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Suceptibility of Seven Varieties of Pepper and Tomato to Root-knot Nematodes(Meloidogyne spp) in Ibadan, Nigeria.

Bello, T.Tesleem.[1], Fawole, B[2] and Abiodun Claudius-Cole.[2]
[1].*Agricultural Education Department, Federal College of Education Abeokuta, Ogun State, Nigeria.*
[2].*Crop Protection and Environmental Biology Department, University of Ibadan, Ibadan, Oyo State Nigeria.*

Abstract: *Seven varieties each of pepper and tomato were screened for resistance to root-knot nematodes.The study was conducted at the Nematology laboratory Unit and at the rooftop garden of the Crop Protection and Environmental Biology Department, University of Ibadan, Ibadan Nigeria.*

Each potted plant was inoculated with a single egg mass of Meloidogyne spp. and harvested six weeks after inoculation. Using the combination of the values of Reproductive Factor (RF) and Galling index (GI), the screened tomato and pepper varieties were rated resistant, susceptible or tolerant to Meloidogyne spp. The pepper varieties rated resistant were Charleston Bell and Carolina Wonder. The pepper varieties rated susceptible to Meloidogyne spp. were Rodo, Tatase, Bawa and Goliath . Sombo variety was rated tolerant to Meloidogyne spp. The results for the seven varieties of tomato indicated that Ibadan Local and Tropmech varieties were susceptible while Big-beef, Jetsetter, Celebrity, Roma VFN and Small-Fry varieties were tolerant to the root-knot nematodes

The results indicate the potential availability of resistant rootstocks in the management of root-knot nematodes on peppers and tomatoes.

keywords: *Root-knot nematodes, Meloidogyne spp, susceptible, resistant, peppers,tomatoes*

I. Introduction

Plant-parasitic nematodes are an extremely important limiting factor in vegetable production. Globally, the total amount of fresh vegetables produced for the market as a percentage of total production has actually decreased slightly since 1990 (Sikora and Fernandez, 2005). Throughout the world, the production of crops, pepper inclusive, is being constrained by biotic factors such as insects, weeds, birds, fungi, bacteria, viruses and nematodes. Published reports show that root-knot nematodes (Meloidogyne spp.) are serious and important pathogens of pepper which reduce the yield (Fery and Thies, 1997; Thies and Fery, 2002).

Over sixty species of plant parasitic nematodes attack tomato but the most destructive nematodes responsible for enormous losses of tomato are the root-knot nematode belonging to the genus Meloidogyne (Udo, 2004). The most wide spread and devastating species on tomato in the tropics on tomato are Meloidogyne javanica. About 29 - 50% yield reduction of tomato in the tropics is attributed to root- knot nematodes (Udo, 2004). In the tropics alone, estimated production losses of tomato due to Meloidogyne sp. reach as high as 50%. M. javanica is stated to cause an estimated 50% loss in economically important vegetables and fruit crops each year (Adesiyan et al 1990 and Sasser, 1980)

Vegetable production in all tropical and subtropical areas is highly dependent on good nematode control. In most cases, nematode control is a pre-requisite to successful production with soil fumigation a standard practice (Sikora and Fernandez, 2005). Ecological concerns associated with the use of chemicals have necessitated the development of environmentally friendly alternatives such as the use of resistance. Grafting with resistant rootstock is gaining acceptance in the management of soil borne pathogens.

Meloidogyne incognita is reported to be predominant in the southern part of Nigeria, however some preliminary studies show that M. incognita – resistant cv present galling symptoms. Due to the fact that Meloidogyne species exist in mixed populations, it is
therefore important to know what species attack pepper and tomatoes and while selecting resistant root stock. Majority of the farmers in Nigeria, due to their ignorance, generally do not consider plant-parasitic nematodes as serious and important pathogens reducing the output and quality of crops. This is against the volumes of researches on plant-parasitic nematode damage on crops, ranging from tubers to grains, legumes, vegetables and fruits. In order to reduce or minimize the lack of information on the root-knot nematode, this study was aimed at investigations of the pathogenic effects of on pepper and tomato, screening of some cultivars for resistance and the use of the resistant rootstock therefrom, in the management of root-knot disease on pepper.

This study was therefore aimed at screening seven varieties each of tomato and pepper for resistance to root-knot nematodes.

II. Materials And Methods

The laboratory investigations were carried out in the Nematology Research Laboratory of the Department of Crop Protection and Environmental Biology. Pot experiments were carried out at the roof top of the Department.

Charleston bell and Carolina wonder pepper varieties and Bigbeef, jetsetter, Roma VFN, celebrity and smallfry tomato varieties were collected from the Texas A and M University, USA, while pepper varieties such as rodo, bawa, tatase, sombo, Goliath and tomato varieties of Tropmech and Ibadan Local were bought from National Institute for Horticultural Research, Ibadan.

Galled tomato roots of Celosia argentea plants was rinsed under tap water in the laboratory.Roots were cut into 2 to 4cm long using a sterile stainless blade. The roots were placed in a Petri dish containing small amount of water and observed under the stereo microscope, single egg masses of the root-knot nematode (Meloidogyne species) were isolated from the galled roots and egg masses were picked singly using an improvised broom and placed in a glass block containing 0.5 ml of distilled water in order to make pure culture of the inoculation.

The method used for screening for resistance was the Standardized method based on Gall Index (GI), as a measure of root damage and Reproductive Factor (RF) (Sasser et al., 1984) . A nursery was raised in plastic pots that contained heat-sterilized soil. The nursery supplied the pepper and tomato seedlings for potted and field experiments. One pepper seedling each of the variety was transplanted at four weeks old into five-litre plastic pots, which contained heat sterilized soil. A week, after the establishment of the seedlings, each pot was inoculated with a single egg mass of Meloidogyne species. The aqueous nematode suspension was poured into four holes, 2-4 cm deep around the base of the plant. This was done in a Completely Randomized Design and replicated 10 times. The plants were watered daily, weeds were hand-pulled when necessary, and after a period of 60 days, the plants were up-rooted, carefully washed under slow-running water, examined with a hand lens and rated for galling on a 0-5 scale as described by Taylor and Sasser (1978).

Where 0 = no gall;
1 = 1-20% of the root system galled;
2 = 21-40% of the root system galled;
3 = 41-60% of the root system galled;
4 = 61-80% of the root system galled; and
5 = 81-100% of the root system galled.

The final nematode population was estimated by adding the extracted second-stage juveniles by Pie-pan method (Whitehead and Hemming, 1965) from 200 ml soil to the number of eggs extracted from 10 g of roots per variety with the sodium hypochlorite method (Hussey and Barker, 1973). Host efficiency was determined by the calculation of the Reproductive Factor (RF) and using it in combination with the Galling index (GI) (Nwauzor and Fawole, 1992; Almeida and Santos, 2002). RF = Pf/Pi where Pf is the final nematode count and Pi the initial inoculum level. The resulting data was used to indicate resistance or susceptiblity of the various pepper and tomato varieties The varieties were rated resistant, susceptible or tolerant as follows: (GI $\leq$ 2, RF $\leq$ 1) = resistant, (GI $\geq$ 2, RF > 1) = susceptible, (GI $\leq$ 2, RF > 1) = tolerant, according to Canto-Saenz (1983).

All data were transformed with standard procedures when necessary and analyzed with ANOVA with SAS 2002 software and the means separated using LSD at five percent level of significance.

III. Results And Discussion

Using the combination of the values of Reproductive Factor (RF) and Galling index (GI), the screened pepper and tomato varieties were rated resistant, susceptible or tolerant to Meloidogyne spp. (Tables 1 and 2).

The pepper varieties rated resistant were Charleston Bell and Carolina Wonder based on GI $\leq$ 2 and RF $\leq$ 1. The pepper varieties rated susceptible to Meloidogyne spp. (Table 1) were Rodo, Tatase, Bawa and Goliath with GI > 2 and RF > 1. Sombo variety was rated tolerant to M. Spp. when GI $\leq$ 2 and RF > 1. As presented in table 2, the screening result of seven tomato varieties revealed that none of the seven tomato varieties was resistant, Ibadan-Local and Tropmech varieties were susceptible with GI > 2 and RF > 1. However, Big beef, Celebrity, Jetsetter, Roma VFN, and Smallfry varieties of tomato were rated tolerant with GI $\leq$ 2 and RF > 1.

There were significant differences ($P \leq 0.05$) in the final nematode population of the nematode (Meloidogyne. spp) accross the seven pepper and tomato varieties as there were significant differences in the root populations and soil populations accross the varieties (Tables 1 and 2), Significant difference ($P \leq 0.05$) was also observed in the multiplication rate of Meloidogyne spp. on the seven pepper and tomato varieties, with a high Reproductive Factor (RF) on the susceptible ones accross the varieties (Tables 1and 2). Significant galling indices caused by Meloidogyne spp. was observed accross the pepper and tomato plants. Root damage was higher in susceptible varieties than in resistant varieties (Tables 1 and 2).

Table 1: Screening of pepper varieties for resistance to Root-knot nematode.

VARIETIES	EGGS/ ROOT	FINAL NEMATODE POPULATION	Pi	G I	RF*	HOST STATUS
Tatase	1875.0	1975.0	300	2.2	6.6	S
Rodo	2125.0	2265.0	300	2.1	7.6	S
Bawa	1875.0	2065.0	300	2.1	6.9	S
Sombo	1375.0	1445.0	300	1.2	4.8	T
Goliath	2007.0	2182.0	300	2.1	7.3	S
Charleston Bell	22.0	25.0	300	0.4	0.1	R
Carolina Wonder	20.0	25.0	300	0.2	0.1	R
LSD ($P \leq 0.05$)	530.3	506.2		0.8	1.7	

* Final nematode population/Pi.
Pi = initial nematode population, GI = Galling Index, RF = Reproductive Factor, T = Tolerant,
S = Susceptible, LSD is for comparing means within the same column.
All values are means of ten replicates

Table 2: Screening of tomato varieties for resistance to Root-knot nematode.

Varieties	EGGS/ROOT	FINAL NEMATODE POPULATION	Pi	G I	RF*	HOST STATUS
Bigbeef	1214.1	1375.0	300	1.2	4.6	T
Celebrity	1283.9	2250.0	300	1.5	7.5	T
Jetsetter	1222.2	1000.0	300	0.9	3.3	T
Roma vfn	1153.0	1625.0	300	0.7	5.4	T
Ibadan local	1201.4	3125.0	300	2.5	10.4	S
Small fry	1257.9	3000.0	300	1.7	10.0	T
Tropmech	2482.1	3375.0	300	2.0	11.3	S
LSD ($P \leq 0.05$)	203.3	311.0		0.9	1.0	

* Final nematode population/Pi.
Pi = initial nematode population, GI = Galling Index, RF = Reproductive Factor, T = Tolerant,
S = Susceptible, LSD is for comparing means within the same column.
All values are means of ten replicates

Plant-parasitic nematodes of various genera are associated with pepper and tomato as with other plants. These nematodes occur with plants with varying population densities and frequency of occurrence. Some of these nematodes are known pests and pathogens of crops, pepper and tomato inclusive. Crops are known to be resistant or susceptible to root-knot nematode infection, the susceptible or resistant varieties needs to be identified. The root-knot nematode, Meloidogyne incognita is pathogenic on susceptible pepper and tomato with expression of the characteristic galling symptom.

The seven variesties of both pepper and tomato screened for resistance to root knot nematodes were rated susceptible, resistant or tolerant from the trial with fewer numbers of resistant varieties and more susceptible ones (Fery and Thies, 1997; Thies and Fery, 2002). The Galling indices and values of Reproductive Factor indicated effective infectivity of the nematode inoculum in susceptible varieties and vice versa in the resistant ones.

In the trial, susceptible pepper variesties were Tatase, Rodo, Bawa and Golliat while the Sombo was tolerant. However, the charleston bell and carolina wonder varieties of pepper were found to be resistant to rootknot nematodes. For the seven tomatovarieties screened, Ibadan local and Tropmech varieties were susceptible, while Big-beef, Jetstter, Roma VFN, Celebrity and Small-fry varieties were found to be tolerant.

The varieties California Wonder, had been rated susceptible to M. incognita (Fery and Thies, 1997; Nwanguma et al., 2011). The varying response of the pepper varieties to Meloidogyne incognita had been reported in other crops such as tomato (Almeida and Santos, 2002), cassava (Coyne and Talwana, 2000), sweetpotato (Cervantes-Flores et al., 2002) and cowpea (Olowe, 2007). Castillo et al. (2001) identified susceptibility in pepper with root damage shown by damaged root systems, and galls (DiVito et al., 2004).

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 reduced the fresh weights of both crops (Mekete et al., 2003). El-Sherif et al. (2007) reported that at two levels (1000 and 2000), 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.

Use of resistant rootstocks is an effective control method for plant-parasitic nematodes. Fruit trees such as Prunus spp., Citrus spp., Vitis spp. are usually grafted onto rootstocks possessing resistance to soil borne pathogens and pests, including nematodes. Rootstocks are also used to improve plant growth. Use of grafted vegetable seedlings, especially watermelon, melon, cucumber, tomato, pepper and eggplant, has been popular in some countries, such as Japan (Lee and Oda, 2003). Withdrawal of effective nematicides and adverse effects of the use of pesticides have promoted development and use of rootstocks in vegetable crops. In the present study, pepper and tomato were tested for resistance to root-knot nematodes. Carolina Wonder and Charleston Belle, which have been reported to be resistant to M. incognita (Fery et al., 1998), were also found to be resistant to the root-knot nematode utilized in this study. Several accessions of Capsicum spp. have been tested for resistance to four Meloidogyne species, and different levels of resistance to the nematodes were found (Di Vito et al.,1991). Resistance of C. chinense lines has also been reported (Fery and Thies, 1997; Thies and Fery, 2000). The rootstock AR-96023, the lines of C. frutescens, and hot pepper cv. Charleston Hot and Carolina Cayenne showed resistance to M. incognita in both growth chamber and greenhouse experiments.

In conclusion, the findings of this study indicate that some of the root-knot nematodes screened in this study may be a virulent strain of M. incognita, or another species entirely. Further studies are on-going for the molecular identification of the root-knot nematode population isolated from this study. This study provides a baseline information for the selection of appropriate scions and rootstocks combination to be used in future root-knot nematode management using resistant rootstock.

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