Control of Chickpea Root knot Nematodes (*Meloidogyne* spp.) in Nakuru County, Kenya using Sudan Grass (*Sorghum sudanese*)

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Abstract

Chickpea is a source of food and nutrients to farmers. Chickpea growth and yield production is affected by root knot nematodes. Loss of yields from chickpeas are estimated billions of money annually. Sudan grass (*Sorghum sudanese*) was used to study the control of root knot disease in chickpea. The study was done in a glasshouse. Completely random design was used. Treatments had eight replicates and uninoculated control was treated with distilled water. The aim of the study was to control root knot nematodes using Sudan grass. There was significant reduction of root galling, gall index and number of juveniles in the soil at P=0.05 in Sudan grass treatment. Inoculated control recorded highest gall ratings, gall index and number of juveniles. There was a relationship between gall index and root weights. Roots with highest and lowest gall index were associated with high and low root fresh and dry weights respectively. The results of this study confirm the nematicidal effect of poultry manure and Sudan grass.

Key words: *Meloidogyne* spp., Sudan grass, *Sorghum sudanese*

Introduction

Chickpea is a rich source of diet for resource poor people (Mulwa *et al*., 2010). Crop and yield loss from chickpea as a result of root knot nematodes (Abad *et al*., 2008; Onkendi *et al*., 2014).Sudan grass hybrids are important for adding organic matter to poor soils (Clark, 2007). These tall, fastgrowing, heat-loving summer annual grasses can suppress some nematode species, smother weeds and penetrate compacted subsoil if mowed once. Sudan grass does best in warm climate with rich loamy soils (USDA, 1993). Forage-type sorghum plants are larger, leafier and mature later than grain sorghum plants. Compared with Sudan grass hybrids, they are shorter, less drought tolerant, and don't re-grow as well. Still, forage sorghum as well as

most forms of Sudan grass can be used in the same cover-cropping roles as Sudan grass hybrids (Clark, 2007).

All sorghum- and Sudan grass-related species produce compounds that inhibit certain plants and nematodes. They are not frost tolerant, and should be planted after the soil warms in spring or in summer at least six weeks before first frost (Clark, 2007). Sudan grass cannot be considered as a green manure unless there is ample nitrogen in the soil or a long period can elapse before it is necessary to use the land (USDA, 1993). Sudan grass hybrids followed by a legume cover crop are a top choice for renovating over farmed or compacted fields. The hybrids are crosses between forage-type sorghums and Sudan grass (Ingels, 1998). They have less leaf area, more secondary roots and a waxier leaf surface, traits that help them withstand drought (Ogumo, 2014), like corn, they require good fertility and usually supplemental nitrogen for best growth. The objective of this study was to determine the effect of Sudan grass on chickpea root knot nematode disease management.

Materials and Methods

Effect of Sudan grass (*S. sudanese*) on root knot nematodes was done as described by Crow *et al.* (2001) and Rehiayani and Hafez (1998). Chickpea seed were sowed in each pot containing autoclaved soil and after germination, six Sudan grass seeds were sowed around chickpea seedling. Each pot was inoculated with a 7ml of juveniles (J2 population) and watering done regularly. Pots were arranged in completely randomized design with eight replicates and control. Evaluation was done on root fresh, dry weight, number of juveniles per 100g of soil and root galls after two months. Number and root knot index was assessed on a scale of 0-5 (Sasser *et al.*, 1984). 0=no galling, 1=trace infections (few galls), 2=galled roots, 3=2550% galling, 4=50-75% galling, and 5=75% of galled roots.

Results

Mean gall index ranged between 0 and 5, treated control with the highest gall index and untreated control with the least. There was a significance difference (P=0.05) of gall index in all the treatments. The mean fresh and dry root weight ranged from0.5263 to 1.7888 and 0.0525 to 0.175 respectively. There was no significance difference between treated control and Sudan grass treatments in both root fresh and dry weights. There was significance difference (P=0.05) between treated control, Sudan grass treatments and untreated control in both fresh and dry root weight (Table 1).

Table 1: Root gall indices, fresh and dry weights of the roots eight weeks after inoculation with *Meloidogyne* spp. juveniles

Treatment [z]	Mean gall index	Mean root fresh weight(g)	Mean root dry weight (g)
INC	5**a**	1.7888**a**	0.175**a**
Sudan grass	2.625**b**	0.8663**a**	0.165**a**
UNC	0**c**	0.5263**b**	0.0525**b**

a*

In the column, means followed by the same letter are not significant different from each other at P=0.05 according to Least Significant Difference (LSD) test.

[z] there were eight replicates in each treatment

[*] INC- Inoculated control, UNC- Uninoculated control

Mean gall index ranged between 0 and 5, treated control with the highest gall index and untreated control with the least. There was significance difference (P=0.05) in all three treatments. The average number of *Meloidogyne* spp. in 100g of soil ranged between zero to 83.5, with treated control with highest and untreated control with lowest. There was a significance difference (P=0.05) in all three treatments. There was a relationship between gall indices and number of juveniles in the soil, highest gall index was associated with high number of juveniles in soil while least gall index related to least number of juveniles in soil (Table 2 and Figure 1).

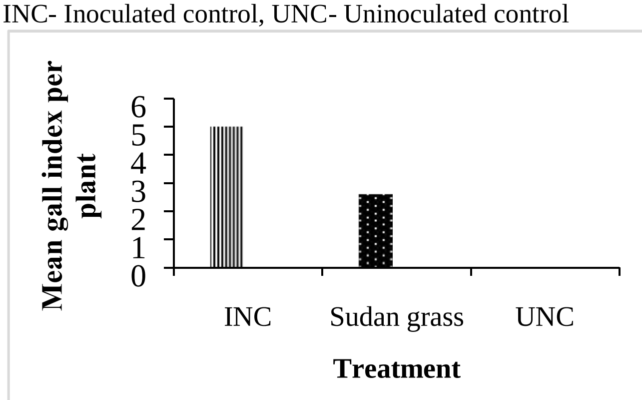
Table 2: Relationship between root gall indices and juveniles in 100g soil eight weeks after inoculation with *Meloidogyne* spp. Juveniles

Treatment [z]	Mean gall index	Average number of juveniles per 100g soil
INC	5**a**	83.5**a**
Sudan grass	2.625**b**	32.875**b**
UNC	0**c**	0**c**

[a*] In the column, means followed by the same letter are not significant different from each other at P=0.05 according to Least Significant Difference (LSD) test.

[z] there were eight replicates in each treatment

[*] INC- Inoculated control, UNC- Uninoculated control



INC - inoculated control,
UNC- uninoculated control

Figure 1: Mean root gall index per plant for each treatment

Discussions

The results demonstrated that there was significant reduction of gall indices and rootknot juveniles population in the soil. When compared to the inoculated control, nematodes heavily infested the roots of chickpeas resulting into many root galls hence high gall index. The number of juveniles in the soil was dependent on number of eggs in root galls, as eggs in the galls hatched so do juveniles drop into the soil. Sudan grass roots revealed that they have nematicidal effect and therefore reduce the population of juveniles by suppressing reproduction or death, therefore this explains why Sudan grass roots are poor hosts of soil nematodes.

Suppression of the root knot nematodes by Sudan grass was primarily attributed to chemical mechanisms involved in the suppression of the rootknot nematode, this is because exposure of juveniles to Sudan grass inhibited root gall index and number of juveniles in the soil (Viaene and Abawi, 1998). The hypothesis that cyanide was the chemical compound responsible for suppression was initially based upon what is known biochemically about Sudan grass. Widmer and Abawi (2002) reported suppression of *M. hapla* by Sudan grass. Cyanide is known to be toxic to different organisms and is present within Sudan grass root tissue as a cyanogenic glucoside. Cyanide appears to have adverse effects to both egg development and hatching (Widmer and Abawi, 2000).

Epidermal cells of roots of Sudan grass contain cyanogenic glucoside dhurrin which degrade into hydrogen cyanide. Hydrogen cyanide (HCN) is a known for its toxicity to nematodes (De Nicola *et al*., 2012). Cyanogenic glucoside dhurrin is degraded through a cyanohydrin intermediate after enzymatic hydrolysis catalyzed by endogenous beta-D-glucosideglucohydrolase and alpha-hydroxynitrilase via a process known as cyanogenesis (Conn, 1991). Once root tissues are damaged, dhurrin is hydrolysed by endogenous dhurrinase found in the intermediate p-hydroxy-(S)-mandelonitrile which is unstable compound and which releases HCN. HCN is toxic to nematodes (Vetter, 2000; Widmer and Abawi 2000, 2002). Similar observations were made by Widmer and Abawi (2000), *M. incognita* juveniles were reduced as a result of dhurrin degradation, dhurrin hydrolysis prevented hatching of *M. incognita* eggs. When *M. hapla* eggs and juveniles were exposed to 0.1ppm of cyanide, root penetration was reduced by 4% and the same concentration of cyanide reduced *M. hapla* infection by 48% (Viaene and Abawi, 1998).

Sudan grass has high dhurrin content and thus suppressed the nematodes. For efficient suppression Widmer and Abawi (2002) suggested that Sudan grass

should be used as green manure at 1-2 months, there is high HCN content in young Sudan grass plants but it decreases with age of the plant. Sudan grass extracts also reduced *M. hapla* populations andthis was associated with the presence of cyanide in the extracts, dhurrin was involved in the mode of action of Sudan grass on *M. hapla* (Widmer and Abawi, 2000). This study showed that Sudan grass suppresses and has nematicidal activity thus can be used as an effective nematicide against root knot nematodes. Further study should be done on Sudan grass green manure to control other *Meloidogyne* spp. attacking chickpeas. It is recommended that further research be done to other legumes susceptible to root knot disease.

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