Potential of an appropriate cropping program for root-Knot (*Meloidogyne Spp.*) nematode management in tomato cropping systems in Kenya

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ABSTRACT

Studies were undertaken under greenhouse and field conditions to determine the suppressiveness of a wide range of plant species to *Meloidogyne* spp. nematodes. Potted plants were inoculated with 6000 eggs and /or juveniles while the field experiments were in nematode infested fields. The data was analyzed using GenStat Edition 3 and means separated using the least significant difference test at (P<0.05). Among the plants tested, *Tagetes patula, Gossypium hirsutum, Desmodium uncinatum, Chloris gayana, Zea mays, Alstroemeria* sp., *Capsicum annuum, Crotalaria juncea, Arachis hypogaea, Sorghum bicolor, Tithonia diversifolia and Pennisetum purpureum* were rated as poor nematode hosts with galling and egg mass indices ranging from 0 to 3. High galling and egg mass indices ranging from 7-9 were recorded on *Lablab purpureus, Coriandum, sativum, Statice* sp., *Brassica oleracea* var. *gloria, Helianthus annuus,* and *Vigna subterranea* while *Mucuna pruriens, Lactuca sativa, Allium ampeloprasum, Sesanum indicum, Allium cepa, Onnis* sp., *Brassica Oleracea* Var. *chinensis, Asparagus* sp., *B. oleracea* var. *botrytis, Ornithogolum arabicum. Tuberose* sp. *and Chrysanthemum indicum* were rated moderately resistant with galling and egg mass indices ranging from 3 to 6. Damage by nematodes was significantly (P<0.05) reduced in tomato planted after sweet corn or in sweet corn with *Tagetes patula, Crotalaria juncea, Sorghum bicolor* and *Asparagus sp.* in the field. This study shows that despite the fact that *Meloidogyne* spp. has wide host ranges, there is a wide range of economically important plants from which suitable candidates can be selected by farmers for use as rotation or interplant in their management.

Key words: Cropping program, Kenya, Management, Nematodes, Tomato

INTRODUCTION

Rotating crops in a sequential cropping system is widely regarded as a good agricultural practice in traditional and modern agriculture (Bridge, 1996, Chen and Tsay, 2006). Crop rotation systems are particularly useful in maintaining soil fertility and reducing or preventing build up of pests and diseases especially in the soil (Netscher and Sikora, 1990, Nolig, 2009). The principle that guides use of crop rotation in nematode management is to reduce populations of the damaging nematode species to levels that allow subsequent crops to complete early growth before being heavily attacked (Bridge, 1996). This can be achieved by alternating poor hosts, non-hosts or resistant crops with susceptible crops (Swamy *et al.*, 1995, Fortnum *et al.*, 2001).

Although sequential cropping is recognized as a strategy in root-knot (*Meloidogyne spp*) nematode (Abawi *et al.*, 2008) management its adoption especially in the smallholder farms is restricted due to scarcity of arable land coupled with market-driven demand of particular crops and/ or varieties (Bridge, 1996). In addition, a lot of skill is required to design and implement effective crop cycles for the control of such pathogens as root-knot nematode that have broad host ranges (Kerry, 1990, Yamada *et al*, 2002). Previous studies have been focused on plants such as *Tagetes* spp., *Crotalaria* spp., *Asparagus* spp., sesame, and neem that are antagonistic to root-knot nematodes because they release root exudates that are toxic to the nematodes (Sukul, 1994, Vargas-Ayala *et al.*, 2000). Low or lack of commercial value of the most intensively studied plants is however, a major hindrance to their adoption into most cropping systems (Johnson *et al.*, 1992) especially in Kenya where there is scarcity of land and therefore farmers are obliged to plant plants with economic, forage or ornamental value. Currently the use of nematicides is on the increase in Kenya resulting in environmental degradation. Some of the currently used nematicides are harmful to the users for instance Furadan which is casinogenic in nature yet it is in continuous use by our farmers.

Suitability of a crop for incorporation into a rotation cycle is not only determined by its efficiency in nematode suppression but also by the economic returns it brings to the farmer (Nolig, 2009, Chen and Tsay, 2006). Farmers in Kenya continually intercrop tomato with crops that are highly susceptible to rootknot nematode like spinach, capsicum among others which have economic returns and this leads to increased nematode population in the soils. The challenge to research is therefore, to identify nematode suppressive crops that satisfy the economic considerations in crop production systems. In an effort to address the above challenges a study was undertaken to identify potential rotation crops with food and forage with commercial value and incorporate them into cropping programs for root-knot nematode management in tomato production systems in Kenya.

MATERIALS AND METHODS

Screening of potential rotation crops for root-knot nematode suppression

Greenhouse experiment

Thirty-six plant species (Table1) were selected and evaluated to determine their reaction to root knot nematodes under greenhouse conditions. Tomato C.V. Moneymaker and *Tagetes minuta* an antagonistic plant were included as positive and negative controls, respectively. Pots measuring 21 cm in diameter were filled with 5 kg heat sterilized loam and sand soil, mixed in the ratio 2: 1(v/v). Three seeds of each test plant were sown in each pot but thinning was done ten days after emergence to leave one seedling per pot. Ten days after seedling emergence, 6000 eggs and/ or juveniles, suspended in 10ml of water, were pipetted into indentations made around the base of the seedlings in each pot and soil pushed back to cover the roots. Treatments were arranged in a completely randomized design with ten replications. Plants were watered twice a week and fertilized on a biweekly basis by adding 5g of calcium ammonium nitrate (CAN) into each pot. The experiment was terminated eight weeks after inoculation.

Plants were gently uprooted and roots washed free of adhering soil using water. Galling was quantified using the scale of 0-10 as described by Bridge and Page (1980) where, 0 = healthy root system, 1 = very few galls only detected upon close examination, 2 = small galls easy to detect, 3 = numerous small galls, 4 = numerous small galls and a few big ones, 5 = 25% of the root system severely galled, 6 = 50% of the root system severely galled, 7 = 75% of the root system severely galled, 8 = no healthy root but plant still green, 9 = completely galled root system and plant dying, 10 = plants and roots dead. Plants with scores ranging from 0-3 were rated as resistant while those with scores ranging from 4-6 and from 7-10 were rated as moderately resistant and susceptible, respectively. Egg masses were stained using phloxine B (Holbrook *et al.*,

1983) and quantified using a scale of 1-9 where 1=no egg masses, 2=1-5, 3=6-10, 4=11-20, 5=21-30, 6=31-50, 7=51-70, 8=71-100, 9= >100 egg masses per root system (Sharma *et al.,* 1994). Second-stage juveniles were extracted from 200cm^3 soils using the modified Baermann funnel technique and enumerated (Hopper, 1990).

Field Experiment

Tagetes patula, Crotalaria juncea, Sorghum bicolar, Desmodium sp., sweetcorn that had been rated as resistant in the greenhouse experiment with tomato C.V. Moneymaker as a control were evaluated in naturally infested soils in micro-plots measuring 1 x 1.8m. Each had 4 rows with 5 plants/row planted in a spacing of 25 x 60cm. 5g of diamonium phosphate was added into each planting hole at planting time and top dressing done using CAN fertilizer three weeks after germination. Weeds were controlled regularly and plants irrigated when necessary. The experimental design was a randomized complete block design with three replications.

Initial nematode inoculum in the soil was determined by taking five 200g soil samples at random following the procedure by Dropkin (1980) and second-stage *Meloidogyne* juveniles extracted using the modified Baermann funnel technique and enumerated (Hooper, 1990). After 90days, five plants were randomly selected from the middle rows of each micro-plot and uprooted by carefully digging out the roots using a hoe, and damage by nematodes assessed using the galling index scale developed by Bridge and Page (1980). Soil samples were collected from ten different points in a zig zag manner in each micro-plot, bulked into five 200g soil samples and second-stage juveniles extracted as described above.

Effect of growing tomato in rotation with antagonistic plants in combination with sweetcorn on *Meloidogyne* spp. in an infested field

The effect of rotating tomato with sweetcorn or sweetcorn under-sown/intercropped with *Crotolaria juncea, Asparagus* spp., *Tagetes patula, Sorghum bicolor* or *Allium sativum* on root-knot nematodes was determined under field conditions during the long rainy season. A nematode infested field was selected and the above plants sown in plots measuring 4 x 4m. The initial nematode density in each field was determined following the procedure described above. The field had spinach and maize during the previous season.

One week after germination of sweet corn, T. *patula, Sorghum bicolor, Asparagus* sp., *Crotalaria juncea,* were intercropped/underswom in between the sweet corn stands and tomato C.V. Moneymaker used as a control. Sweet corn was planted at a spacing of 30 x 75cm and single rows of the antagonistic plants sown in between sweet corn stands. Plants were fertilized by adding 5g of diammonium phosphate into each planting hole. Weeds were regularly controlled and the plants irrigated when necessary. The experimental design was randomized complete block design with five replications. After three months, ten sweet corn plants were randomly selected from each plot, uprooted and their roots washed free of soil. Data on dry shoot and cob weights were taken. Data on root galling of undersown plants were determined. Soil samples were taken from ten different points in each plot for juvenile population assessment. Plots were tilled before transplanting one-month-old tomato C.V. Moneymaker seedlings at a spacing of 25 x 75cm.

The experiment was terminated 60 days after transplanting by gently uprooting10 randomly selected tomato plants by digging using the hoe from each plot and roots washed free of soil before rating them for galling and egg masses following the procedures described above. Second-stage juveniles were extracted from soil samples and enumerated as described above. Dry shoot weight of the ten plants was also taken and the experiment repeated once during the following season following the same procedure.

All data collected was subjected to analysis of variance using GenStat discovery EDITION 3 computer package and means separated using the least significant difference (LSD) test at (P<0.05).

Table 1: Galling and egg mass indices and numbers of *Meloidogyne* juveniles (J_2) on different plant species grown in soil infested with root-knot (*Meloidogyne* spp.) nematodes

Plant	Galling indices Test I	Galling indices Test II	Egg mass indices Test I	Egg mass indices Test II	Juvenile counts/ 200cm^3 Test I	Juvenile counts/ 200cm^3 Test II	Overall reaction
Tagetes (*Tagetes patula*) (control)	1.0	1.0	1.0	1.0	229	48	Resistant
Tagetes (Tagetes minuta)	1.0	1.8	1.0	1.8	235	13	"
Desmodium (*Desmodium uncinatum*)	1.0	1.0	1.0	1.0	299	85	"
Rhodes grass (*Chloris gayana*)	1.0	1.0	1.0	1.0	299	46	"
Alstroemeria (*Alstroemeria sp.*)	1.0	1.1	1.0	1.1	182	88	"
Cotton (*Gossypium hirsutum*)	1.4	2.0	1.4	2.2	255	80	"
Crotalaria (*Crotalaria juncea*)	1.5	1.6	3.4	3.6	239	77	"
Napier grass (*Pennisetum purpureum*)	1.6	1.0	1.6	1.0	621	80	"
Sorghum (*Sorghum bicolor*)	1.8	1.9	4.4	3.7	314	47	"
Peanut (*Arachis hypogaea*)	1.8	1.5	1.6	1.5	100	59	"
Sweetcorn (*Zea mays saccharata*)	1.9	2.2	2.0	2.6	219	101	"
Capsicum (*Capsicum sp.*)	2.2	1.0	2.1	1.0	260	50	"
Tithonia (*Tithonia diversifolia*)	2.9	3.6	3.0	3.3	405	75	"
Garlic (*Allium sativum*)	3.1	3.8	3.4	4.0	373	50	Moderately resistant
Velvet bean (*Mucuna pruriens*)	3.8	3.1	3.6	3.6	370	46	"
Lettuce (*Lactuca sativa*)	3.9	4.8	3.9	4.2	248	158	"
Leekswiss (*Allium ampeloprasum*)	4.1	4.0	4.4	4.2	703	171	"
Sesame (*Sesamum indicum*)	4.4	3.5	4.3	3.6	966	117	"
Red Onion (*Allium cepa*)	4.5	4.0	4.3	4.2	346	130	"
Onnis (*Onnis sp.*)	4.6	4.8	5.0	5.2	520	117	"
Chinese cabbage (*Brassica chinensis*)	4.6	5.7	4.5	6.1	847	132	"
Asparagus (*Asparagus sp*)	4.9	3.6	5.8	4.0	756	150	"
Broccoli(*Brassica campestris var. botrytis*)	5.1	7.3	5.1	6.6	195	270	"
Ornithogolum (*Ornithogolum arabicum*)	5.6	5.1	5.9	4.1	652	319	"
Tuberose (*Tuberose sp.*)	5.9	5.2	5.6	6.1	238	37	"
Chrysanthemum (*Chrysanthemum indicum*)	6.1	5.6	6.0	6.1	246	85	"
Mustard (*Brassica campestris* spp)	6.6	7.1	6.6	7.3	944	133	Susceptible
Statice (*Statice sp.*)	7.2	5.0	7.0	7.2	330	70	"
Spring onion (*Allium cepa*)	7.2	7.5	7.3...	8.1	342	186	"
Rapeseed (*Brassica napus*)	8.0	6.2	7.5...	6.7	438	118	"
Cabbage cv. Gloria (*Brassica campestris*)	8.4	7.1	8.3	7.3	380	86	"
Sunflower (Helianthus annuus)	8.4	8.7	8.4	9.0	547	160	"
Dolichos (Dolicos *lablab*)	8.5	9.0	8.4	9.0	738	120	"
Corriander (*Corriander sp.*)	9.0	9.0	9.0	9.0	370	119	"
Bambara nuts (*Voandzeia subterranea*)	9.0	9.0	9.0	9.0	381	141	"
Tomato (*Lycopersicon esculentum*) (Control)	9.0	9.0	9.0	9.0	1457	373	"
LSD (P<0.05).	0.6	1.0	1.3	1.0	104	30	

RESULTS

Greenhouse experiment

There were significant ($P<0.05$) differences in galling, egg masses and juvenile counts among the plants tested (Table1). Galling and egg mass indices ranged from 6.6–9.0 in tomato, rapeseed, lablab, coriander, spring onion, and cabbage C.V. Gloria, sunflower, statice and bambara nuts. These plants were rated as susceptible. Onnis, leekswiss, chrysanthemum, garlic, velvetbean, Chinese cabbage, asparagus, broccoli, lettuce, sesame and red onion were rated as moderately resistant with galling and egg mass indices ranging from 3 – 6. *Tagetes patula*, desmodium, rhodes grass, alstroemeria, cotton, crotalaria and Napier, were resistant with galling and egg mass indices ranging from 1-3.

No egg masses were observed on roots of desmodium, Rhodes grass and alstroemeria. Few egg masses (<10 per root system) were observed on sweet corn, cotton, capsicum and Napier grass roots. Tomato C.V. Moneymaker had the highest number of egg masses but was not significantly different from cabbage C.V. Gloria, rapeseed, sunflower, lablab, bambara nuts and coriander (Table 1). The highest count of *Meloidogyne* juveniles was recovered from soils grown with tomato whereas the lowest was from soils grown with peanut (Table1).

Field experiment

Results of the microplot experiment were similar to those observed in the greenhouse. Significant differences in galling and egg mass indices were observed among the plants tested (Table 2). Galling indices ranged from 1.2 to 6.8 with Rhodes grass having the lowest (1.2) and tomato the highest (6.8). All the tested plants had galling indices that ranged between 1.2 and 2.4 thus being rated as resistant compared to tomato (control) that was susceptible with a galling index of 6.8. The egg masses followed a trend similar to that of the galling index and ranged from 1.4 to 2.9 among the tested plants while tomato C.V. Moneymaker had the highest of 7.3. There were significant differences in juvenile (J_2) populations between treatments and the control (Table 2). *Meloidogyne* juvenile count was highest (1630) in plots where tomato was grown and lowest (373) in plots grown with *Tagetes* spp. (Table 2).

Effect of growing tomato in rotation with sweetcorn under-sown with antagonistic plants on root-knot nematodes

The effect of growing tomato in rotation with sweet corn undersown/interplanted with antagonistic plants on root-knot nematodes populations differed significantly among the treatments (Table 3). Galling was lowest (1.9) on tomato grown in rotation with sweetcorn under-sown with *Tagetes patula* and highest (7.4) under continuous tomato (Table 3). Galling indices ranged from 1.9 to 3.0 on tomatoes grown in rotation with sweetcorn alone or in combination with plants antagonistic to nematodes. The egg masses on tomato grown in rotation with different rotational treatments followed a trend similar to that observed on galling index (Table 3). Tomato grown in rotation with sweetcorn under-sown with *Tagetes patula* had the lowest (2.9) egg mass index.

There were significant differences in juvenile (J_2) populations among the treatments (Table 3). The lowest juvenile population was recovered from plots planted with sweetcorn under-sown with *Tagetes patula* while the highest was recovered from plots under tomato monoculture. Shoot weights of tomato were significantly different among the treatments (Table 3).

The lowest shoot weight (10.5g) was recorded under tomato monoculture and the highest (21.6) on tomato grown in rotation with *Tagetes patula.*

Table 2: Galling indices, egg mass indices and numbers of *Meloidogyne* juveniles (J_2) on several antagonistic plants in nematode-infested micro-plots in Kenya

Plant (treatment)	Galling index	Egg mass index	J_2 counts/ 200cm^3
Rhodes grass (*Chloris gayana*)	1.2	1.4	831
Cotton (*Gossypium hirsutum*)	1.3	1.2	671
Marigold (*Tagetes patula*)	1.3	1.4	373
Alstroemeria (*Alstroemeria sp.*)	1.5	1.7	502
Desmodium (*Desmodium uncinatum*)	1.6	1.8	399
Sweetcorn (*Zea mays saccharata*)	1.8	2.0	954
Sorghum (*Sorghum bicolor*)	2.4	2.9	829
Tomato (*Lycopersicon esculentum*)	6.8	7.3	1630
LSD ($P<0.05$)	0.60	0.73	746
C.V%	47.2	52.2	48
SE	1.1	1.3	426

There were significant differences in the yield of sweetcorn among different rotational treatments (Table 3). The lowest sweetcorn yield was recorded in plots where sweetcorn was underswon with *Tagetes patula* while the highest was observed in plots undersown with *Crotalaria juncea*. The dry weight of sweetcorn stalks followed a similar trend (Table 3).

Generally nematode populations in plots planted with sweetcorn alone or sweetcorn under-sown with *Tagetes spp.*, Crotalaria, sorghum, asparagus or garlic continued to decrease during season 1 compared to tomato monoculture (Figure 1). However, at the harvest of the tomato crop, nematode population increases were observed in all the plots. The highest nematodes population increase was obtained from plots where tomato was rotated with sweetcorn and under-sown with *Crotalaria juncea* while the lowest was in those plots of tomato rotated with sweetcorn under-sown with *Tagetes patula* (Figure 1). There was a continuous nematode population increase in tomato monoculture while the highest reduction in nematode population was noted in rotations using sweetcorn under-sown with *Tagetes patula*.

Table 3: Galling indices, egg mass indices, yield of sweetcorn cobs, dry weight of stalks, number of *Meloidogyne* juveniles (J_2), and shoot weight of tomato plants grown in rotation with sweet corn under-sown with antagonistic plants in Kenya

Treatment		Galling index	Egg mass index	J_2 count /200 cm^3	Dry weight of stalk (g)	Dry shoot weight of tomato (g)	Yield of sweetcorn (kg)
Season I	Season II						
Sweetcorn + *Tagetes patula*	Tomato	1.9	2.9	240	22.9	21.60	79
Sweetcorn + *Crotalaria juncea*	Tomato	2.4	4.9	444	33.1	19.50	197
Sweetcorn + *sorghum bicolor*	Tomato	2.8	5.5	437	24.4	15.50	110
Sweetcorn + *Asparagus*	Tomato	2.7	5.1	371	28.6	20.0	122
Sweetcorn + Garlic	Tomato	3.0	5.3	300	25.3	18.3	122
Sweetcorn alone	Tomato	2.7	4.5	363	28.5	19.0	160
Tomato	Tomato	7.4	8.2	906	-	10.5	-
SE		0.97	1.27	134	7.8	5.97	55.5
C.V%		29.7	24.4	30	28.6	34.0	42.2
LSD ($P<0.05$).		0.4	0.6	175	11.7	2.63	83.7

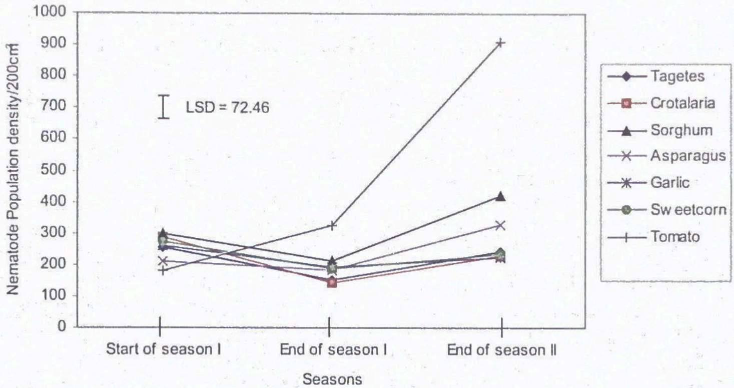

Figure 1: Nematode population changes in plots where sweetcorn, was under-sown with different antagonistic plants and rotated with Tomato in Kenya

DISCUSSION

Marigold *(Tagetes patula* and *T. minuta),* sunnhemp *(Crotalaria juncea),* cotton (*Gossypium hirsutum*), desmodium, Rhodes grass, sorghum, sweetcorn, alstroemeria, capsicum and peanuts suppressed root-knot nematodes under greenhouse and field conditions. These findings are in agreement with previous studies (Swamy *et al.,* 1994, Mc Sorley, 1999; Kinloch and Rich 2001; Nolig, 2009; Chen and Tsay, 2006) who found that these crops surpressed rootknot nematode populations. However, little has been done on most of the above plants in Kenya. The likely explanation for effectiveness of marigold in the tolerance of root-knot nematode is the toxic chemical, α-terthienyl and derivatives of bithienyle that they produce that are toxic to nematodes (Uhlenbroek and Bijloo, 1957,).

Desmodium legume is a high quality forage crop that can be incorporated into cropping systems for soil fertility improvement and soil erosion control, with the added advantage of root-knot nematode suppression. Suppression of *Meloidogyne spp* by sorghum could be attributed to presence of glycosides in its cells that become exposed in its tissues if injured by nematodes leading to the release of the highly toxic hydrogen cyanide (Meyer and Fry, 1978) that kill the nematodes. This cereal can be incorporated in diverse cropping systems particularly as a fallow crop during dry seasons in order to boost food security in these areas, as it is well adapted to a wide range of environmental conditions.

Cotton suppressed root-knot nematode reproduction. Although *Meloidogyne* spp. are a serious pest of cotton, varieties that are highly resistant to the nematodes have been identified elsewhere but not in Kenya (Veech and McClure, 1977; Fortnum *el at.,* 2001). This could be one of the varieties and its ability to reduce nematode densities could be because it has high concentrations of terpernoid aldehydes found in their roots that are toxic to the nematodes. This crop can be used in Kenya to revitalise the textile industry that has collapsed and alleviate poverty in cotton producing areas. Apart from production of nematicidal compounds, antagonistic plants may also reduce nematode populations by acting as trap crops as has been found elsewhere by Bridge and Noling (1996). Nematodes invade roots of such plants but their development and reproduction is inhibited. For instance, Dasaeger and Rao (1999) reported that juveniles of *Meloidogyne* species freely entered roots of resistant plants like sunhemp but failed to multiply. In addition, roots of some plants may not be a food source for certain nematodes, thereby reducing their numbers by starvation (Bridge, 1996).

There was moderate nematode damage on roots of garlic, velvet bean, lettuce, leckswiss, sesame, red onion, onnis, Chinese cabbage, asparagus, broccoli, ornithogolum, tuberose and chrysanthemum. This indicates that these crops support root-knot nematode reproduction to a certain extent and should therefore be introduced into cropping systems with caution and particularly those farmers who constantly interplant these crops with the susceptible ones. Farmers should be encouraged to rotate them with resistant ones to reduce the nematode inoculum level in the soils.

Damage by root-knot nematodes on mustard, statice, spring onion, rapeseed, cabbage C.V. Gloria, sunflower, lablab, coriander and bambara nuts was similar to that observed on tomato. This is proof that these crops are susceptible and should be avoided in cropping systems particularly in soils known to be heavily infested by *Meloidogyne*. These findings are very important since very little work has been done in Kenya concerning the reaction of root knot nematodes on these plants.

Under-sowing sweetcorn with nematode antagonistic plants suppressed galling by root-knot on subsequent tomato nematodes resulting in vigorous growth of tomato crop. These findings agree with previous reports (Sikora, 1992; Korthals *et al.*, 2000). Increase in nematode population density was slowest under tomato plants grown in plots previously under sweetcorn and *Tagetes patula*, indicating that there was continued nematode suppression after removal of marigold. Tomato plants grown in rotation with sweetcorn under-sown with *Tagetes patula* had higher shoot weight than tomato grown after tomato.

Undersowing sweetcorn with *Crotalaria juncea* resulted in reduced nematode populations and minimal damage on the succeeding tomato crop. It also resulted into increase in yield of sweetcorn implying that nitrogen fixation was taking place that might have lead to improved plant growth. This study clearly demonstrates that there is an increase in the nitrogen pool if the above system is used. This is in consistence with Tu *et al.* (2006) and Clark *et al.* (1999) who observed that the yield of companion or proceeding crops increases when you incorporate nitrogen fixing plants. Therefore farmers should be encouraged to use crotalaria as a rotational crop as it both reduces root knot nematode population density and increase the yield of a companion or succeeding crop. Crotalaria should be promoted to be used as vegetable by most individuals and this will earn farmers some income as well as control root knot nematodes in farms.

CONCLUSION

In the greenhouse, micro-plot and on-station field, *Tagetes patula*, *Gossypium hirsutum*, *Desmodium uncinatum*, *Chloris gayana*, *Zea mays*, *Alstroemeria* sp., *Capsicum annuum*, *Crotalaria juncea*, *Arachis hypogaea*, *Sorghum bicolor*.

Tithonia diversifolia and Pennisetum purpureum were rated as poor hosts with galling and egg mass indices ranging from 0 to 3. High galling and egg mass indices ranging from 7-9 were recorded on *Lablab purpureus, Coriandum, sativum, Statice* sp., *Brassica oleracea* var. *gloria, Helianthus annuus, Vigna subterranea* while *Mucuna pruriens, Lactuca sativa, Allium ampeloprasum, Sesamum indicum, Allium cepa, Onnis* sp., *Brassica Oleracea* Var. *chinensis, Asparagus* sp., *Brassica oleracea* var. *botrytis, Ornithogolum arabicu, Tuberose* sp. *and Chrysanthemum indicum,* were rated moderately resistant with galling and egg mass indices ranging from 3 to 6. Damage by nematodes was significantly reduced in tomato planted after sweet corn or in sweet corn with *Tagetes patula, Crotalaria juncea, Sorghum bicolor* and *Asparagus sp.*. On-farm studies should be carried out to validate these findings and establish the acceptability of selected crops as rotational or inter-plants for root-knot nematode management. Also studies to explore the mechanisms of resistance involved in these plants such as, physical barriers like xylem bundle sheaths, production of toxic substances and post-infection substances that these plants produce when attacked by nematodes, should be undertaken. Use of antagonistic plants should be evaluated in combination with other control strategies like organic amendments to establish their effect on biodiversity that is necessary for sustainable management of nematodes in agro ecosystems.

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