EVALUATION OF LEAF EXTRACT OF PAWPAW (*Carica papaya* (L.)) IN THE CONTROL OF ROOT-KNOT NEMATODE (*Meloidogyne javanica*) IN GARDEN EGG (*Solanum melongena* (L.))

ABSTRACT

The root-knot nematode *Meloidogyne javanica*is one of the most important soil borne pathogen affecting Garden eggplant in Nigeria. Thestudy was conducted in the Screen house of Department of Crop Protection, Modibbo Adama University of Technology in 2013 to evaluate the effect of (Pawpaw) *Carica papaya* leaf powder for the control of root-knot nematode *M. javanica* on Garden egg. The experiment consisted of five treatments replicated three times in a Completely Randomized Design in the screenhouse. *C. papaya* powder at different levels 50 g, 40 g, 30g, 20g and control which received no treatment were incorporated into fifteen (15) separate pots of 20cm diameter containing 4 kg sterilized soil. Data collected on plant height (cm), number of leaves, fresh shoot weight (g), fresh root weight, dry root weight (g), gall index and final nematode population. The result indicated that Garden eggplant amended with 50 g *C. papaya* recorded higher growth parameters, plant height (33.75cm), number of leaves (29.00), fresh shoot weight (145.40g), gall index (1.33) and the least final nematode population (160.50), whereas the control recorded the least growth parameters, plant height (10.20cm), number of leaves (9.33), fresh shoot weight (9.76g) and highest gall index (5.0) and final nematode population (1063.87). It can then concluded that *Carica papaya* powder when used as an amendment was effective in controlling *M. javanica* in garden egg under screenhouse and has the potential for use as a nematicide in the future. This study recommends that *C. papaya*leaf powder should be put to field trials to ascertain its efficacy in controlling *M. javanica* on garden egg.

Keywords: *M. javanica*, *Carica papaya*, Garden egg, amendment

Introduction

Garden egg (*Solanum melongena* (*L*.,)) belongs to the family Solanaceae, it is believed to have originated from West Indies (Grubben and Denton, 2004). It is one of the most important vegetable crop in Nigeria and West Africa (Norman, 1992; Onwusah-Ansah *et al*., 2001). The crop is known by different names, Eggplant is the common name in North America and Australia. In Britain, it is called Aubergine, while in South Asia, South East Asia and South Africa it is knownas brinjal (Grubben and Denton 2004).Garden egg is a warm season crop that prefers relatively high temperature for optimum growth and development (Norman, 1992; Obeng-Ofori et al., 2007). Egg plants are effective for curing a number of diseases, including cancer, high blood pressure and hepatitis due to content of anthocynins and strychnine (Magioli and Mansur, 2005; Silva *et al*., 1999). According to Grubben and Denton (2004), some medicinal properties are attributed to the roots and fruits, they are described as carminative and sedative, and are used to treat colic and blood pressure. The crop also have some nutritional value as it contains vitamin C, 100g of garden egg contains 96.6g of water, 32 Kcal of energy, 1.5g protein, 0.1g fat, 7.29g Carbohydrate, 2.0g fibre, 28g Calcium, 4.7g phosphorus, 1.5g Iron, Vitamin A 70 iu, b-carotene 0.35 iu, 0.07 mg Thiamin, 0.06 mg riboflavin, 8 mg ascorbic acid (Grubben and Denton, 2004). Garden egg ranked amongst the top ten vegetables in terms of antioxidant capacity due to its fruit phenolic acid contents (Singh, *et al*., 2009).

The production of garden egg is greatly affected by different factors or constraints which include pest and diseases infestation. Prominent among the pest and disease affecting eggplant production are root-knot nematode. Eggplant is highly susceptible to Meloidogyne species (Zarina and Shahina, 2010). Root-knot nematodes are distributed worldwide and are obligate parasites of the roots of thousands of plant species, including monocotyledonous and dicotyledonous, herbaceous and woody plants. They have their greatest impact on Garden egg production when they attack the root of the plants immediately after seedling germination (Nchore et al., 2010). Different management strategies have been employed to control *Meloidogyne* spp. which includes chemical control which is successful but costly to economically low income farmers as well as being environmentally unfriendly. Other management options include, physical, cultural and biological methods which include use of plant extracts and powder. *Carica papaya*, belongs to the family of caricaceae and several species have been used as remedy against a variety of diseases (Nirosha and Mangalanayaki, 2013).The plant is also used as medicine against Typhoid and Malaria by local people in Nigeria. This work is therefore aimed at identifying the effect of *C. papaya* leaf powder on *M. javanica* infected garden egg plants in the screenhouse.

Materials and Methods

The experimental plant, Pawpaw (*C. papaya*) leaves was obtained from home gardens in Yola, Adamawa State, Nigeria.

The experiment was carried out in the screenhouse of the Department of Crop Protection, School of Agriculture and Agricultural Technology, Modibbo Adama University of Technology, Yola between November, 2018 and February, 2019. Yola lies between Latitudes 9^{o}N and 11^o and Longitude 11.5^o and 13.5^{o}E and at an altitude of 185.9m above sea level (Bashir, 2000). The experiment consisted of fifteen (15) plastic pots of 30 cm in diameter. Each of the plastic pots was perforated and filled with 4 kg sterilized soil and arranged on top of wooden benches in screenhouse. The experimental pots were laid out in Completely Randomized Design, with five (5) treatments and three replications. The treatments were different level of Pawpaw leaves i.e. 50g, 40g, 30g, 20g and 0g or the control. The Pawpaw leaves after collection were shade dried on polythene sheets, pounded before 50g, 40g, 30g, 20g and 0g or control each was weight separately and mixed thoroughly with 4 kg soil contained in perforated plastic pots. The inocula for this experiment were second stage juveniles of *M. javanica* extracted from pure culture of infested tomato rootsand extracted by Modified Baermann tray method (Whitehead and Hemming, 1965). This involved using shallow trays with sieve lined with tissue paper and macerated roots of tomato placed on it. Water was poured in from the side of the tray to a level just submerging the materials on the sieve. This set up was left to stand for 24 hours and the nematode juveniles were collected by decanting into a beaker. Aliquots of 10 ml in syringes were taken and counted under a Stereoscopic microscope using a grid counting dish and 1000 juveniles were used for inoculation of potted plants.Yarfara a cultivar of garden known to be susceptible to *M. javanica* were raised in nursery for twenty-one (21) days.

The pots were irrigated for two (2) weeks to allow for proper decomposition of the amendment and curing of the sterilized soil to be stabilized before transplanting of the seedlings. Each of the fifteen pots was separately transplanted with two (2) seedlings. All potted plants were inoculated with 1000 juveniles of *M. javanica*,(3) three days after transplanting. All agronomic practices such as weeding and irrigation were done whenever necessary. Phytochemical test were also carried out in the laboratory to identify the constituents of tanins, saponins, flavonoids, alkaloids, glycosides and phenols. Using the method described by Trease and Evans (1989); Sofowora (1993). Data were collected on plant height, number of leaves, fresh shoot weight, fresh root weight and dry root weight, gall were rated from the roots of egg plant at the end of experiment using the rating scheme of Sasser *et al.,* (1984). Final nematode population was obtained by taken soils from replications of a root zones of all treatments pooled and from it 250cm^3 soil was used for nematode extraction using the methods described by Whitehead and Hemming (1965). All data collected were subjected to analysis of variance (ANOVA) and mean were separated using Duncan Multiple Range Test (DMRT) at 5% probability. Analysis of data was done using SAS Version 2001.

Results and Discussion

Mean Number of Leaves

The result on number of leaves indicated that eggplants treated with amendments produced higher number of leaves than the control plants(Table 1). This could be as a result of decomposition of the incorporated powder that release nutrients into soil as well as the effect of the phytochemical that hinder nematode activity, which resulted in the luxirant growth of the treated plants. This is inline with studies of Mohammed and Umar (2012) who showed that Okra infested with *M. javanica* amended with powder of Tridax (*Tridax procumbens*) Lemon grass (*Cymbopogon citratus*); Garlic (*Allium sativum*) and Onion (*Allium cepa*) significantly increased both growth and vegetative parameters as well as reduction in galling index and soil nematode population.

Phytochemical Composition of Pawpaw (*C. papaya*) Powder result showed that it contained high amount of tanins, saponins and phenols, moderate quantity of flavonoid was detected while alkaloid was slightly present.

Mean Plant Height (cm)

The results of the experiment are presented in Table 1-2. Result on plant height showed that there was significant difference between treated plants and the untreated plants (control). The significantly taller plants were observed in plant treated with 50 g (T_1) after two (2), four (4), and six (6) weeks after inoculation this was closely followed by 40 g (T_2) amendment and the least height was observed in untreated control (T_5), Table 2. These may be due to the phytochemical constituents such as tannins, saponins, flavonoids, phenols and glycosides which are found in the powder of Pawpaw (*Carica papaya*). Jada and Oaya (2013) reported that *Ficus syncomorus* root exudate contain saponins, phenols and alkaloids which inhibited egg hatching and resulted in 100% mortality of *M. javanica* larvae in the laboratory. Nafesh *et al.* (2010) reported that Chinaberry and Castor bean oil immobilized *M. incognita* juvenile population in soil and increased the longitudinal growth in cucumber. The least plant height observed in the untreated plant is typical of above ground symptom of nematode attack. Kakan *et al.* (2015) reported that nematode infected plants become stunted due to root dysfunction, reduction of rooting volume and inefficient utitlization of water and nutrients.

Table 1: Effects of Varying Levels of *C. papaya* Powder Amendment Number of Leaves and Plant Height on Garden Egg Infested with *M. javanica*

Treatments (g)	Number of Leaves			Plant Height (cm)		
	2WAI	4WAI	6WAI	2WAI	4WAI	6WAI
T_1 = 50	13.33[a]	23.67[a]	29.00[a]	14.27[a]	24.30[a]	33.57[a]
T_2 = 40	12.33[a]	18.00[ab]	24.33[ab]	12.33[ab]	20.10[ab]	30.27[ab]
T_3 = 30	12.33[a]	16.33[ab]	24.00[ab]	12.33[ab]	19.27[ab]	27.27[ab]
T_4 = 20	12.00[a]	14.00[b]	21.33[b]	12.20[ab]	18.33[b]	23.83[b]
T_1 = Control	9.33[b]	9.33[b]	9.33[c]	7.20[b]	9.73[c]	10.20[c]
SE	2.72	4.29	3.85	3.49	3.02	4.64

Means in the same column followed by the same letter are not significantly different at $P<0.05$

Key: WAI = Weeks after Inoculations
SE = Standard Error

Mean Fresh Shoot Weight

Garden egg plants treated with *C. papaya* powder had higher fresh shoot weight than non-treated control.Furthermore among the treated plants 50 g (T_1) amended plants produced highest fresh shoot weight ((Table 2). This could be attributed to release of ammonia as the amendment decayed due to beneficial microbial activity at the root zone (Oka, 2010) as well as slow release of phytochemical. The result of this study agrees with those of Olabiyi *et al.* (2011) who reported that *Chrysanthemum coronarium* when applied to soil as green manure effectively controlled root-knot nematodes *M. incognita* and *M. javanica* on tomato and significantly improve fresh shoot weight of tomato in both greenhouse and micro plots.

Mean Fresh Root Weight

Results on mean fresh root weight revealed that the untreated control plants had the highest fresh root weight (Table 2). The higher root weight could be due to nematode infection which resulted in the formation of root galls. Plant with nematode damaged roots exhibit reduced root system fewer feeder roots (Anwar and Javid, 2010), Kumar *et al.*

(2010) also revealed that galls otherwise called root knot cause increase in root weight of many Malvacious and Solanaceous crops.

Mean Dry Root Weight

Mean dry root weight result indicated that the untreated control had the highest dry root mean when compared to other treatments (Table 2). This could have occurred because of the numerous galls which were caused by nematode feeding on the roots. This is in line with the studies of Ojo and Umar (2013) on the effect of two botanicals, oil palm fibre and cocoa bean testa in the control of root knot nematode revealed that control plants recorded the lowest growth rates, high galling index due to nematode activity at the root zone resulting in giant cell formation, high population of nematodes larvae were able to penetrate roots freely and reproduce without inhibition.

Mean Galling Index

The results on mean galling index revealed that the control plant had significantly higher galling (Table 2) index than the treated eggplants this could be due to absence of the amendment that will inhibit nematode activities and therefore the nematodes were able to penetrate the plant roots feed and produce knots and the knots coalesce to form larger galls. Hal (2014) galls are diagnostic symptom of root-knot nematode infestation on The treated plants had lower number of galls, however, 50 g (T_1) amended egg plants observed least number of gall which might be due phytochemicals present in the amendment which prevented the nematode from penetrating the roots and formation of galls. This is in agreement with study conducted by Bawa *etal.*, (2014), reported that soil treated with ethanol extracts of plant leaves, red bell pepper fruits, ginger rhizomes and African locust beans seed extracts have a significantly lower root galls as against the untreated control. Ugwuoke *et al.*, (2011) who reported that dry powder of *Newbouldia laevis* when applied to African Yam bean significantly reduced galls produced by *M. incognita*.

Mean Final Nematode Population

The control or untreated eggplant had the highest nematode population when compared to treated eggplants (Table 2). The relatively high population of M. javanica in control might be ascribed to non-application of the C. papaya powder which resulted in nematodes being free to penetrate, feed and reproduce with in the roots of the control plants. This is in line withIzuogu etal.,who reported that *Hypitis suaveolens* Wondimeneh et al. (2013) who reported that the application of botanicals reduced the formation off galls aqueous extract have bioactive ingredients (saponins,alkaloids, flavonoids and steroids) were responsible for the suppression and reduction of population density of M. incognitaon infested cowpea. Wondimeneh *etal.*,(2013), also reported that the application of botanicals reduced the formation of gallson tomato roots, number of egg and final nematode density in soil infested with *M. incognita*.

Table 2: Effect of Different Levels of *C. papaya* Powder Amendment on some Plant Growth and Nematode Parameters of Garden Egg Infested with *M. javanica*

Treatments (g)	FSW(g)	FRW(g)	DRW(g)	GI	FNP
T_1 = 50	145.40[a]	81.84[a]	26.23[a]	1.33[a]	160.50[e]
T_2 = 40	114.86[ab]	77.06[a]	23.10[b]	2.33[b]	282.86[d]
T_3 = 30	92.28[bc]	60.60[ab]	16.33[c]	3.33[c]	568.20[c]
T_4 = 20	67.79[c]	49.83[c]	15.23[c]	4.33[d]	620.80[b]
T_1 = Control	9.76	8.30[d]	11.20[d]	5.00	1063.87[a]
SE	16.50	3.80	1.61	0.52	45.16

Means with the same alphabets are not significantly different from one another column wise

Key: FSW = Fresh Shoot Weight
FRW = Fresh Root Weight
DRW = Dry Root Weight
GI = Galling Index
FNP = Final Nematode Population

Conclusions

In conclusion, this study showed that *C. papaya* powder used as soil amendment was effective in controlling nematode population in potted eggplants under screen house conditions. This powder has the potential being used as natural environmental safe nematicide as the plant is available throughout the tropics. We therefore, recommend the trial of *C. papaya* powder in the field under natural conditions to ascertain their efficacy.

REFERENCES

Anwar, S. A. and Javid, N. (2010). *Meloidogyne incognita* infecting Dhalia. *Parkistan Journal of Zoology*, 42: 348-350.

Baker, K. R., Hussey, R. S. and Krusberg, L. R. (1994). Plant and oil nematodes: *Societal impact focus for the future*,26: 127-137.

Bashir, A. B. (2000). Water quality and outbreak of diseases in Yola, Adamawa State, M.Sc. Thesis submitted to the Department of Geography, Federal University of Technology, Yola (Unpublished) Thesis 120p.

Bawa, J. A., Mohammed, I. and Liadi, S. (2014). Nematicidal Effect of Some Plant Extract on Root knot Nematodes (*Meloidogyne incognita)* of Tomato *(Lycopersicon esculentum). World Journal of Life Science and Medical Research, 3(3):81-87*

Grubben, J. H. and Denton, O. A. (2004). *Plant resources of tropical Africa 2. Vegetables* PROTA Foundation. Backhuys Publisher, Wageningen, Netherlands.

HAL (2014). Management of Root –knot Nematode in Vegetable Crops Horticulture *Australia Limited (HAL), Project MT 09067*.

Izuogu, N. B., Abolusoro, S. A. and Yakubu, L. B. (2016). Nematicidal Potential of Aqueous Extract of Hyptis suaveolens in the Management of Root knot Nematode *Meloidogyneincognita* of some Cowpea cultivars. *Croatian Journal of Food Science Technology. 8(1):15-19*

Jada, M. Y., Oaya, C. S. and Stephen, S. N. (2013). Effect of Fig Tree (Ficus sycomorus) root exudates on root-knot nematode (*Meloidogyne javanica*) *IOSR Journal of Agriculture and Veterinary Science* (IOSR-JAVS), 3:5, 24-28.

Kankan, F., Slowley, E. N. and Alhassan, M. (2015). Management of root-knot nematode (*Meloidogyne* species) on Okra (Albelmoschus esculentus) with aqueous sesame seed extracts. *International Journal of Agronomy and Agricultural Research*, 6(4), 24-31.

Kumar, S; Dagnoko, S; Haougui, A; Ratnadass, A; Paster nak, D. and Kouame, C. (2010): Okra (*Abelmochus spp*) in West and Central Africa: Potential and Progress, on its improvement. *African Journal of Agricultural Research*, 5: 3590 -3595.

Magioli, C. and Mansur, E. (2005). Eggplant (Solanum melongeba L.). Tissue culture, genetic transformation and use as an alternative model plant. *Acta Botanical Brasillica*, 19, 139-148.

Nafeseh, K; Esma, M. M; Abdolhosein, I. and Saeid, N. (2010). Management of root knot nematode *Meloidogyne incognita* on cucumber with the extract and oil of nematicidal plants. *International Journal of Agricultural Research*, 5(8): 582-586.

Nchore, S. B.Waceke, J. W. and Kariuki, G. M. (2011). Use of agro-industrial waste and organic amendments in managing root – knot nematodes in black night shade in selected parts of Kenya. In 10th African Crop Science Conference proceedings, October 10 -13, 2011, Maputo, Mozambique. 187 – 193.

Nirosha, N. and Mangalanayaki, R. (2013). Antibacterial Activity of leaves and Stem Extract of *Carica papaya* L. *International journal of Advances in Pharmacy, Biology and Chemistry. IJAPBC Vol. 2(3).*

Norman, J. C. (1992). *Tropical vegetable crops*. Devon, Arthur Stockwell. Ltd

Obeng-Ofori, D.; Danquar, E. Y. and Osu-Anim, I. (2007). Vegetable and Spice Crop Production in West Africa, City Publishers Limited, Ghana. 77-79.

Ojo, G. T. and Umar, I. (2013). Evaluation of some Botanicals on Root Knot Nematode (Melodogyne javanica) in Tomato (*Lycopersicon esculentum mill*) In Yola Adamawa State, Nigeria. *Biological forum-An International Journal,*5(2): 31-36.

Oka, Y. (2010). Mechanism of nematode suppression by organic soil amendments *areviewApplied Soil Ecology,* 44: 101 – 115.

Olabiyi, T. I., Adepoju, I.O., Abolusoro, S.A. and Oyedunmade (2011). Suppression of nematode pests of tomato with aqueous leaf extracts of Nitta, Tobacco and Pawpaw. *American-Euroasian Journal of Agronomy,* 4(2):23-27.

Singh, A. P., Luthria, D., Wilson, T. Vorsa, N., Singh, V., Banuelos, G. S., Pasakdee, S. (2009). Polyphenols content and antioxidant capacity of eggplant pulp. *Food Chemistry,* 114: 955-961.

Sofowara, A. (1993). *Medicinal Plants and Traditional Medicine in Africa*. Spectrum Books Ltd. Ibadan, Nigeria P. 289.

Trease, G. E. and Evans, W. C. (1989). Pharmacognosy 11th Edition. Brailiare Tindal and Macmillan Publishers, London

Ugwuoke, K.I., Ukwueze, B. O. and Ogwulumba, S. I. (2011). Powdery leaf extracts for control of Root-knot Nematode in African Yam bean. *African Crop Science Journal* 19, 131-136.

Whitehead, A. G. and Hemming, J.R. (1965). A comparison of some quantitative methods of extracting small vermiform nematodes from Soil *Annals of Applied Biology,* 55 : 25- 38.

Wondimeneh, T., Sakhuja, P. K. and Tadele, T. (2013). Root-Knot nematode (*Meloidogyne incognita*) management using botanicals in tomato (*Lycopersicon esculentum*). *Academia Journal of Agricultural Research,* 1(1): 009-016.

Zarina, B., and Shahina, F. (2010). Management of root-knot nematode disease in Pakistan. *Pakistan Journal of Nematology*. 28, 153-239.