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# Eco-Friendly Management of Root-knot Nematode *Meloidogyne incognita* (Kofid and White) Chitwood Using Different Green Leaf Manures on Tomato under Field Conditions

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**Abstract:** A field study was conducted to test the effect of different green leaf manures elucidate as eco-friendly management of *M.incognita* on tomato. Recommended dosage of green leaf manures, such as *Gliricidia maculata*, *Thespesia populnea*, *Calotropis gigantia, Azadiracta indica* and *Glycosmis pentaphylla* were compared with control as treatments. The results revealed that extent of galling (35.87), gall index (0.327), yield (17.87 Mt/ha), Reproductive factor (0.411) and plant growth includes height and dry matter, respectively (22.47 cm and 45.08 g) were significantly best in *Gliricidia maculata* compared to other treatments. While other green leaf manures, *T. populnea* and *A. indica* ranked second and third, respectively in managing *M. incognita*. This study also revealed that green leaf manures improve the plant growth and reduced the nematode infestation in tomato fields. Moreover, *G. maculata* can be used as an alternative in eco-friendly manage root-knot nematode.

**Key words:** *Gliricidia maculata* · *Meloidogyne incognita* · Tomato · Root-knot · Greenleaf manures

## INTRODUCTION

Root-knot nematodes are serious and economically most important pest of many cultivated crops around the world [1]. They are particularly damaging vegetables in tropical and subtropical countries [2] and cause losses up to 80% in heavily infested fields [3]. Short life cycle of six to eight weeks enables them to survive well in the presence of a suitable host. In susceptible plants, the nematode population build up to a maximum usually as crop reach maturity [4] and in some cases the plants die even before reaching maturity [5].

Root-knot nematodes of genus *Meloidogyne* are among the main pathogens of tomato (*Lycopersicon esculentum* Mill) plants all over the world [6]. Infested plants show the symptoms of stunting, yellowing, aberrant development of root system characterized by the formation of typical galls, a general unthrifty appearance and limited fruit production, estimated yield losses ranging from 28% to 68% [7,8]. The control of plant parasitic nematodes is a difficult task, has mainly depended on chemical nematicides for decades and remarkable reduction of nematode population has been achieved [9]. Although soil nematicides are effective and fast-acting, they are currently being reappraised with respect to the environmental hazards and human health [10]. In addition to that they are relatively unaffordable to many small-scale farmers.

Inventing alternative strategies for management of root-knot nematodes has been emphasized to researchers, farmers and scientists that do not pollute the environment [11]. There are lots of alternative strategies that have been reported by the crop protectionist through researches, such as application of soil organic amendments of crop residues and animal manures, heat treatment, soil solarization and crop rotation with non hosts for managing root-knot nematodes [12].

Application of green manures in the soil is not only beneficial to disease management but also improving the plant growth and productivity. On the other hand, application of green manure leads to build-up of beneficial microflora, that keep the plant healthy and vigour, around the rhizosphere, which will help to reduce the plant parasitic nematodes in the soil [12]. Green manures of cabbage and cauliflower leaves, chopped pineapple leaves, dry straw of rice, rye or oats and cotton wastes are reported to reduce the incidence of root-knot in the field. Application of oil-cake of pongamia (*Pongamia glabra*) and margosa (*Azadiracta indica*) each at the rate of 2.5 Mt/ha was very effective in reducing root-knot of okra and tomato [13]. Jourand *et al*., [14] reported that *Crotalaria virgulata* subsp. *grantiana* leaf extract is having nematicidal property hence leaf can be used as both green manure and natural alternative to synthetic chemical in integrated pest management strategies. Nazli *et al*. [15] reported that leaf extract of *Gliricidia*

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*sepium* has some insecticidal, nematicidal and antibacterial activity and it causes 60% mortality of second stage juvenile of *M. incognita*.

There is no more evidences in the application of *G.sepium* or *G.maculata* as green leaf manure and hence an eco-friendly and environmentally safe technique is aimed incorporating this green leaf manure in the management of root-knot nematode under field conditions.

## MATERIALS AND METHODS

A preliminary study was conducted to determine mean number of galls on tomato in an untreated nematode infested soil. Well prepared land was divided in to same sized (180×150 $cm^2$) four blocks. Each block was further divided in to six sub plots. Three weeks old tomato seedlings of cv. KC1 were transplanted at the rate of one healthy plant per hill. All the agronomical practices were done carefully until flowering. At the time of flowering, tomato plants were up rooted randomly from each plot and transferred carefully to laboratory. Uprooted tomato plants containing root galls were washed free of adhering soil particles. Plant roots were examined carefully under stereomicroscope and number of galls per root system was counted.

Thereafter, these plots were treated with different types of green leaf manures and allowed 15 days for complete decomposition. Green leaf manures used for this study was selected on the basis of availability, high nitrogen content and traditional usage of these leaves as green manure by potential farmers. Green leaf manures such as *Thespesia populnea, Calotropis gigantia, Azadiracta indica, Gliricidia maculata* and *Glycosmis pentaphylla* were applied at the rate of 25 ton/ha. Three weeks old tomato seedlings were transplanted at a spacing of 80 cm × 50 cm. This experiment was carried out using the experimental design of Randomized Complete Block Design (RCBD). Gall changing factor were calculated as number of galls in treated plants divided by number of galls in untreated plants. Dunnet mean separation was done by using SAS statistical package.

Table 1: Green leaf manures used for nematode management

| Common name | Scientific name | Family | N% |
|---|---|---|---|
| Potria | *Thespesia populnea* | Malvaceae | ----- |
| Calotropis | *Calotropis gigantia* | Asclepidaceae | 2.1% |
| Neem | *Azadiracta indica* | Meliaceae | 2.8% |
| Gliricidia | *Gliricidia maculata* | Fabaceae | 2.9% |
| Glycosmis | *Glycosmis pentaphylla* | Rutaceae | ------ |

Daily mean temperature and rain fall were recorded. Height of plants was measured weekly until flowering. The plants were carefully dug out at the time of 50% of flowering and gently washed to remove soil from roots and plant dry weight, were determined. Plant roots were examined carefully under stereomicroscope and number of galls per root system was counted. Gall index was determined using a scale described by Sasser *et al*., [16]. Scale of 0 = No galling; 1 = 1-10 galls; 2 = 11-20; 3 = 21-30; 4 = 31-100 galls and 5 = more than 100 galls was used. Yield of tomato and nematode reproductive factor (RF) was also determined.

## RESULTS AND DISCUSSION

**Nematode Suppressive Effect of Green Leaf Manure:** The number of galls or knots on tomato was varied with type of green leaf manure. Results revealed that extent of galls were statistically significant in *G. maculata, A. indica* and *T. populnea* (Table 2). Number of galls was lowest (35.87) in *G. maculata* and 37.85, 44.37 in *A. indica* and *T. populnea,* respectively.

Green leaf manures have the ability to suppress root disease by changing soil physical and chemical properties, and by enriching the soil with beneficial microflora. Incorporation of selected green leaf manures to the soil can reduce the soil borne pathogens such as *Rhizoctonia*, *Pythium*, and *Fusarium* population. Root-knot nematodes can also be controlled by application of green leaf manures to the infected soil [17].

Also, *A. indica* and *G. maculata* leaf extracts had nematicidal properties such as inhibition of egg hatching and increasing larval mortality up to 60% at various

Table 2: Effect of green leaf manures on tomato growth and root-knot nematode *M.incognita*

| Treatment | Plant height(cm) | Dry weight(g) | No. of galls | Yield (Mt/ha) | Gall Index | RF |
|---|---|---|---|---|---|---|
| *T.populnea* | $15.97^b$ | $31.89^b$ | $37.87^a$ | $12.25^b$ | 0.346 | $0.434^a$ |
| *C.gigantia* | $20.35^a$ | $33.09^b$ | $56.12^b$ | $9.75^b$ | 0.513 | $0.644^a$ |
| *A.indica* | $17.62^b$ | $29.12^b$ | $44.375^a$ | $15.00^b$ | 0.405 | $0.509^a$ |
| *G.pentaphylla* | $20.2^a$ | $36.17^b$ | $103.75^c$ | $14.53^b$ | 0.948 | $1.190^b$ |
| *G.maculata* | $22.47^a$ | $45.08^a$ | $35.87^a$ | $17.87^a$ | 0.327 | $0.411^a$ |
| Control | $15.52^b$ | $24.32^b$ | $109.37^c$ | $10.37^b$ | 1.0 | $1.255^b$ |

(Values are means of four replicate plots; means followed by the same letter within a column are on par at á=0.5)

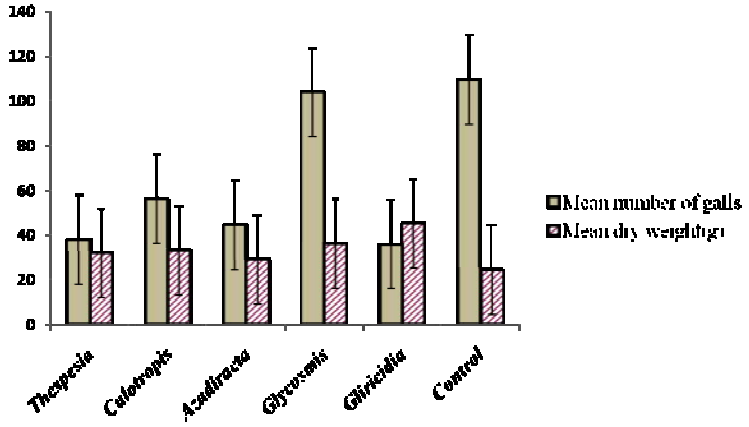


Fig. 1: Plant height and weight combination in different green leaf manures

concentrations since these leaves contained chemical compound called ethanol which has nematicidal property [18,15]. Moreover, Wachira *et al*., [10] stated that *G.maculata* has high potassium (1.7 %) which is responsible for production of healthy root system, compared to other green leaf manures.

The effect of *T. populnea* leaves might be the altering of soil physical or chemical properties that kill or repel the nematode juveniles. Green leaf manures suppress nematode reproduction and gall formation by action of root exudates that attracted the soil antagonistic microbes such as *Pseudomonas fluorescence* and *Trichoderma* sp [19], kill the nematodes [20] or altering soil physical and chemical properties specially soil pH that may not be conducive for nematode development [17]. Wachira *et al*. [10] reported that application of organic amendments (green leaf manure) to the soil acts as a stimulant of nematode-destroying fungi which arrest the nematode population increase.

Nematode reproductive factor is an indication of nematode multiplication. RF was high in *G. phentaphylla*. Hence application of this as green leaf manures is not an ideal practice for the nematode management because it facilitates the nematode reproduction. Increasing growth and decreasing RF suggest the nematicidal potential of *G. maculata* and similar observations are made by Alam *et al*. [21,22].

**Effect of Different Leaf Manures on Plant Growth:** Green leaf manures such as *G. maculata*, *G. pentaphylla* and *C. gigantia* were highly effective on tomato height. Table 2 illustrate that growth rate of tomato was statistically significant ($p<0.05$) compared to control. Tomato growth was highest in *G. maculata* (22.47 cm) *G. pentaphylla* (20.2 cm) and *C. gigantia* (20.35 cm). Table 2 shows that increment of dry weight was statistically significant ($p<0.05$) in *G.maculata* compared to control. Dry weight increment was highest (45.08 g) in *G. maculata*.

Plants showed quick response to green leaf manures because of the presence of low C/N ratio. This facilitated the decomposition of green leaves which released the necessary nutrients such as N, P and K to the plants. Hence a positive correlation (Figure 1) was obtained between application of green leaf manures and biomass increment except *G. pentaphylla*. Because *G. maculata* consisted o f highest nitrogen (2.9%) than other green leaf manures such as *A. indica* (N=2.8%) and *C. gigantia* (2.1%) [23], there is no report of others.

**Effect of Different Green Leaf Manures on Tomato Yield:** Yield obtained from *G.maculata* was statistically significant ($p<0.05$) and superior than other green leaves used (Table 2). Green leaf manures are effective alternatives to chemical fertilizers in the management and preservation of soil fertility and productivity, adding organic matter and nutrients to the soil [24].

High production of fruits needed high amount of nitrogen. *G. maculata* has high amount of N, P and K in 2.5-3.5%, 0.15-0.5% and 1.3-1.7%, respectively, than other leaves used. Green leaf manures substitute chemical fertilizers because they improves soil properties, plant growth and productivity [24]. Hence the use of *G. maculata* as green leaf manure is not only improves the plant growth but also increases the yield and reduces the nematode attack.

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