendment used, the treatment T_6- Farmyard manure + spent mushroom compost + Drumstick leaf waste significantly decreased the number of root knots (41) in cowpea when compared to other botanicals amendment [Plate 3]. The treatments (T_2, T_3) are not significantly differ from each other. Similar findings have been reported where application of moringa leaf compost has found effective against *Meloidogyne* spp. under field conditions [14-17].

The results presented in Table 1 revealed that all the treatments were statistically significant and increased the number of rhizobium nodules of cowpea as compared to control. Among the botanical's amendment used, the treatment T_6- Farmyard manure + spent mushroom compost + Drumstick leaf waste significantly increased the number of rhizobium nodules (26) in cowpea when compared to other botanicals amendment. The treatment (T_1, T_5, T_3) are not significantly differ from each other. Similar findings have been reported where application of moringa leaf enhance the plant development due to the nutrients in it. Highest number of nodules were observed in soil amended with moringa leaf powder as compost under field conditions [14].

The result presented in Table 2 revealed that all the treatments were statistically significant and increased the plant growth parameters of cowpea as compared to control. Among the botanical's amendment used, the treatment T_6- farmyard manure + spent mushroom compost + Drumstick leaf waste significantly increased the plant height (85.91 cm) of cowpea when compared to other botanical amendment. The treatment (T_4, T_1, T_5) are not significantly differ from each other. Among the botanical's amendment used, the treatment T_6- farmyard manure + spent mushroom compost + Drumstick leaf waste significantly increased the shoot weight (111.32 gm) of cowpea when compared to other botanical amendment. The treatment (T_1, T_5) (T_2, T_6) are not significantly differ from each other. Among the botanical's amendment used, the treatment T6- farmyard manure + spent mushroom compost + Drumstick leaf waste significantly increased the root length (17.31 cm) of cowpea when compared to other botanicals amendment. The treatment (T_5, T_3) (T_3, T_2) are not significantly differ from each other. Nematicidal properties of the powder on nematodes in the soil is probably due to the interference of the moringa powder with the roots thereby dissolving the proteins [15].

The result presented in Table 3 revealed that all the treatments were statistically significant and decreased the root weight of cowpea as compare to control. Among the botanical's amendment used, the treatment T_6- farmyard manure + spent mushroom compost + Drumstick leaf waste significantly decreased the root weight (3.37 gm) of cowpea when compared to other botanicals amendment. The treatment (T_2, T_3, T_5) (T_5, T_1, T_4) are not significantly differ from each other.

The root weight decreased due to less number of root knots in the root system. Highest root weight was recorded in control T_0- (10.75 gm) due to higher number of root knots in the root system of cowpea. The present investigation indicates that incorporation of farmyard manure + spent mushroom compost + drumstick leaf waste into the soil can be used as an effective treatment for root knot nematodes and to develop eco-friendly strategy for the management of root knot nematodes of cowpea.

Table 1. Effect of botanicals amendment along with spent mushroom compost on number of root knots and rhizobium nodulation in root system of cowpea at 60 DAS

Tr. No.	Treatments	Number of root knots	Rhizobium nodulation
T0	Control	125	14
T1	FYM + SMC + Marigold leaf waste	89	16
T2	FYM + SMC + Neem leaf waste	53	24
T3	FYM + SMC + Lantana leaf waste	58	20
T4	FYM + SMC + Rose leaf waste	105	15
T5	FYM + SMC + Berseem leaf waste	71	18
T6	FYM + SMC + Drumstick leaf waste	41	26
	F-Test	S	S
	S.E. (d)	3.25	1.54
	C.D. (5%)	6.82	3.24

Plate 3. Root knots in the root system of cowpea at 60 days after sowing

Table 2. Effect of botanicals amendment along with spent mushroom compost on plant growth parameters of cowpea

Treatments	Plant height (cm)	Shoot weight (gm)	Root length (cm)	Root weight (gm)
T_0	77.09	92.37	10.28	10.75
T_1	79.8	101.37	12.11	9
T_2	83.95	110.25	16.58	5.12
T_3	82.78	107.5	14.97	5.5
T_4	79.18	98.37	11.85	9.25
T_5	80.34	104.5	13.95	7.87
T_6	85.91	111.37	17.31	3.37
F-test	S	S	S	S
S. E (d) ±	1.47	1.72	0.82	1.60
C.D. (5%)	3.09	3.61	1.72	3.35

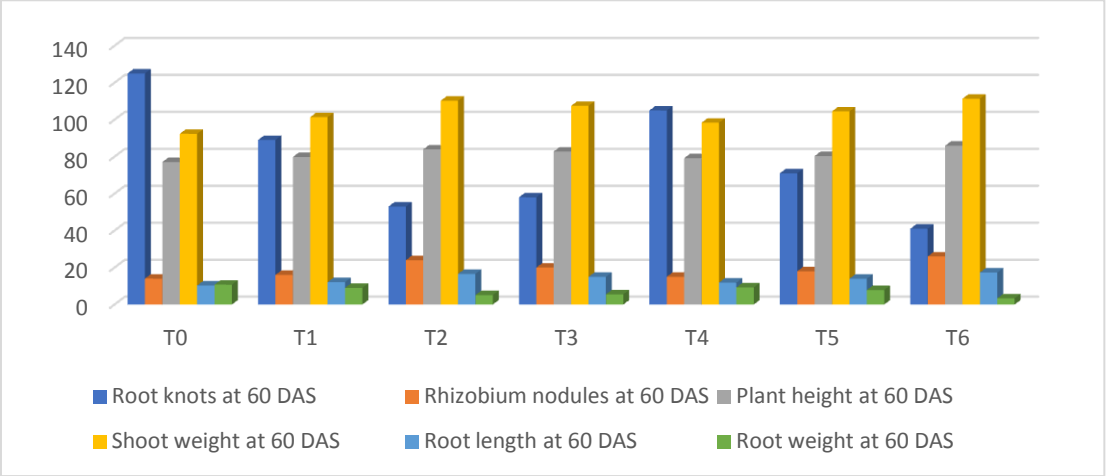

Fig. 1. Effect of botanicals amendment along with spent mushroom compost on plant growth parameters of cowpea

4. DISCUSSION

Probable reason for such finding may be due to the inhibitory impact of botanicals amendment because of the nemato-toxic compounds present in the amendments which helped to reduce the severity of the nematodes in the soil and plants [18]. Application of moringa leaf powder had a significant effect on root knot nematode population and found toxic to *Meloidogyne* spp. due to the alkaloids and tannins present in the moringa leaves.

5. CONCLUSION

In the present study on the basis of observation, it was found that for managing the root knots in the root system of cowpea, farmyard manure @ 8t/ha + spent mushroom compost @ 8t/ha + drumstick leaf waste @ 8t/ha (41) was significant in comparison to control (125). Hence from present study it can be concluded that farmyard manure + spent mushroom compost + drumstick leaf waste can be used effectively to reduce the root knots and to increase the plant growth of cowpea [Fig. 1].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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