Asian Journal of Agriculture and Food Science (ISSN: 2321 – 1571)
Volume 02 – Issue 03, June 2014

Effect of Tillage Practices on Root Knot Nematodes (*Meloidogyne* spp.) Associated with Maize (*Zea Mays*)

F. Kankam*[1] and J. Adomako[2]

[*1]University for Development Studies, Faculty of Agriculture
Department of Agronomy, P.O. Box TL 1882, Tamale, Ghana
E-mail: fredkam08 {at} yahoo.com

[2]CSIR-Crops Research Institute, P.O.BOX 3785, Kumasi, Ghana

---

ABSTRACT— ***An investigation was carried out at Nyankapala in the Northern Region which lies within the interior Guinea Savanna Zone of Ghana to assess the effect of disc ploughing, manual ridging and zero tillage systems on root knot nematodes and yield of maize. The trial was conducted in the 2012 major season. The Randomized Complete Block design with four replications was employed in the study. The tillage practices included ridging, disc ploughed and zero tillage. Results from the study indicated that disc ploughed plots were able to reduce root knot nematodes population under maize by 96% compared to zero tillage. Similarly, root galls observed were significantly (p<0.05) lower when the field was ploughed compared to zero tillage. However, maize planted under a zero tillage system recorded a higher grain yield compared to manual ridging and disc ploughing. Whilst the yield under zero tillage system was 48% higher than manual ridging, it was only 35% higher than disc ploughing.***

Keywords— Tillage practices, root knot nematodes, infection, maize

---

1. INTRODUCTION

Maize (*Zea mays*) is an important cereal food and feed in most parts of the world. Global production exceeds 600 metric tons (McDonald and Nicole, 2005), with about 60% produced in the developed countries. In Ghana it is the main source of carbohydrate for both rural and urban families. However maize production supports the buildup of nematodes and according to McDonald and Nicole (2005), more than 60 nematode species are associated with the crop with the most economic group being the root knot nematodes (*Meloidogyne* spp.), root lesion nematodes (*Pratylenchus* spp.) and the root cyst nematodes (*Heterodera* spp.). Maize germplasm screened for different species of root knot nematodes showed a variable response (Ngobeni *et al*., 2011).

As invertebrate organisms, the nematodes movement and the damage that they produce are determined greatly by soil physical and morphological properties (Neher *et al.*, 1999). Tillage is considered the most effective farm practices for the purpose of developing a desired soil structure. It improves the physical conditions of soil and favours the rooting characteristics of plants which lead to an enhanced nutrient uptake and better yield of crops (Arif *et al*., 2007). Tillage and non tillage of the field before cropping can greatly impact on nematode density, survival and infectivity. The impact of tillage practices, in contrast to a no tillage/conservation system, on nematode population has been inconsistent on various crops perhaps due to the larger effect of weeds, soil structure, nutrition and other factors on crop growth (Barker and Koenning, 1998). The effect of different tillage system on nematodes associated with maize needs to be investigated. The purpose of this study therefore was to determine the effect of three tillage system on root knot nematodes density on maize in Nyankpala in the Northern Region of Ghana.

2. MATERIALS AND METHODS

2.1 Study area

The study was conducted in 2012 at Nyankpala, (9°25’41”N, 0°58’42”W) in the Tolon Kumbugu district of the Northern Region which lies within the interior Guinea Savanna Zone of Ghana. The field was initially cropped with cowpea which is a good host to root knot nematodes. The area experiences a unimodal rainfall with annual rainfall ranging between 1000–1200 mm and a temperature range of 21°C-32°C (SARI, 2001). Effective rainfall is mostly between the months of June and September each year followed by the dry season. The soil is moderately brown and drained sandy loam. The area is characterized by natural vegetation dominated with shrubs.

2.2 Experimental set up

A field study involving three different tillage practices (ridging, disc ploughed and zero tillage) were evaluated for their potential in managing a mixed population of root knot nematodes under maize. The seeds were sown after the field had been demarcated and the treatments applied. Ploughing was done with a 20 cm disc plough mounted on a disc whilst ridging was done manually with a hoe. Planting was done at a distance of 80 cm x 40 cm with two seeds per hole on plots measuring 4 m x 4 m. The seeds were not treated with any chemical and weeds were managed manually. The study was laid out in a randomized complete block design with four replications.

2.3 Sampling and extraction of nematodes

Soil samples were collected before and after the study with a 5 cm soil auger to a depth of 20 cm to assess nematodes population. Ten core soil samples were taken for each treatment and thoroughly mixed to form a composite sample. The nematodes were extracted from 100 cm^3 of soil samples using soil sieving (850, 250, 75 and 38 µm) and a 48 h decanting period through a Baermann funnel (Christie and Perry, 1951). Counting of root knot nematodes was carried out with stereoscopic microscope. Root knot nematodes were identified based on Siddiqui (2000) identification key.

2.4 Data collection and analysis

Twelve weeks after planting, the test plants were harvested and population of root knot nematode J_2/100 cm^3 soil, J_2/5 g root and yield were determined. Roots were assessed for gall index using a hand lens and scored on a scale of 0-10 as described by Adegbite (2011). The population of root knot nematode was transformed using $\log_{10}(x+1)$ to improve homogeneity of variance. Data collected were analyzed with analysis of variance, using the statistics package Genstat version 12.1. Significant mean separation was done using the Duncan Multiple Range Test (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1 Effect of tillage practices on vegetative growth of maize

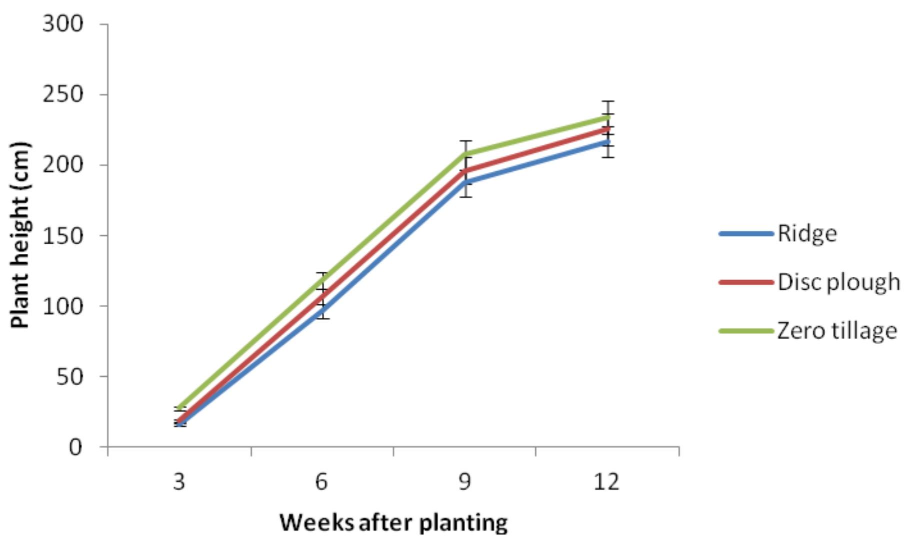

Figure 1: Effect of tillage practices on plant height of maize. Bars represent Standard Error of Means (SEM)

Plant height is an important determinant in the growth performance of a crop. Plant height was significantly influenced by tillage practices at some growth stages. At 3 weeks after planting (WAP) plant height was not significantly different between treatments. However, at 6, 9, 12 WAP, plant height was significantly different ($p<0.05$) between treatments, with crops planted on zero tillage plots producing the tallest plants followed by disc plough and ridge (Figure 1). The results of this study is contrary to the finding of Kombiok *et al*. (2005) who reported a taller cowpea plants under disc ploughed compared to no tillage. It however corroborates the report of Ojeniyi and Adekayode (1999) that taller cowpea plants were recorded in no tillage plots compared with that of disc plough. The performance of the crop in zero tillage on plant growth compared to all the other treatments could be attributed to increases in readily available plant nutrients. Liu *et al*. (2006) reported of improved soil enzyme activities involved in nutrient cycling in the surface soil layer under no tillage practice compared to the conventional tillage system.

3.2 Nematode population and root galls

The results showed that there was a significant difference ($p<0.05$) in the number of root knot nematodes J_2 recovered from the soil under the different treatments. The highest number of juveniles (512) was extracted from the zero tillage system compared to the disc ploughed (22) and manual ridged (86) systems (Table 1). Roots of the test crop on zero tillage recorded the highest galling score (2.50) compared to those planted on ridges plot (Table 1). The reduction in root knot nematodes population in disc ploughed plots could be attributed to the fact that the turning up of the soil during ploughing exposed the nematodes to adverse environmental conditions which subsequently reduced their ability to reproduce. Contrary to this, zero tillage, according to Pankaj *et al*. (2006) reduces disturbance of the soil, increases organic matter content, improves soil structure and buffers soil temperatures. Zero tillage therefore provides a favourable condition for the development and reproduction of the pest. According to House and Parmelee (1985) soil cultivation affects soil fauna in both quality and quantity. Also, the reduced number of root knot nematode juveniles under the disc ploughed plot could be attributed to the reduction in alternative host which remained buried in the plough layer (Pankaj *et al*., 2006). The relative good performance of disc plough over ridging and zero tillage agrees with Bilgrami and Dubey (2001) that ploughing of the plots helps in reducing the incidence of nematodes. Nematodes require a well porous soil for their movement and infectivity. The presence of galling therefore defines their feeding activities. The high galling indices under ridging suggests a favourable medium for nematode movement because ridging unlike ploughing breaks down soil lumps for easy drainage and porosity.

Table 1: Effect of tillage practices on nematode population and galling index

Treatment	Nematode population/200 cm^3 soil	Galling index scale (0-5)
Ridge	$86(2.0)^b$	1.50^{ac}
Disc plough	$22(1.4)^c$	0.80^b
Zero tillage	$512\ (2.7)^a$	2.50^a
LSD (0.05)	95 (0.2)	1.10
CV %	11.8 (1.4)	15.30

Notes: Figures in parenthesis are transformed means of four replicates. Data were transformed by $\log_{10}(x+1)$ prior to analysis of variance (ANOVA). Columns with different letters are statistically different according to Duncan test ($p<0.05$).

3.3 Effect of tillage regimes on grain yield

Table 2 shows the effect of tillage system on J_2 recovered from 5g root sample and grain yield of maize. The least number of J_2 (31.20) was recovered from the roots of the test crop planted on disc ploughed plots compared to those planted on ridges (35.23). There was no significant difference in the J_2 recovered from all the treatments. There was however a significant difference in yield from all the plots (Table 2). Yield obtained from the ridged plots was 48% less than that of the zero tillage plots. Although more J_2 were recovered from zero tillage plots, it recorded the highest grain yield. This indicates that the mere presence of nematodes do not always lead to a reduction in yield quantity. Yield reduction may depend on factors such as population levels and virulence of the species. Again crops with tolerable genes may out yield a susceptible variety even under a nematode infested soil. However, tolerable crops are detrimental to subsequent crops as it could leave a high a population density in the soil and affect yield of susceptible crops. Another factor is soil nutrient levels, which could also be improved by decomposition of organic matter. Parraga (1995) indicated that organic matter has an important role to play in building and maintaining soil fertility and structure, helping the retention of soil moisture and nutrients. This could allow maize to extend their roots to deeper soil layers, resulting in 3529.71 kg grain yield at harvest.

Table 2: Effect of tillage systems on J_2/5g roots and grain yield (kg) of maize

Treatment	J_2/5g roots	Grain yield (kg/ha)
Ridge	35.23^a	1820.00^a
Disc plough	31.20^a	2284.75^b
Zero tillage	33.81^a	3529.71^c
LSD (0.05)	5.49	463.90
CV %	12.70	13.00

Columns with different letters are statistically different according to Duncan test ($p<0.05$)

CONCLUSION

The results of this study showed that disc ploughing the field before planting maize reduced root knot nematodes population. However the highest yield was realized under a zero tillage practice. The tillage system practiced can therefore be said to have an influence on the activities of root knot nematodes associated with maize.

REFERENCES

1. Adegbite, A.A. Reaction of some maize (*Zea mays*) varieties to infestation with root knot nematode, *Meloidogyne incognita* under field conditions. African Journal of Plant Science, 5(3) pp.162-167, 2001.
2. Arif, M., Munsif, F., Waqas, M., Khali, I.M. and Ali, K. Effect of tillage on weeds and economics of fodder maize production. Pakistan Journal of Weed Science Research, 23(3-4): pp.167-175, 2007.
3. Barker, K.R. and Koenning, S.R. Developing sustainable systems for nematode management. Annual Review of Phytopathology, 36: pp.165-205, 1998.
4. Bilgrami, K.S. and Dubey, H.C. A Textbook of Modern Plant Pathology. Vikas Publishing Ltd, New Delhi, pp.199-200, 2001.
5. Christie, J., and Perry, V. Removing nematodes from soil. Proceedings of Helminthological Society of Washington, 18: pp.106-108, 1951.
6. Gomez, K.A and Gomez, A.A. Statistical Procedures for Agricultural Research. John Wiley and Sons, New York, pp.680, 1984.
7. House, G.H. and Parmelee, R.W. Comparison of arthropod and earthworm from conventional and no till agro ecosystems. Soil and Tillage Research, 5: pp.351-360, 1985.
8. Kombiok, J.M., Safo, E.Y. and Quansah, C. Yield and nitrogen fixation of cowpea as affected by tillage and cropping systems in the northern savanna zone of Ghana. West African Journal of Applied Ecolology, 7: pp.95-108, 2005.
9. Liu, X., Zhang, W., Liang, W., Jiang, Y and Wen, D. Effects of tillage practices on soil enzyme activities and nematode communities during the growth of maize (Zea mays). World Journal of Agricultural Sciences, 2(3): pp.259-266, 2006.
10. McDonald, A.H. and Nicol, J.M. Nematode parasites of cereals. In: Luc, M, Sikora, R. A. and Bridge, J. (eds.), *Plant parasitic nematodes in subtropical and tropical Agriculture*, 2nd ed. CAB International, UK, pp.131-192, 2005.
11. Neher, D.A., Weicht, T.R., Savin, M., Görres, J.H. and Amador, J.A. Grazing in a porous environment. 2. Nematode community structure. Plant and Soil, 212: pp.85-99, 1999.
12. Ngobeni, G.L., Fourie, H., McDonald, A.H. and Mashela, P.W. Host-suitability of selected South African maize genotypes to the root knot nematode species *Meloidogyne incognita* race 2 and *Meloidogyne javanica*. South African Journal of Plant and Soil, 28: pp.49-54, 2011.
13. Pankaj, Sharma, H.K., Gaur, H.S. and Singh, A.K. Effect of zero tillage on the nematode fauna in a rice-wheat cropping system. Nematologia Mediterranea, 34: pp.175-178, 2006.
14. Parraga, M.S. Effect of organic matter on quantity and quality of roots in carrot (*Daucus carota* L.) harvested at three dates. Semira, 16: pp.80-85, 1995.
15. Ojeniyi, S.O. and Adekayode, F.O. Soil conditions on cowpea and maize yield produced by tillage methods in the rainforest zone of Nigeria. Soil and Tillage Research, 51(1): pp.161-164, 1999.
16. Savana Agricultural Research Institute (SARI). Agro Meteorological Unit, Nyankpala, 2001.
17. Siddiqui, M.R. Tylenchida: Parasites of plants and insects, 2^{nd} ed. CABI Publishing, Wallinford, UK, pp. 848, 2000.