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Research Article

Nematicidal effect of sunn hemp *Crotalaria juncea* leaf residues on *Meloidogyne incognita* attacking tomato *Solanum lycopersicum* roots

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Abstract: Field experiments were conducted to determine the optimum application rate of sunn hemp *Crotalaria juncea* leaf residue in the management of *Meloidogyne incognita* on tomato. Sunn hemp applied at rates of 0 (control), 2, 4 and 6 kg/ha showed a varied effect on second stage juveniles of *M. incognita*. There were no differences in plant height and stem girth. The 6 kg/ha treatment reduced the *M. incognita* population by 94% compared with the control. The highest yield of tomato (168.7 kg/ha) was recorded in 6 kg/ha treatment of sunn hemp.

Keywords: *Crotalaria juncea*, leaf residue, *Meloidogyne incognita*, root galling, Tomato

Introduction

Tomato *Solanum lycopersicum* L. is the second most important vegetable worldwide after potato (FAO, 2009). It is a major source of lycopene, a dietary carotenoid found in high concentrations in processed tomato products according to Di Mascio *et al*. (1998). However, the worldwide production is affected by several pests and diseases. The root knot nematodes (*Meloidogyne* spp.) are among the most important devastating pests which attack and feed on the roots of the host plants (Noling, 2009). Their feeding activity stimulates the formation of root galls, which interfere with nutrient and water supply, resulting in stunted and chlorotic growth (Waller *et al.,* 2002). In addition to yield reduction, plant stunting associated with root knot nematodes infection can further reduce canopy and increase weed problems. Management of root knot nematodes is usually dependent on synthetic nematicides which are usually expensive, of limited availability, difficult to store, and also pollute the environment (Luc *et al.,* 2005). In view of this, several strategies are being identified to effectively manage these pests. Application of leaf residue as soil organic amendment agents has proven to be effective in managing nematodes (Youssef and Lashien, 2013). These materials applied as green manures suppress the growth of nematodes and enhance the activities of nematode trapping fungi in the rhizosphere (Wang *et al.,* 2003). Sunn hemp is a non-traditional leguminous, annual crop that is drought tolerant and can be used as a green manure crop for soil improvement and for controlling insects and nematodes. (Hooks *et al.,* 2006). There is limited information on the use of this crop as green manure in Ghana. In present study, sunn hemp leaf residues were applied as green manure at different rates to study its nematicidal potential.

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Materials and Methods

Experimental site

The research was carried out on the Research Fields of the University for Development Studies (UDS), Nyankpala, Ghana during the minor cropping seasons of 2012 and 2013. Nyankpala is located at latitude 9° 25′ 41″N and longitude 0° 58′ 42″ W with an altitude of 200 m. The mean annual rainfall is 118.64 mm with a mean temperature of 22.4 °C. The soil type of the study area is Ferric Luvisol (Ahiabor *et al.,* 2010). Ten core soil samples were collected from the field and initial *M. incognita* juveniles recovered from the soil was 230 J_2/200 cm^3.

Source of tomato seeds and sunn hemp leaves

Tomato seeds were obtained from Wumpini Agrochemical Limited, Tamale, a local certified seed dealer. The variety of the tomato was Pectomech which is reported to be susceptible to root knot nematodes (Kankam and Adomako, 2014). Sunn hemp leaves were harvested two months after planting on the research fields of the Faculty of Agriculture, UDS. Wang *et al.* (2012) identified that incorporating sunn hemp leaves into the soil 2-3 months after planting suppressed root knot nematodes effectively.

Experimental design and treatments

The experiment was laid out in a randomized complete block design with four treatments, each treatment replicated four times. The field was harrowed to a fine tilt, and 3 m × 3 m experimental plots were demarcated. Sunn hemp leaves were broadcasted and ploughed into the soil with a 20 cm disc plough at a rate of 0 (control), 2, 4 and 6 kg/ha one week before transplanting of tomato seedlings.

Data collection, soil sampling and *Meloidogyne incognita* extraction

Twenty core soil samples were taken from each plot and thoroughly mixed to form a composite sample. The *Meloidogyne incognita* juveniles (J_2) were extracted from 200 cm^3 of soil samples using a series of sieves (850, 250, 75 and 38 μm) and a 48 h decanting period through a Baermann funnel method (Christie and Perry, 1951). Counting of J_2 was carried out with stereoscopic microscope. *Meloidogyne incognita* juveniles (J_2) were identified based on Siddiqui (2000) identification key.

At harvest, three plants per plot were uprooted and rated for galls according to Zeck's 0-10 scale (Sikora and Fernandez, 2005). Plant height, stem girth and yield were also measured at harvest.

Statistical analysis

Statistical analysis was performed using Genstat 8.1 software. Significant mean separation was determined with Fisher's Least Significance Difference (LSD) at $p < 0.05$ and Duncan's Multiple Range Test (DMRT)

Results

The measured agronomic parameters of tomato plants were not significantly affected by the application of sunn hemp leaf residue. Use of 4 kg/ha sunn hemp increased plant height by 18% compared with the control. The 6 kg/ha treatment increased stem girth by 16% compared with the control. There were however no significant differences ($p > 0.05$) among the treatments in terms of plant height (Fig. 1) and stem girth (Fig. 2). Results from the current study indicates that the incorporation of sunn hemp leaf residue into the soil at different rates significantly ($p < 0.05$) affected root knot nematodes as was evident by the population of second stage juveniles (J_2) recovered from the soil and level of galling (Table 1) on the tomato roots. The 6 kg/ha treatment reduced root knot nematodes population in the soil by 94% compared with the control plots. Root galls on tomatoes planted on the control plots were 76% higher compared with 6 kg/ha soil amendment. The highest yield of 168.7 kg/ha was recorded for the 6 kg/ha treatment, which was 43% higher than the control which recorded the lowest yield of 95.9 kg/ha (Table 2).

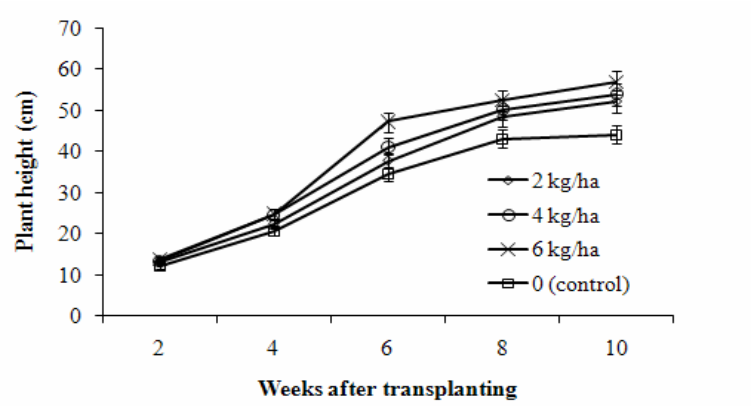

Figure 1 Effect of sunn hemp *Crotalaria juncea* leaf residue on plant height of tomato at two week intervals after transplanting. Bars represent SEM.

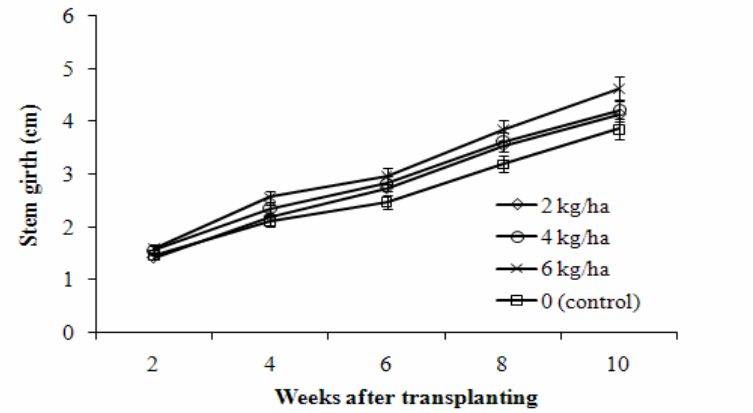

Figure 2 Effect of sunn hemp *Crotalaria juncea* leaf residue on stem girth of tomato at two week intervals after transplanting. Bars represent SEM.

Table 1 Effect of sunn hemp *Crotalaria juncea*. leaf residue on root galls and second stage juveniles (J_2) of *Meloidogyne incognita.*

Sunn hemp leaf residue (kg/ha)	Root gall index (0–10)	J_2/200 cm^3 soil
2	5.62b	175b
4	4.50c	108b
6	1.75d	79b
0 (control)	7.38a	1358a
LSD (0.05)	0.854	267.20
CV (%)	11.10	38.30

Means followed by different letters in a column are significantly different according to Duncan's Multiple Range Test at $P < 0.05$.

Table 2 Effect of sunn hemp *Crotalaria juncea*. leaf residue on yield of tomato.

Sunn hemp leaf residue (kg/ha)	Yield of tomato (kg/ha)
2	114.20b
4	134.40ab
6	168.70a
0 (control)	95.90b
LSD (0.05)	49.20
CV (%)	26.00

Means followed by different letters in a column are significantly different according to Duncan's Multiple Range Test at $P < 0.05$.

Discussion

The results of the current study are in accordance with previous studies confirming plant residues suppress nematode populations in soil. Application of sunn hemp leaf residue at 2, 4 and 6 kg/ha resulted in a significant reduction in J2 population by 87%, 92% and 94% respectively compared with the control. Our findings are in agreement with the results of Youssef and Lashien (2013), confirming that application of 10g crushed cabbage leaf residue before planting was more effective in suppressing egg mass, number of galls, and number of juveniles of *Meloidogyne incognita* compared with the application of 2.5g of the crushed cabbage leaves. Hooks *et al*. (2006) and Schmidt (1998) found that incorporation of sunn hemp into the soil suppressed the pest while the crop was growing. Organic amendment agents such as sunn hemp increase the population of organisms that are antagonist to root knot nematodes (Hooks *et al.,* 2006). Ossom *et al*. (2011) recorded an increase in number of leaves of sweet potato when sunn hemp was incorporated into the soil at different application regimes. The use of cruciferous residues as soil amendments according to Wang *et al*. (2012) enhances solarization against soilborne pathogens and nematodes. The good performance in growth of the tomato plants could be attributed to the negative effect of the leaf residues on the nematodes. Kankam and Adomako (2014) reported in a previous study the effect of root knot nematodes population on the tomato variety "Pectomech". Kluchinski *et al*. (2004) observed an increase in the yield of corn and soybean after applying leave residues as soil manure. Agyeman *et al*. (2012) also observed an increase in the yield of maize when the soil was amended with *Gliricidia sepium* fresh leaves. The addition of sunn hemp as green manure adds organic matter and nitrogen (Hooks *et al.,* 2006) to the soil thereby making nutrients available to the plant and could provide tomato farmers a cheaper and environmentally friendly option in managing *Meloidogyne incognita.*

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