Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.19, 2015

Pathogenicity of Meloidogyne Incognita (CHITWOOD) on Some Pepper (Capsicum spp.) Cultivars

Agaba[1] T.A., B. Fawole[2] B. Claudius-Cole[2]
1.Department of Agricultural Education, College of Education
Oju, P.M.B 2035, Otukpo, Benue State
2.Department of Crop Protection and Environmental Biology, Faculty of Agriculture and Forestry, University of Ibadan

Abstract
Pepper, a vegetable grown for human consumption. Its production was being constrained by the root-knot nematode, *Meloidogyne incognita* an important pest of pepper. This study was done to provide information on the pathogenicity of *M. incognita* on pepper.Four pepper cultivars rated susceptible were used. In pot experiment, pepper seedlings were transplanted into pots and inoculated at one month with 0, 1,500, 2,500, 3,500 or 5,000 *M. incognita* eggs extracted with sodium hypochlorite. The experiment was factorial in Completely Randomized Design. In field experiment, Split-plot Design consisted of main plots (nematicide-treated and nematicide-untreated) with pepper cultivars as the subplots were used. Plant heights measured, number of leaves counted. At termination, fresh shoot weight, dry shoot weight, fresh root weight were measured. Final Nematode Population (FNP), Reproductive Factor (RF) and Galling Index (GI) were estimated. There were direct relationships between the inoculation levels of *M. incognita* on pepper, Galling Index, Final nematode Population but inverse relationship with Reproductive Factor.*Meloidogyne incognita* infection of pepper resulted in gall formation, reduced height by 58.7±12.3%, number of leaves 10±3.1%, fresh shoot weight 39.4±10.5%, dry shoot weight 34.0±8.6%, fresh root weight35.6±9.8% and yield 67.9±18.6%.
Meloidogyne incognita was pathogenic on the pepper cultivars.
Keywords: cultivars, final nematode population, galling index, inoculation, reproductive factor, root-knot nematode. .

Introduction

Pepper (*Capsicum* spp.) is one fruit vegetable grown worldwide (Fayemi, 1999) for human consumption, supply of raw materials, medicinal purposes, pest control measures (Fayemi, 1999; Celocia *et al*., 2006). The root-knot nematode, *Meloidogyne incognita* is a major nematode pest of pepper (Sikora and Fernandez, 2005) and have been reported to be highly pathogenic on pepper by the formation of galls on the roots, reduced top growth and reductions in yield (Thomas *et al*., 1995; Mekete *et al*., 2003; Udo *et al*., 2005). Reductions in the yield of pepper have been reported, ranging from 50% reduction in yield (Celocia *et al*. 2006), to 74-78% reduction in fruit numbers (Sogut and Elekcioglu, 2007). This study was carried out to determine the pathogenic reactions of four pepper cultivars susceptible to *M. incognita*.

Materials and methods

The pepper cultivars G.H.A, Prof-fintashi and Ex-Sam-St were collected from the Virology Laboratory, Department of Crop Protection, Ahmadu Bello University, Zaria while California Wonder was purchased from an Agro Store at Mokola, Ibadan. These cultivars were rated susceptible to *M. incognita* in earlier screening experiments using Galling index (GI) and Reproductive Factor (RF) as parameters (Sasser *et al*., 1984). *Meloidogyne incognita* was maintained on celosia plants and the inoculum extracted from the galled celosia roots with sodium hypochlorite method (Hussey and Barker, 1973). Pot and field experiments were carried out and nurseries were established to supply the seedlings for both experiments.

Pot experiment.

The experiment was set up on the roof-top garden of the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, 2009 to 2010. Five-litre polythene bags were filled with heat-sterilized soil and the pepper seedlings were transplanted at one month old, one seedling each in a polythene bag. The pepper seedlings were inoculated with 0, 1,500, 2,500, 3,500 and 5,000 *M. incognita* eggs one week after transplanting. The nematode suspension was poured into 2-4 holes around the bases of the plants through syringe. The treatments were applied in Completely Randomized Design, replicated four times. The plant heights were measured at inoculation with the metre rule and recorded. Subsequently, the plant heights were measured at weekly intervals until harvest. The number of leaves were counted and recorded at inoculation and at weekly intervals. The plants were watered and weeds handpulled when necessary. At eight weeks after inoculation, the pepper plants were uprooted, the fresh roots rinsed in a gentle stream of water and gallings on the roots were rated on 0-5 scale (Taylor and Sasser, 1978). The fresh shoot weights, oven- dry shoot weights and fresh root weights were determined with PG Mettler Balance. The soil population of the nematode (J2) was estimated with the Pie-pan method (Whitehead and Hemming, 1965) and root population (number of eggs) was determined with the sodium hypochlorite method (Hussey and Barker, 1973). The final nematode populations were determined (soil population + root population) and Reproductive Factor (RF) was estimated where RF = final nematode population (Pf)/initial nematode population (Pi). All the data were log transformed prior to Analysis of Variance with SAS 2002 software and the means separated with Fisher LSD at five percent level (DiVito *et al*., 2004) when necessary.

Field experiment.

The field experiment was carried out in the Crop Garden of the Department of Crop Protection and Environmental Biology, University of Ibadan and the soil was identified as loamy sand. The plot size was 3m x 5m. Split-plot Design was used and comprised main plots (nematicide-(carbofuran) treated plots and untreated plots) with pepper cultivars as subplots. The pepper plants were transplanted at one month and were inoculated one week later with 5,000 *M. incognita* eggs poured into 2-4 holes around the bases with a syringe. Plant heights were measured with the metre rule and number of leaves counted at inoculation and subsequently at weeky intervals. The plants were watered and weeds handpulled when necessary. The plants were maintained for ten weeks, then uprooted and roots rated for galls on 0-5 scale (Taylor and Sasser, 1978). The number of fruits, fresh fruit weights, fresh shoot weights, oven-dry shoot weights, fresh root weights, final nematode population and Reproductive Factor were determined. All data were log transformed prior to Analysis of Variance with SAS 2002 software (DiVito *et al*., 2004) and the means separated with t-test at five percent level (Biro and Toth, 2009).

Results.

In the pot experiment, the four pepper cultivars varied in their reactions to the increasing levels of *M. incognita* eggs. There were no significant ($P \leq 0.05$) differences in the plant heights and the number of leaves among the inoculation levels. An increase from zero to 1500 inoculation levels resulted in mild increases in heights before subsequent reductions at higher inoculation levels (Tables 1 and 2). In the field experiment, there were significant ($P \leq 0.05$) differences in heights of the pepper plants between treated plots and untreated plots. Reductions in height was 58.2% in untreated plots (Table 4) while with the number of leaves there were no significant ($P \leq 0.05$) differences between treated and untreated plots except at harvest with 20.0% reduction (Table 5). In the pot experiments, there were no significant differences in fresh shoot and dry shoot weights among the inoculation levels. An increase in inoculation levels led to decreased fresh shoot and dry shoot weights though differences were not significant. In the field experiments, there were significant ($P \leq 0.05$) reductions in fresh shoot weights (30.9%), dry shoot weights (31.1%) and fresh root weights (41.1%) between nematode-treated plots and nematode-infested plots (Table 6).

In the pot experiment, there was no significant differences in the yield among the inoculation levels, while in the field experiment there was significant ($P \leq 0.05$) difference in the yield between nematode-infested plots and nematicide-treated plots. A reduction in yield of 69.1% occurred in nematode-infested plots as compared to the yield in the nematode-treated plots (Table 6). In both pot and field experiments, the inoculation of the pepper plants with *M. incognita* resulted in the formation of galls on the root system of the plants. In the pot experiment, an increase in the inoculation levels resulted in significant ($P \leq 0.05$) increases in the GI (Table 3). In the field experiment there was a significant ($P \leq 0.05$) difference in GI between pepper plants in nematode-infested plots and carbofuran-treated plots (Table 6). In the pot experiment an increase in the inoculation levels resulted in significant ($P \leq 0.05$) decrease in Reproductive Factor (RF) (Table 3). In the field, there was a significant ($P \leq 0.05$) difference in the RF between nematode-infested and nematicide-treated plots, with a higher RF in the nematode-infested plots (Table 6). In the pot experiment, an increase in the inoculation levels resulted into significant increases in the final population of the nematode on pepper (Table 3). In the field, there was a significant ($P \leq 0.05$) difference in the final nematode population of *M. incognita* on pepper between nematode-infested and nematicide-treated plots, with a higher final nematode population in the nematode-infested plots as compared to nematicide-treated plots (Table 6).

Discussion.

Meloidogyne incognita caused reductions in shoot height, fresh shoot and root weights, dry shoot weights and number of leaves per plant. These findings were similar to findings by Thomas *et al*. (1995), Hafez and Sundararaj (2000), Castillo *et al.* (2001). The reduction in plant/shoot height in this study was similar to the works of other researchers on the reduction of plant growth caused by *Meloidogyne* spp. Thomas *et al*. (1995) reported that inoculation of chile peppers with *M. incognita* at 0, 50, 100, 200 or 500 eggs per 500 g of soil resulted in reduction in shoot growth, number of leaves and dry shoot weights of the peppers. The growth of tomato and pepper was impaired by *M. incognita* and *M. javanica*, at levels of 0, 1, 2, 4, 8, 16 juveniles per cubic cm of soil significantly reduced the fresh weights of both crops (Mekete *et al*., 2003). El-Sherif *et al*. (2007)

reported that at two levels (1,000 and 2,000), *M. incognita* eggs reduced the plant growth of pepper as compared to the uninoculated check plants, and vegetative growth in uninoculated plants was higher than the inoculated ones. Olabiyi (2008) reported that tomato plant height and number of leaves per plant were reduced as a result of inoculation with 5,000, 10,000, 15,000, 20,000 and 25,000 *M. incognita* eggs. The higher the inoculum level, the lower the plant height and number of leaves. The highest nematode population level had the most deleterious effect on fluted pumpkin plant growth when inoculated with 0, 5,000 or 10,000 *M. incognita* eggs (Izuogu *et al*., 2010).

The reduced top growth could be due to root destruction by root-knot nematode and utilization of nutrients and related resources by the galled roots to the detriments of the tops. *Meloidogyne* infection results in nutrient or metabolic sink as the manufactured food is re-directed to the roots to meet the parasitic needs of the nematodes (Abbas *et al*., 2009) leading to disease of the host. A stimulation in plant height occurred at inoculum level of 1,500 *M. incognita* eggs before decline at higher levels. This agrees with Thomas *et al*. (1995) who reported that mild stimulation in growth parameters have been recorded for *M. hapla* on vegetables and *M. javanica* on pepper. This finding was similar to those of Khan *et al*. (1996) and Agwu and Ezigbo (2005) who stated that low nematode level stimulate plant growth as a result of some pathological changes manifested in shoot weight, shoot height and root weights as the formation of galls results in the formation of lateral roots which enhances uptake of water and nutrients by the inoculated plants until more damage of the root cells by the entry of the second-stage juveniles. Nematode feeding results in the increase of root weight because of the galls which have negative effect on shoot weight and causes reduction in foliage at increased inoculum (Khan, 2009).

The severity of galling in all the cultivars increased with increase in initial nematode population in this study, was similar to the findings of Mekete *et al*. (2003) reported that root galling severity in tomato and pepper increased with increase in inoculum level of *M. javanica*. The higher the nematode level, the more pathogenic *M. incognita* was on tumeric plants as the roots had more galls at higher inoculum than low density (Udo and Ugwuoke, 2010) An increase in initial population density resulted in decrease of Reproductive Factor (RF) in all the pepper cultivars used in this study. This was similar to findings of Castillo *et al*. (2001) and DiVito *et al*. (2004) who reported that reduction of nematode reproductive rate with increasing initial nematode inoculum density have been recorded to be associated with infections of several crops by *Meloidogyne* spp. The Reproductive Factor (RF) of *Meloidogyne* spp., was negatively correlated with initial inoculum density (Olabiyi, 2008). This reduction could be a consequence of nematode competition for nutrients or root tissue availability (feeding sites) and of which a smaller proportion of the inoculum would develop successfully (Castillo *et al*., 2001).

An increase in inoculum levels of *M. incognita* resulted in an increased final population of the nematode on the pepper cultivars used in this study. This finding was similar to the findings of Kheir *et al*. (2004) who reported that the final nematode population density of *M. incognita* on banana cultivars tested, increased proportionally with increase of initial inoculum levels and all inoculum levels suppressed the plant growth regardless of the cultivar. The numbers of juveniles of *M. incognita* recovered from soil at time of harvest varied among inoculum levels but did not follow the trends in suppression of pepper growth, this was in line with the findings of Thomas *et al*. (1995).

The very poor yield recorded in this study was similar to the findings of other workers, that *M. incognita* infection of pepper resulted in significant yield losses on pepper (Thomas *et al*., 1995; Udo *et al*., 2005). The reproductive rate and degrees of root damage (galls) shown by *M. incognita* on the pepper cultivars indicates the suitability of pepper as a host for this nematode. It also demonstrated the pathogenic effect of *M. incognita* on pepper and severe damage could occur if the crop is grown in field-infested by the nematode.

The root-knot nematode (*Meloidogyne incognita*) is pathogenic on susceptible pepper cultivars with galls formed on the roots. In addition, there was also reduced top growth, number of leaves, fresh shoot and dry shoot weights, fresh root weights and yield. The cultivation of susceptible pepper cultivars demand the control of the root-knot nematodes with appropriate management measures.

Acknowledgement

I wish to thank and appreciate Prof. B. Fawole and Claudius-Cole, A. O of the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan for their guidance during my PhD study. Also my employer Benue State Government through College of Education, Oju, Benue State for granting me study leave. My family for my absence during the study.

References

Abbas, S., Dawar, S., Tariq, M and Zaki, M. J (2009). Nematicidal activity of spices against *Meloidogyne javanica* (Treub) Chitwood. *Pakistan Journal of Botany,* 41(5): 2625-2631.

Agwu, J. E and Ezigbo, J. C (2005). Effect of *Meloidogyne incognita* (root-knot nematode) on the development of *Abelmoschus esculentus* (okra). *Animal Research International*, 2 (3):358-362.

Biro, T and Toth, F (2009). Effect of Trifender (*Trichoderma asperellum*) on the number of root-knot nematode (*Meloidogyne hapla* Chitwood). *Acta Phytopathologia et Entomologica Hungarica*, 44 (2) : 363-371.
Castillo, P., DiVito, M., Vovlas, N and Jimenez-Diaz, R. M (2001). Host-parasite relationships in root-knot disease of white mulberry. *Plant Disease*, 85: 277-281.
Celocia, A. J. R., Uy, A. J. L and Ruelo, J. S (2006). Response of hot pepper (*Capsicum annuum* L. Var. PBC 535) to single and 2-4 combinations of biological and chemical control against the root-knot nematode. *Philippines Scientific*, 43: 15-33.
DiVito, M., Vovlas, N and Castillo, P (2004). Host-parasite relationships of *Meloidogyne incognita* on spinach. *Plant Pathology*, 53, 508-514.
El-Sherif, A. G., Refael, A. R., El-Nagar, M. E and Salem, H. M. M (2007). The role of eggs inoculum levels of *Meloidogyne incognita* on their reproduction and host reaction. *African Journal of Agricultural Research*, 2 (4): 159-163.
Fayemi PO (1999). *Nigerian Vegetables*. Heinemann Edu. Books (Nigeria Plc). Ibadan 327pp.
Hussey, R. S and Barker, K. R (1973). A comparison of methods of collecting inocula of *Meloidogyne* spp. *Plant Disease Reporter*, 57: 1025-1028.
Izuogu, N. B., Oyedunmade, E. E. A and Babatola, J. O (2010). Screenhouse assessment of fluted pumpkin *Telfairia occidentalis* Hook. F., to root-knot nematode, *Meloidogyne incognita. Journal of Agricultural Sciences*, 2 (3); 169-173.
Khan, S. A (2009). Screening of tomato cultivars against root-knot nematodes and their biological management. PhD thesis, Faculty of Agriculture, University of Agriculture, Faisalabad, Pakistan.
Khan, Z., Jairajpuri, M. S., Khan, M and Fauzia, M (1996). Seed soaking treatment in culture filtrates of blue-green algae, *Microcolues vaginatus*, for the management of *Meloidogyne incognita* on okra. *International Journal of Nematology*, 8 (1): 40-42.
Kheir, A. M., Amin, A. W., Hendy, H. H and Mostafa, M. S (2004). Effect of different inoculum levels of *Meloidogyne incognita* on nematode reproduction and host response of four banana cultivars under greenhouse conditions. *Arab Journal of Plant Protection*, 22: 97-102.
Mekete, T., Mandefro, W and Greco, N (2003). Relationships between initial population densities of *Meloidogyne javanica* and damage to pepper and tomato in Ethiopia. *Nematologia mediterranea*, 31: 169-171.
Olabiyi, T. L (2008). Pathogenicity study and nematoxic properties of some plant extracts on root-knot nematode pest of tomato (*Lycopersicon esculentum* L.) Mill. *Plant Pathology Journal*, 7 (1): 45-49.
SAS. (2002). version,9.2. SAS. Institute. Cary, NC.
Sasser, J. N., Carter, C. C and Hartman, K. M (1984). *Standardization of host suitability studies and reporting of resistance to root-knot nematodes*. A co operative publication of the North Carolina State University, Department of Plant Pathology and USAID. 7pp.
Sikora, R. A and Fernandez, E (2005). Nematode parasites of vegetables. Pp 319- 392. In Luc, M., Sikora, R. A and Bridge, J (eds). *Plant-Parasitic Nematodes in Subtropical and Tropical Agriculture*. 2nd Edition. CAB International.
Sogut, M. A and Elekcioglu, I. H (2007). Methyl bromide alternatives for controling *Meloidogyne incognita* in pepper cultivars in the Eastern Mediterranean region of Turkey. *Turk Journal of Agriculture and Forestry*, 31: 31-40.
Taylor, A. L and Sasser, J. N (1978). *Biology, Identification and Control of Root- knot Nematodes Meloidogyne spp*. North Carolina UniversityUSAID. 111pp.
Thomas, S. H., Murray, L. W and Cardenas, M (1995). Relationship of preplant population densities of *Meloidogyne incognita* to damage in three chile pepper cultivars. *Plant Disease*, 79: 557-559.
Udo, I. A., Uguru, M. I and Ogbuji R. O (2005). Pathogenicity of *Meloidogyne incognita* race 1 on Nigerian pepper (*Capsicum spp*.) lines. *Global Journal of Agricultural Sciences*, 4 (1): 23-27.
Udo, I. A and Ugwuoke K. I (2010). Pathogenicity of *Meloidogyne incognita* race 1 on turmeric (*Curcuma longa* L.) as inflenced by inoculum density and poultry manure amendment. *Plant Pathology Journal*, 9 (4): 162-168.
Whitehead, A. C and Hemming, J. R (1965). A comparison of some quantitative methods of extracting small vermiform nematodes from soil. *Annals of Applied Biology*, 55: 25-28.

Table 1: Effect of various inoculation levels of *Meloidogyne incognita* on heights, fresh shoot and root weights and dry shoot weights of four pepper cultivars* (Pot experiment).

		Plant height (cm)											
Cultivar	Pi	Inco	1WAI	2 WAI	3 WAI	4 WAI	5 WAI	6 WAI	7 WAI	8 WAI	Fresh Shoot Weight (g)	Fresh root weight (g)	Dry shoot weight (g)
California Wonder	0	4.3±0.3	5.3±0.5	7.1±0.7	8.7±0.6	9.5±0.9	10.3±0.1	10.8±0.7	10.6±0.9	10.5±0.8	4.1±0.4	3.3±0.7	1.4±0.1
California Wonder	1500	4.7±0.3	5.6±0.5	6.8±1.0	9.2±1.1	11.8±1.3	13.2±1.4	13.7±1.6	12.7±1.6	12.7±1.6	4.0±0.6	3.7±0.8	1.3±0.1
California Wonder	2500	4.0±0.0	4.6±0.1	5.5±0.3	6.7±0.7	8.5±1.1	12.0±1.3	12.3±0.6	10.1±1.5	12.3±1.4	4.6±0.6	4.2±1.0	1.1±0.1
California Wonder	3500	4.3±0.1	4.8±0.2	6.7±1.0	8.3±1.1	10.0±1.2	10.5±0.1	11.7±1.5	11.3±1.4	10.5±1.4	5.6±1.2	5.6±1.4	1.0±0.3
California Wonder	5000	4.1±0.1	5.2±0.3	8.0±0.7	10.0±0.6	11.5±0.3	8.5±0.6	9.3±0.6	9.7±0.5	9.8±0.6	5.5±0.9	8.2±0.6	0.9±0.2
G.H.A	0	4.3±0.2	5.6±0.4	7.7±0.3	9.2±1.8	10.6±1.2	12.7±0.9	12.6±0.9	12.2±0.7	12.1±0.8	5.5±1.0	4.0±1.0	1.8±0.3
G.H.A	1500	4.6±0.2	5.7±0.4	8.7±0.3	11.6±0.2	11.7±0.4	12.5±0.3	12.5±0.3	12.2±0.5	12.2±0.5	5.1±1.4	4.2±1.4	1.4±0.3
G.H.A	2500	4.7±0.1	6.2±0.4	8.0±0.8	10.5±1.8	11.3±2.0	12.1±1.9	12.1±1.9	12.0±1.8	12.0±1.8	5.2±1.7	4.3±1.3	1.3±0.4
G.H.A	3500	4.0±0.0	5.0±0.2	6.7±0.8	8.5±0.7	11.2±0.9	11.6±1.2	11.7±1.6	11.3±1.7	11.3±1.7	7.5±0.5	7.5±1.2	1.3±0.1
G.H.A	5000	4.0±0.0	5.1±0.1	6.5±0.6	7.8±0.8	9.1±1.0	10.5±1.0	10.8±1.0	10.5±0.8	10.1±0.8	5.8±1.6	9.1±0.6	1.2±0.4
Prof – fintashi	0	4.0±0.0	4.7±0.2	5.5±0.3	6.1±0.5	7.0±1.0	8.3±1.6	9.0±1.9	9.0±1.7	9.0±1.7	3.7±1.1	5.2±1.3	1.6±0.2
Prof – fintashi	1500	4.3±0..0	4.6±0.1	5.3±0.1	5.8±0.3	7.2±0.7	9.1±1.1	10.3±1.1	9.7±1.2	9.8±1.2	6.1±1.7	9.8±1.9	1.5±0.4
Prof – fintashi	2500	4.0±0.0	4.5±0.2	5.2±0.4	5.7±0.4	7.0±0.6	8.5±0.8	9.3±0.9	9.7±1.5	9.7±1.5	5.0±0.4	10.2±0.7	1.2±0.1
Prof – fintashi	3500	4.0±0.0	4.3±0.1	4.5±0.5	5.5±0.3	6.5±0.6	7.7±1.1	8.7±1.4	8.8±1.4	8.8±1.4	5.2±0.9	12.0±4.5	1.3±0.2
Prof – fintashi	5000	4.1±0.1	4.6±0..1	5.1±0.3	5.8±0.5	6.2±0.4	7.7±1.1	8.5±1.9	8.8±1.1	8.8±1.1	6.2±1.7	12.1±2.9	0.9±0.4
Ex – Sam – St	0	3.3±0.2	5.6±0.2	8.2±0.4	10.0±0.7	11.5±1.0	12.3±0.9	12.5±1.0	12.3±1.1	12.3±1.1	4.3±0.8	3.7±0.7	1.3±0.2
Ex – Sam – St	1500	4.5±0.0	5.7±0.2	8.6±1.1	10.6±1.7	11.2±2.0	12.2±1.9	12.3±1.9	12.1±1.8	12.1±1.8	6.1±1.5	5.3±2.2	1.3±0.3
Ex – Sam – St	2500	4.3±0.2	5.3±0.2	7.0±1.0	7.8±1.0	9.2±1.0	11.6±0.8	12.0±1.9	12.0±1.9	12.0±1.9	4.1±1.8	5.7±2.1	1.3±0.3
Ex – Sam – St	3500	4.7±0.3	6.0±0.4	7.8±0.5	9.8±1.1	10.8±1.5	11.6±1.5	11.7±1.4	11.3±1.5	11.3±1.5	5.5±1.8	5.7±1.7	1.0±0.2
Ex – Sam – St	5000	4.7±0.4	5.8±0.7	8.0±1.8	9.2±2.0	9.8±1.8	10.5±1.9	10.6±2.1	10.1±2.0	10.1±2.0	5.5±0.8	9.2±1.2	1.0±0.2
LSD 0.05		0.5	1.0	8.1	3.1	3.4	3.7	4.0	4.1	4.1	3.7	5.3	0.9

*Data are means of four replicates, Inoc = At inoculation, WAI = week after inoculation.

Table 2: Effect of various inoculation levels of *Meloidogyne incognita* on the number of leaves of four pepper cultivars* and yield. (Pot experiment)

		Number of leaves									
Cultivar	Pi	Inoc	1 WAI	2 WAI	3 WAI	4 WAI	5WAI	6 WAI	7 WAI	8WAI	Number of fruit at harvest
California Wonder	0	4.5±0.5	7.0±0.7	9.2±1.9	16.5±0.4	18.5±1.7	24.0±2.3	23.5±2.3	21.7±1.7	21.7±1.7	0
California Wonder	1500	4.2±0.2	6.7±0.2	9.7±0.8	12.0±0.7	15.5±3.3	19.5±4.1	22.5±3.7	19.5±2.8	19.5±2.8	1
California Wonder	2500	4.2±0.2	6.5±1.0	9.2±1.0	11.5±1.0	15.5±1.5	17.7±1.6	19.0±1.0	17.5±1.2	17.5±1.2	1
California Wonder	3500	4.2±0.2	6.0±0.2	9.0±0.4	11.5±1.5	15.0±1.8	17.2±2.0	17.2±2.1	15.2±0.9	15.2±0.9	1
California Wonder	5000	4.7±0.4	5.7±0.7	9.0±1.8	11.2±3.4	13.7±2.9	14.5±4.3	15.2±3.9	14.7±2.9	14.7±2.9	0
G.H.A	0	5.0±0.5	7.5±1.1	10.0±1.5	14.0±1.7	24.7±3.7	24.0±4.2	27.7±3.3	27.5±2.5	27.5±2.5	2
G.H.A	1500	4.7±0.2	8.0±0.4	13.2±1.3	18.0±0.7	19.7±1.3	23.0±3.1	21.7±1.8	23.2±0.9	23.2±0.9	0
G.H.A	2500	5.2±0.4	7.5±0.8	12.2±2.8	16.2±4.4	19.5±5.2	22.5±4.8	21.0±3.0	18.7±4.9	18.7±4.9	0
G.H.A	3500	4.7±0.4	6.7±0.6	9.2±0.9	11.0±1.2	17.7±2.7	20.7±6.3	20.0±6.9	17.5±6.0	17.5±6.0	3
G.H.A	5000	4.7±0.4	6.5±0.2	9.0±0.4	11.0±0.9	15.7±1.5	19.0±2.4	20.0±2.4	15.5±2.5	15.5±2.5	0
Prof – fintashi	0	4.5±0.2	6.0±0.5	8.7±0.8	10.0±1.4	38.2±2.4	20.2±2.3	24.5±2.0	25.0±1.5	25.0±1.5	2
Prof – fintashi	1500	4.7±0.2	6.7±0.2	8.5±0.5	11.2±1.4	16.5±3.6	15.5±3.8	23.2±6.1	17.2±3.7	17.2±3.7	0
Prof – fintashi	2500	4.5±0.2	5.7±0.4	8.5±0.6	9.7±0.4	12.0±1.1	14.7±1.7	18.0±2.0	17.0±2.1	17.0±2.1	0
Prof – fintashi	3500	4.2±0.2	5.5±0.2	7.5±0.7	9.2±0.8	11.7±1.5	14.5±1.9	17.0±2.1	17.0±2.4	17.0±2.4	0
Prof – fintashi	5000	4.5±0.2	5.2±0.4	7.0±1.9	7.5±2.0	10.5±2.4	13.2±3.3	14.7±3.5	13.7±3.5	13.7±3.5	1
Ex – Sam – St	0	4.7±0.4	8.2±1.0	11.5±1.5	16.5±1.5	18.2±1.8	21.0±2.0	21.0±3.1	19.7±3.5	19.7±3.5	0
Ex – Sam – St	1500	5.5±0.2	8.5±0.6	13.5±0.6	16.0±0.7	18.2±1.3	20.0±1.2	19.7±2.6	19.0±1.6	19.0±1.6	1
Ex – Sam – St	2500	5.2±0.2	8.5±0.6	13.0±1.0	13.7±1.6	16.0±2.2	19.5±3.0	18.5±1.5	18.7±2.3	18.7±2.3	2
Ex – Sam – St	3500	5.2±0.2	9.0±1.1	11.5±1.7	12.5±2.9	15.5±3.3	19.0±4.7	16.7±4.1	16.5±4.2	16.5±4.2	1
Ex – Sam – St	5000	5.0±0.4	7.0±0.8	11.0±2.0	14.0±1.7	13.7±3.4	14.7±4.2	16.0±5.2	15.7±6.1	15.7±6.1	0
LSD 0.05		1.0	2.0	13.1	5.5	17.5	9.9	10.2	10.7	10.7	NS

*Data are means of four replicates, Inoc = At inoculation, WAI = week after inoculation, NS = Not significant.

Journal of Biology, Agriculture and Healthcare www.iiste.org
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.19, 2015

Table 3: Reproduction of *Meloidogyne incognita* on four pepper cultivars at various inoculation levels at harvest* (Pot experiment)

Cultivar	Pi	Root population (E)	Soil population J_2/5kg soil	Final population (E + J_2)	GI	RF
California wonder	0	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)
California wonder	1500	1416.5±158.7(3.1)	1250.0±1250(3.0)	2667.0±1168.6(3.4)	1.5±0.2(0.3)	1.7±0.7(0.4)
California wonder	2500	2345.0±142.9(3.3)	1250.0±1250(3.0)	3595.0±1167.0(3.5)	2.0±0.0(0.4)	1.4±0.4(0.3)
California wonder	3500	3350.0±392.8(3.5)	2500.0±1443.3(3.3)	5850.0±1135.4(3.7)	2.2±0.2(0.5)	1.8±0.2(0.4)
California wonder	5000	3281.0±316.2(3.5)	5000.0±2041.2(3.6)	8281.0±1848.3(3.9)	2.7±0.2(0.5)	1.6±0.3(0.4)
GHA	0	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)
GHA	1500	1537.5±53.6(3.1)	1250.0±1250.0(3.0)	2787.5±1218.2(3.4)	1.0±0.0(0.3)	1.8±0.8(0.4)
GHA	2500	2720.0±169.9(3.4)	2500.0±1443.3(3.3)	5220.0±1520.5(3.7)	2.0±0.4(0.4)	2.0±0.6(0.4)
GHA	3500	3591.0±91.3(3.5)	2500.0±1443.3(3.3)	6091.0±1531.8(3.7)	3.5±0.2(0.6)	1.7±0.4(0.4)
GHA	5000	5633.5±221.1(3.7)	3750.0±2393.5(3.5)	9383.5±2502.5(3.9)	3.0±0.5(0.6)	1.6±0.4(0.4)
Prof-fintashi	0	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)
Prof-fintashi	1500	1536.5±42.7(3.1)	1250.0±1250.0(3.0)	2787.0±1224.9(3.4)	1.5±0.2(0.3)	1.8±0.8(0.4)
Prof-fintashi	2500	2482.5±84.8(3.3)	2500.0±1443.3(3.3)	4983.0±1409.3(3.6)	1.7±0.2(0.3)	1.9±0.5(0.4)
Prof-fintashi	3500	3195.0±243.5(3.5)	3750.0±1250.0(3.5)	6945.0±1012.0(3.8)	2.5±0.2(0.5)	1.9±0.2(0.4)
Prof-fintashi	5000	4104.0±286.4(3.5)	5000.0±2041.1(3.6)	9104.0±1309.1(4.0)	3.0±0.4(0.6)	1.7±0.4(0.4)
Ex-Sam-st	0	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)	0.0±0.0(0.0)
Ex-Sam-st	1500	1449.5±114.4(3.1)	1250.0±1250.0(3.0)	2699.5±1147.9(3.4)	1.2±0.2(0.3)	1.7±0.7(0.4)
Ex-Sam-st	2500	2417.5±66.1(3.3)	2500.0±1443.3(3.3)	4918.0±1381.5(3.6)	1.5±0.2(0.3)	1.5±0.3(0.4)
Ex-Sam-st	3500	3291.3±220.9(3.5)	2500.0±1443.3(3.3)	5791.2±1358.9(3.7)	1.5±0.5(0.3)	1.4±0.3(0.3)
Ex-Sam-st	5000	4566.5±210.1(3.6)	3750.0±1250.0(3.5)	8317.0±1444.6(3.9)	1.7±0.2(0.4)	1.3±0.2(0.4)
LSD 0.05		487.7(2.6)	3961.9(3.5)	3934.8(3.5)	0.7(0.2)	1.3(0.3)

*Data are means of four replicates, Pi = initial population level, FP = Final population, GI = Gall Index, RF = Reproductive Factor, Log 10 (X+1) in parentheses

Table 4: Effect of *Meloidogyne incognita* on heights of four pepper cultivars in treated and untreated plots. (Field experiment)

	Height (cm)										
Treatment	Inoc.	1 WAI	2 WAI	3 WAI	4 WAI	5 WAI	6 WAI	7 WAI	8 WAI	9 WAI	10 WAI
Control	8.2±0.4	10.4±0.3	12.8±0.6	17.4±1.2	28.5±1.9	37.3±1.7	47.6±1.1	52.4±1.5	53.8±1.3	53.8±1.3	53.8±1.3
Untreated	6.9±0.4	8.3±0.5	10.1±0.8	12.8±1.0	15.2±1.0	17.5±1.3	19.7±1.3	21.4±1.3	22.4±1.0	22.4±1.0	22.3±1.4
t-test (0.05)	0.6	0.7	1.4	1.8	2.6	1.2	1.8	2.4	2.5	2.4	3.3
Remarks	S	S	S	S	S	S	S	S	S	S	S

WAI = weeks after inoculation, S = Significant difference, Inoc = At inoculation.

Table 5: Effect of *Meloidogyne incognita* on the number of leaves of four pepper cultivars in treated and untreated plots. (Field experiment)

	Number of leaves										
Treatment	Inoc	1 WAI	2 WAI	3 WAI	4 WAI	5 WAI	6 WAI	7 WAI	8 WAI	9 WAI	10 WAI
Control	6.8±0.1	8.8±0.1	11.3±0.5	21.7±2.1	36.5±4.3	49.1±7.3	64.6±9.9	75.8±13.2	77.6±13.1	74.0±12.6	66.9±11.6
Untreated	5.8±0.2	7.2±0.3	10.1±1.2	17.5±2.6	29.8±4.6	51.1±6.4	72.1±8.1	72.1±11.4	67.6±10.7	59.5±10.8	53.0±9.8
t-test (0.05)	0.3	0.6	3.0	5.1	5.2	13.2	17.4	19.7	18.9	15.0	13.5
Remarks	S	S	NS	NS	S	NS	NS	NS	NS	NS	S

WAI = Weeks after inoculation, S = Significant difference, NS = No significant difference, Inoc= At inoculation.

Table 6: Effect of *Meloidogyne incognita* on the yield, biomass and root population, soil population, final population, reproductive factor, galling index of *M. incognita* on four pepper cultivars in treated and untreated plots. (Field experiment)

Treatment	Number of fruits	Yield tons/ha	Fresh shoot weight(g)	Dry shoot weight(g)	Fresh root weight(g)	Root population (No. of eggs)	Soil population (J_2/200ml soil)	Final nematode population	Reproductive factor (RF)	Galling index (G1)
Control	10.3±0.9	3.1±0.2	45.6±17.8	21.8±3.7	6.8±0.9	5789±430(3.7)	150.0±38.7(2.1)	5676±533.4(3.7)	1.1±0.0(0.0)	2.1±0.1(0.3)
Untreated	4.0±0.5	0.9±0.1	31.5±9.5	15.0±4.6	4.0±0.4	13416±2067.7(4.1)	1712.5±834.2(3.2)	14241±2027.6(4.1)	2.8±0.4(0.4)	3.6±0.2(0.5)
t-test (0.05)	2.3	1.0	13.2	6.3	1.0	4544.5(3.6)	1917.1(3.2)	4617.5(3.6)	0.8(0.2)	0.5(0.1)
Remarks	S	S	S	S	S	S	NS	S	S	S

Pi = 5000 *M. incognita* eggs, S = significant difference, NS = No significant difference