ISSN:
Print - 2277 - 0755
Online - 2315 - 7453

Journal of Agricultural Science and Environment

EVALUATION OF *Tithonia diversifolia* AND *Chromolaena odorata* RESIDUES AS POTENTIAL ORGANIC COMPOST MATERIALS FOR THE MANAGEMENT OF *Meloidogyne incognita* ON COWPEA (*Vigna unguiculata* L. WALP)

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ABSTRACT

Screen house studies were conducted to assess the efficacy of *Tithonia diversifolia* and *Chromolaena odorata* powder as alternative organic fertilizer materials in comparison with the local commercial neem organic fertilizer in the management of *Meloidogyne incognita* infection on cowpea **(***Vigna unguiculata* var. Ife Brown**)**. The experiments were laid out in completely randomized design with six replications. Cowpea seedlings were raised in sterilized soils in plastic pots and inoculated with 5000 eggs of *M. incognita* at two weeks after emergence. At 60 days after emergence, destructive sampling of plants was done to assess nematode indices: root galls, nematode population and reproduction factor. Results obtained show that growth and yield of cowpea was significantly($p<0.05$) improved by *Tithonia* and *Chromolaena* soil amendments effectively as the neem fertilizer. It also show that, *M. incognita* infectivity (number of galls, nematode population, reproduction) were significantly($p<0.05$) reduced by *Tithonia* and *Chromolaena* soil amendments as the neem fertilizer. The findings of this study recommend the residues of these common weeds for evaluation in organic composting with potential for plant parasitic nematode management combined with release of nutrient to plants as organic fertilizer..

Keywords: Cowpea; *Chromolaena odorata*; Neem; Organic fertilizer; *Tithonia diversifolia*; Root knot nematode

INTRODUCTION

Cowpea *Vigna unguiculata* (L) Walp is a grain legume grown mainly in the savannah region of the tropics in Africa. Cowpea is an important source of qualitative nourishment to urban and rural poor, who cannot afford meat and milk products (Brader, 2002). It is estimated that cowpea supplies 40% of the daily protein requirement to most people in Nigeria (Muleba *et al.* 1997).

Despite the nutritional importance of cowpea, many subsistence farmers in Nigeria consider it a high-risk investment because of numerous pests associated with it (Sosanya, 2006). Among the pest associated with cowpea production, nematodes play an important role. Plant parasitic nematodes often referred to as farmers hidden enemies are among the most widely spread and important pest causing yield loss (Adesiyan *et al*., 1990).

Root knot nematode have been implicated in the low yield being recorded on the field in cowpea production (Ogunfowora, 1976; Bridge,1981; Babatola and Omotade, 1991). The most important of the species of *Meloidogyne* pathogenic in cowpea is *M. incognita*. The southern Root knot nematode, *Meloidogyne incognita* causes up to 65-95% reduction in yield and in sever cases total loss can occur in cowpea production (Olowe, 1992; Adesiyan *et al*., 1990).

Several methods are available for the control of plant parasitic nematodes. The use of synthetic nematicides is superior to all known strategies of nematode control as they are effective and quick in action. Yet their application requires technical skills for environmental safe application. The continued dependence on these chemical substances is also seen as accelerating environmental pollution, threat to live and creation of new socio-economic problems that must be avoided (Atungwu, 2006).

Recent banning of many nematicides has increased the need for development of non-chemical options. Among the alternative strategies, plant residue and organic fertilizer amendments may become an alternative to local farmers in Nigeria because of their low cost, little or no technical-know and the more general positive agronomical effects related to the incorporation into the soil. Use of plant residue and organic fertilizer amendment is known to suppress soil plant parasitic nematode population since many years (Rodriguez – kabana and Hollis, 1965; Rodriguez – kabana *et al.,* 1990). Incorporation of these plant materials is known to influence physical, chemical and organic properties of the soil leading to a direct impact on plant health and crop productivity (Odeyemi, 2011; Odeyemi *et al.,* 2011; Atungwu, 2006). Also, Mechanism of suppressive action by organic amendment of plant residue and organic fertilizer seem to be related to the release of nemato- toxic compounds and to the increase activity of naturally occurring antagonist (predator and parasites) of nematode pests (Stirling, 1991).

In Nigeria, locally produced organic based fertilizer from agro-industrial, municipal waste and plants materials by Governments and Non-Governmental Organizations are now available in commercial quantities and affordable for subsistence farmers. The reports of Atungwu, (2006); Renco *et al*., (2007); Atungwu and Kehinde, (2008) on suppression of *M. incognita* populations in the soil by neem powder gave a further justification for the inclusion of neem plant in the formulation of organic fertilizer in crop production with added advantage of managing plant parasitic nematodes. Hence the need to exploit other plants with bioactive compounds against plant parasitic nematodes as readily available raw materials for the formulation of organic based fertilizer. *Chromolaena odorata* (L.) King and Robinson and *Tithonia diversifolia* F. Hook are common Asteracea plants in farmers' fields in the southwestern part of Nigeria. They have high biomass production and decompose quickly leading to an improvement of soil properties (Kanmege *et al.,* 1999 and Gachengo, 1997). These plants have been shown to contain bioactive compounds that have nematicidal properties on *M. incognita* (Fatoki and Fawole, 2000; Odeyemi and Adewale, 2011). Besides, these plant species are easy to handle by farmers due to absence of thorns. The present study was therefore set to assess the potential of *Chromolaena odorata* and *Tithonia diversifolia* residues for root knot disease management in cowpea.

MATERIALS AND METHODS

The soil used for the experiment was collected from the field within the premises of the Federal University of Agriculture, Abeokuta, Nigeria. The soil was sandy-loam (80 % sand, 6.2% clay and 13.8 % silt) with a pH of 6.10. The soil was heat sterilized using an electric soil steriliser at 65°C for 90 minutes. The soil was then allowed to cool and later stored in jute sacs to rest for six weeks to regain its stability. The experiment was set in a completely randomised design with six replications under screen house condition. Treatments include:

(i) Nematode-inoculated cowpea with 1 % v/v of *C. odorata* powder
(ii) Nematode-inoculated cowpea with 1 % v/v of *T. diversifolia* powder
(iii) Nematode-inoculated cowpea with 1 % v/v of neem fertilizer
(iv) Cowpea inoculated with nematode only
(v) Cowpea plant grown in nematode free soil (Control)

Chromolaena odorata and *T. diversifolia* plants used were sourced from near-by fields. Preparation of the powder was done by sun -drying the plants for two weeks, after which it was ground to powder.

The soil was thoroughly mixed to ensure homogeneity. Seven- litre plastic pots were filled with 5 kg of the sterilised soil. The soil was mixed with 1% (v/v) of the plant powders or neem fertilizer. The pots were watered daily for 14 days to allow mineralization of the organic substances incorporated. Two weeks after application of the treatments, 2 seeds of cowpea var. Ife Brown were planted per pot, but thinned to one per pot six days after emergence to ensure uniform plant vigour.

Eggs of *M. incognita* used as inoculum were sourced from roots of *Celosia argentea* on which pure culture of the nematode was multiplied. Roots of *C. argentea* were thoroughly washed in cool tap-water in order to remove soil. Washed roots were mopped dried with serviette paper and then cut into 1 - 2 cm pieces. Root segments were placed into conical flasks and 0.52% sodium hypochlorite (NaOCl) solution added into each flask, corked with a stopper; and shaken manually but vigorously for 3-4 minutes to dissolve the gelatinous egg matrix (Hussey and Baker, 1973). Eggs freed from the egg sacs in the diluted NaOCl were rinsed under gentle stream of cold tap-water to wash away excess NaOCl and were collected on a 500-mesh sieve. Eggs were calibrated using a Doncaster counting dish under a stereomicroscope and poured into a 500 ml beaker for purpose of inoculation. At 2 weeks after planting, seedlings of cowpea were inoculated with 5000 eggs of *M. incognita,* by pipetting the egg suspension into a shallow trench close to the base of each plant and covered lightly with sterilised top soil. At 60 days after inoculation, three replicates of plant roots were gently lifted from the soil, washed using water and manually scored for number of root galls. Juveniles of *M. incognita* remaining in soil were extracted using the Whitehead and Hemming (1965) method. Eggs extracted from the root tissues were counted under stereomicroscope and recorded. The remaining three replicates of the cowpea plants were grown to maturity and harvested to collect yield data. Data collected on growth and yield data for the two experiments were pooled before subjection to analysis of variance (ANOVA) using SAS version 8.1. Statistically different means were separated using Least Significant Difference (LSD) at 5 % level of probability.

RESULTS

The comparative effectiveness of *Tithonia* and *Chromolaena* powder in comparison with neem organic fertilizer on growth and yield parameter of cowpea infected with 5000 eggs of *M. incognita* are presented in Tables 1 - 3 and Figure 1. Two weeks after inoculation, the cowpea plants grown under the various treatments were significantly ($p<0.05$) taller than cowpea plant infected with *M. incognita* only and this trend was observed throughout the study (Table 1). Also, Cowpea plants grown in *Tithonia* amended soil were tallest compared with plants grown in other treatments despite the presence of *M. incognita*. However, shortest plants were observed in pot inoculated with nematode only.

In terms of leaf number and leaf area, Tithonia treatment had more and the biggest leaf and was significantly higher than in other treatments. Fewer leaves and the smallest leaf size were found on cowpea plants inoculated with nematode only. At 60 days after planting, fresh shoot and root weights varied significantly ($p<0.05$) among the cowpea plants based on the treatments (Table 2). Cowpea plants grown in amended soil treatments had heavier shoot and root weights than those infected with nematode only and the control. Whereas, shoot and root weights of cowpea in the control treatments were heavier than in the *M. incognita* infected only treatment.

Table 3 shows some nematode indices on cowpea plant treated with *Tithonia*, *Chromolaena* and neem organic fertilizer. The population and number of galls inflicted by *M. incognita* differed ($p < 0.05$) significantly among the treatments. Fewer galls were recorded on cowpea plants grown in amended soil with *Tithonia* (4.67 galls), *Chromolaena* (5.00 galls) and neem fertilizer (6.33 galls), while cowpea plants infected with nematode only (77.33 galls) had significantly ($p<0.05$) more galls per plant than the organically amended treatments. The total number of eggs and nematodes within the amended treatments were significantly lower than within the nematode only treatment. Neem, *Tithonia* and *Chromolaena* do not differ significantly from each other. However, the nematode population within the cowpea infected with nematode only was significantly highest.

Yield component of cowpea varied significantly ($p<0.05$) amongst the treatments (Figure 1). Number of pods and grain yield were highest on Tithonia amended cowpea but do not differ statistically compared with Chromolaena and neem fertilizer amendment. Also, all amended treatments gave significantly higher yield than the control. However, significantly lowest yield was observed on cowpea infected with nematode only.

Table 1: Effects of T*ithonia* and C*hromolaena* powders, and neem fertilizer on plant height, leaf area and number of leaf per plant of cowpea infected with *Meloidogyne incognita.*

		Mean Plant height (cm)	
Treatments	2WAI*	4WAI	6WAI
Tithonia	33.26	66.15	95.13
Chromolaena	29.62	49.83	77.10
Neem	29.27	39.73	60.40
Nematode only	21.77	27.12	34.53
Control	23.64	40.80	61.14
LSD (0.05)	16.70	12.8	14.6
		Mean Leaf Area (cm^2)	
Treatments	2WAI	4WAI	6WAI
Tithonia	72.3	78.46	79.82
Chromolaena	58.5	65.76	72.43
Neem	56.56	60.30	62.63
Nematode only	43.07	45.59	46.90
Control	46.32	60.10	62.38
LSD (0.05)	10.72	18.14	16.66
		Mean Number of leaf per plant	
Treatments	2WAI	4WAI	6WAI
Tithonia	20.20	38.80	46.60
Chromolaena	14.80	29.75	38.75
Neem	16.50	27.50	38.00
Nematode only	11.50	15.50	20.75
Control	12.60	20.20	29.60
LSD (0.05)	4.8	16.70	14.80

WAI – Weeks after inoculation

Table 2: Fresh shoot and root weights of cowpea plant as influenced by *M. incognita* infection and soil amendment with T*ithonia*, C*hromolaena* and neem fertilizer.

Treatments	Shoot weight (g)	Root weight (g)
Tithonia	61.78	11.33
Chromolaena	49.75	10.46
Neem	40.02	11.44
Nematode only	23.22	4.31
Control	45.24	10.44
LSD ($p<0.05$)	13.40	3.46

Table 3: Mean number of galls and population of *M. incognita* on cowpea treated with *Tithonia*, *Chromolaena* and neem fertilizer

Treatments	Mean galls	Eggs in root	Juveniles in soil	Reproduction Factor
Tithonia	4.67	24	160	0.036
Chromolaena	5.00	30	293	0.064
Neem	6.33	49	130	0.035
Nematode only	77.33	1330	9240	2.11
LSD (0.05)	25.17	71.17	56.34	0.21

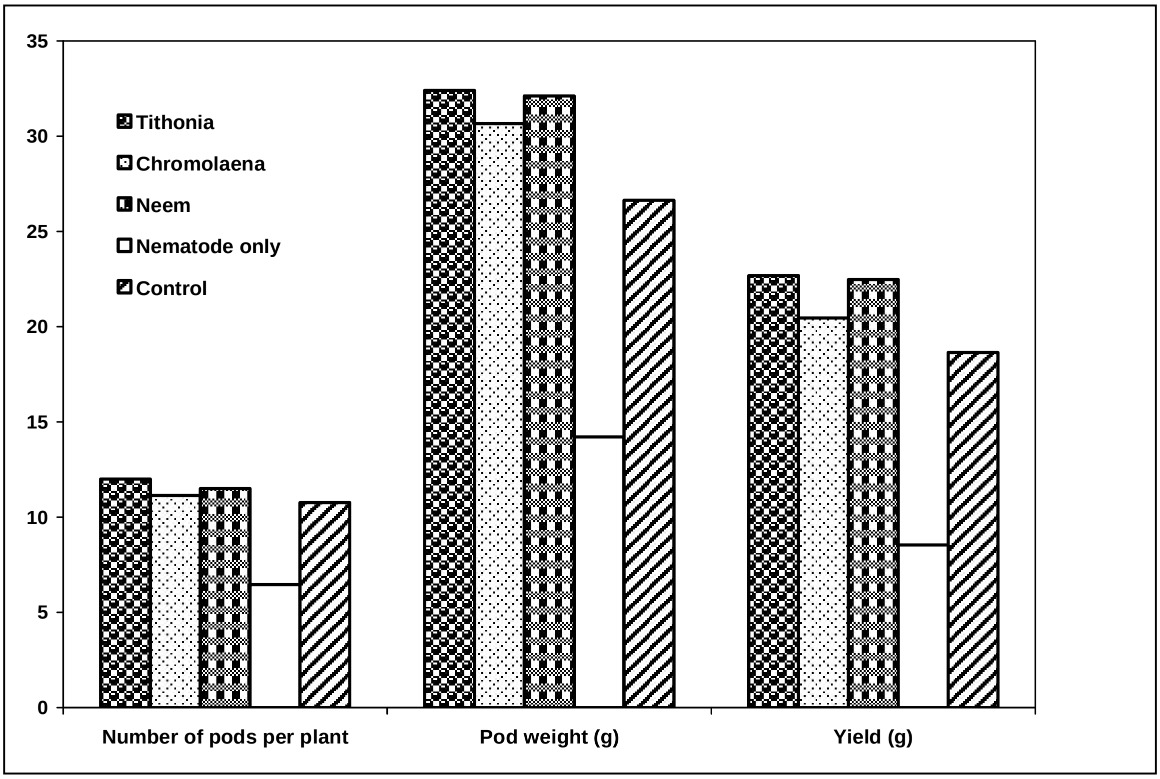

Figure 1: Effects of *Tithonia*, *Chromolaena* and neem fertilizer soil amendment on yield of cowpea infected with *M. incognita*

DISCUSSION

The efficacy of *Tithonia* and *Chromolaena* powder was compared with neem fertilizer for suppression of root-knot nematode disease caused by *M. incognita* on cowpea. Significant reduction in growth and yield of cowpea was observed as a result of the negative effect of *M. incognita*. This was earlier documented by Odeyemi 2004 and Odeyemi and Afolami 2008 that stunted growth, fewer pods and significant reduction in grain yield are symptoms of *M. incognita* infection on cowpea.

Soil amendment with *Tithonia* and *Chromolaena* powders along with neem organic fertilizer improved growth and yield of cowpea probably due to addition of nutrients to the soil (Atungwu, 2011) in addition to physical improvement of soils and their release of nematicidal compounds that are known to suppress nematodes, especially *M. incognita* in the soil (Odeyemi and Halliday, 2012; Odeyemi and Adewale, 2011; Fatoki and Fawole, 2000).

The comparative effectiveness of *Tithonia* and *Chromolaena* powder on *M. incognita* suppression on cowpea and subsequent improvement in growth and yield of cowpea favourably as the neem fertilizer postulate these plant materials as a good source of plant nutrients in the soil thereby not only suppressing M. incognita but at the same time improving crop growth and yield (Apori *et al.,* 2000; Gachengo *et al.*1999).

CONCLUSION

This study demonstrated that powder of *Tithonia diversifolia* and *Chromolaena odorata* exhibited nematicidal properties on *M. incognita*, released nutrient into the soil and subsequently increased cowpea growth and yield. Thus suggesting these plant materials as new composting materials for local farmers and are likely to become a good and cheap source of raw materials for organic fertilizer production with potential for root knot nematode suppression. .

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(Manuscript received: 29th January, 2013; accepted: 20th June, 2014).