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Susceptibility of elite cultivars of pepper *Capsicum fruitisens* to the root-knot nematodes, *Meloidogyne incognita* Race 2, in parts of Southwestern Nigeria

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Abstract

Two season field trials were conducted in the early and late planting seasons of 2008 to test the vulnerability of thirty-two elite cultivars of pepper collected from Southwestern Nigeria to *Meloidogyne incognita* attack. Infested root systems of field grown twelve week-old *Celosia argentea* L. cv. TLV-13 was ploughed 0.20m depth into the experimental plot to serve as primary source of inoculums. Initial population of the predominant nematodes species prior to experimentation was determined from composited 200cm^3 soil sample. The design was a randomized completed block with three replications. Resistance to *M. incognita* was observed in six of the tested lines while eight cultivars were highly susceptible to the nematodes with significantly high number of eggs, soil and root nematode populations as well as highest values in root-knot rating. Plant biomass was also significantly low at 5% level of probability in susceptible cultivars. Other cultivars displayed varying degrees of virulence to the nematodes. None of the tested cultivars was immune to the pest attack. Line AI07-8 recorded the highest number of seeds. The number of fruits and corresponding weights were significantly higher in eight of the tested cultivars. However, AI07-3 had the highest significant yield value suggestive of its genetic desirability in breeding program.

Keywords: *Meloidogyne incognita*; pepper cultivars; susceptibility

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1. Introduction

Pepper, *Capsicum* species belongs to the family Solanaceae (Gill, 1998). Pepper is a short-lived herb normally grown as an annual crop or a shrubby perennial. In tropical Africa, the four main types (sweet pepper, chilli pepper, bird pepper and aromatic pepper) are grouped into two main classes namely the sweet (bell-shaped) *C, annum* and the hot (chilli) peppers *C. frutescence*. The genus Capsicum is widely cultivated in Nigeria within latitude 7^0 23^0N and longtitude 3^0 50^0E with altitude of 168m above sea level. They are often grown sole or intercropped with other vegetables or in mixtures with starchy staple food crops such as Cassava (*Manihot* spp), Yam (*Discrorea* spp) etc. (Grubben and Tahir, 2004). Pepper is a shade tolerant crop and day neutral up to 45% solar radiation. It thrives well in well drained sandy-loam top soils with pH of between 5.5-5.8. Nutrient requirement in pepper production is put at 130kgN, 80kgP and 110kgK while rainfall requirement for optimum growth is 600mm (Grubben and Tahir, 2004).

Peppers are rich sources of vitamins and minerals and are veritable ingredient in the production of various spices, hot sauces, canned foods preservatives, ginger beer and some pharmaceutical formulations (Grubben and Tahir, 2004). Growth and yield reduction in pepper production are related in part to the biological stress occasioned by nematode attack (Berkelaar, 2000). The quest for increased production is often constrained by root-knot nematodes which constitute one of the biotic factors militating against increased pepper production. Increasing cropping intensity in an effort to satisfy the demands of the consumer populace has encouraged high dependence on pesticides usage (Aminu-Taiwo 2007). However their usage is not environmentally friendly due to the hazards they cause both to man and the environment. The need to evaluate other safe methods of controlling their menace becomes imperative. There is evidence to suggest that genetic resistance provides a sustainable method for nematode control. However, the utility of resistant cultivars often diminish upon continuous cropping due to increased nematodes populations pressures (Nwanguma, et al*.*, 2010) the approach remains the most cost-effective, environmentally-safe and ecologically-sound nematode management tactics (Ng'ambi et al.,1995). There is dearth of information on the vulnerability of some land races of pepper to nematode invasion in infested field. The identification of nematode resistant lines will be a useful tool in genetic improvement programs. Several methods have been standardized for evaluating for root-knot nematode resistance.

Evidence of the existence of races for some *Meloidogyne* species demonstrated a need to evaluate cultigens response to specific race(s). Afolami (2000) however showed the need to extend resistance screening against root-knot nematodes infestation to include yield responses in order to avoid the danger of overestimation when the plant is hypersensitive or underestimating the plant reaction when they are hyper susceptible to the prevailing nematode species. This study was undertaken to evaluate the susceptibility of some elite cultivars of pepper to *Meloidogyne incognita* Race 2 (Kofoid and White, 1919) Chitwood, 1949 infestation and to obtain some indication of possible effect on their growth due to the nematode attack.

2. Materials and methods

Two field trials were carried out in the rainy and dry seasons 2008 at the vegetable research plot of the National Horticultural Research Institute of Nigeria (NIHORT), Ibadan which lies between latitude 70 24' N and longitude 30 54' E in a high humidity of 80% region to evaluate the reactions of 32 pepper cultivars to the root knot nematodes, *Meloidogyne incognita* Race 2. in naturally infested soils as well as their effect on some growth and yield parameters of pepper in the early and late cropping seasons of 2008. Physical and chemical properties of the soils are in (Table 1).

Table1. Physical and chemical properties of the experimental field

Parameter	experimental field	
	0-15cm	15-30cm
Acidity (cmol/kg^{-1})	0.1	0.3
pH (1:1)H_2O	5.4	4.5
pH (1:1)KCl	4.6	3.5
ECEC (cmol/kg^{-1})	20.8	24.6
Total N (g/kg^{-1})	1.1	0.6
Available P (mg/kg^{-1})	26.4	10.9
K (cmol/kg^{-1})	1.5	1.7
Ca (cmol/kg^{-1})	12.6	15.2
Mg (cmol/kg^{-1})	5.8	6.4
Na (cmol/kg^{-1})	0.9	1.0
Zn (cmol/kg^{-1})	72.8	70.6
Cu (cmol/kg^{-1})	12.3	11.0
Mn (cmol/kg^{-1})	120.3	175.3
Fe (cmol/kg^{-1})	92.4	106.7
Sand (g/kg-1)	812.0	722.0
Silt (g/kg^{-1})	95.0	84.0
Clay (g/kg^{-1})	95.0	194.0
Organic C (%)	10.0	7.6
Texture	sandy-loam	

Pepper fruits from which the seeds of the pepper cultivars were extracted were collected from different locations in Southwestern Nigeria. The seeds of each cultivar were raised in steam-sterilized sandy-loam top soil. Prior to experimentation, root-knot nematode- susceptible *Celosia argentea* L. cv. TLV-13 seeds were sown in the plot to increase the population of the pathogens. Twelve week after sowing, the nematode-infected root systems of the celosia plants were ploughed 0.20m deep into the soil to serve as primary source of inoculum. Pre-plant soil samples from the plot were collected using the systematic sampling technique. The soil samples were taken to the laboratory for bioassay to determine the population of the nematodes. The population of the second-stage juveniles (J_2) of *M. incognita* identified at the onset of each trial was 814 and 825 respectively. Six week old pepper seedlings were transplanted 0.5m x 0.75m apart in plots 2.0m x 3.0m in size. The trials were replicated three times in a randomized complete block design. Six weeks after plant establishment, five plants which had earlier been tagged within each plot were carefully harvested by uprooting using a garden fork to determine the soil and root nematode populations. The soil nematode population was assessed from composited 200cm^3 soil sample collected around the root rhizosphere of the tagged plants in each plot using the method of Whitehead and Heming (1965) modified tray method. Root nematode populations were determined using the method of Byrd et al. (1983). The numbers of eggs per root system were determined using the method of Hussey and Barker (1973). The root systems were also rated for gall development using the method of Barker (1978) viz: 0=Immune; 1=Highly resistant; 2=Resistant; 3=Moderately susceptible; 4=Susceptible; 5=Highly susceptible. The second batch of plants consisting of four plants in each plot was used for measuring growth parameters and yield assessment. The fraught of root degeneration as the pepper plant ages that would have led to inaccurate assessment of root galls was surmounted by the first premature destructive harvesting of five plants within each plot. The pooled data was subjected to analysis of variance (ANOVA) test using the SAS (1987) statistical tool while the means were partitioned using the Duncan's Multiple Range Test (DMRT) at 5% level of probability.

3. Results and discussions

The weather elements varied in the two seasons due to agro ecology in which the crop was grown. The raining season crops benefited from the higher amount and widely distributed rainfall, but were adversely affected by lower sunshine, season has been reported to significantly affect the crop because of the variability in climate conditions and their interaction with the cultivars (Idowu-Agida et al 2012). The results obtained from the studies showed that none of the tested pepper cultivars was immune to *M. incognita* attack. Six cultivars AI07-5, AI07-6, AI07-16, AI07-17, AI07-29, and AI07-30 were resistant to the nematodes. The differential vulnerability of cultivars to the pest invasion could be attributed in-part to the dearth of emigration of the nematodes from the roots or due to failure by the nematodes to establish a feeding site in resistant cultivars which explains the fewer numbers of the nematodes in the roots of the cultivars. These results thus imply that incompatible reactions to root-knot nematodes attack are often expressed in resistant cultivars. This phenomenon probably explains the differential reactions of the pepper cultivars to *Meloidogyne incognita* invasion. The observations of Ng'ambi et al. (1995).were in consonance with this view

Susceptibility to the nematodes attack was significantly highest (HS) in AI07-2, AI07-4, AI07-11, AI07-14, AI07-19, AI07-22, AI07-31 and NHV1-F (control). These pepper cultivars recorded significantly high number of egg masses, soil and root nematode populations as well as root-knot rating (Table 2). Five cultivars were susceptible (S) while 12 cultivars were moderately resistant (MS) to the nematode invasion. Regardless of the differences in host status of the cultivars, plant height showed no correlation with severity indices which suggest a display of genetic variability among the tested lines (Table 3).

Table 2. Reactions of pepper cultivars to *Meloidogyne incognita* in naturally intested soil

Cultivar/ Accession	Location	Soil nem.pop. /200cm3 soil	Root nem. Pop./5g wt. root	Egg pop. /5g wt. root	Root-knot rating (1-5)
AI07-1	Sango	624	10	339	2.33c
AI07-2	Saasa	1122	19	723	4.33a
AI07-3	Oja-oba	584	13	401	2.67c
AI07-4	Bodija	1076	15	701	4.00a
AI07-5	Ogbomoso	196	6	355	1.67d
AI07-6	Odo-oba	210	8	401	1.67d
AI07-7	Saki	801	10	504	2.00cd
AI07-8	Ikire	1649	21	687	4.33a
AI07-9	Ile-ife	995	12	465	3.67ab
AI07-10	Osogbo	573	9	444	2.33c
AI07-11	Ikirun	1129	19	689	4.33a
AI07-12	Ado-ekiti	601	12	323	2.33c
AI07-13	Ikole	589	10	554	2.33c
AI07-14	Aramoko	1112	17	701	4.33a
AI07-15	Ifaki	765	12	534	3.00b
AI07-16	Otta	324	11	227	1.60d
AI07-17	Abeokuta	278	9	231	1.67d
AI07-18	Sagamu	546	8	346	2.67bc
AI07-19	Ago-iwoye	1089	21	699	4.67a
AI07-20	Offa	866	16	489	3.00b
AI07-21	Ilorin	563	8	351	2.67bc
AI07-22	Igbaja	1221	20	747	4.67a
AI07-23	Omu-aran	657	9	340	2.33c
AI07-24	Ikorodu	677	9	379	2.67bc
AI07-25	Ipaja	890	15	470	3.00b
AI07-26	Oshodi	899	15	511	3.33b
AI07-27	Agege	632	9	384	2.33c
AI07-28	Akure	600	9	394	2.33c
AI07-29	Ore	309	5	193	1.67d
AI07-30	Ikare	298	6	189	1.50d
AI07-31	Ifon	1224	17	661	4.00a
NHV1-F	Ibadan	2579	20	780	5.00a

Means with the same letter are not significantly different at P = 0.05 by DMRT.

Table 3. Effect of root-knot nematodes on some growth and yield parameters of pepper cultivars

Cultivar/ Accession	Location	Day to 1st flowering	Ht at 50% flowring (cm)	No.of fruits /plant.	Fruit weight/ plant (g)
AI07-1	Sango	88	4.8	8.8	48.31
AI07-2	Saasa	166	7.8	16.6	98.3
AI07-3	Oja-oba	189	6.7	18.9	119.3
AI07-4	Bodija	179	11.2	17.9	126.5
AI07-5	Ogbomoso	146	5.9	14.6	82.6
AI07-6	Odo-oba	132	6.6	13.2	76.2
AI07-7	Saki	192	8.3	19.2	105.2
AI07-8	Ikire	181	5.4	18.1	108.6
AI07-9	Ile-ife	165	6.9	16.5	85.0
AI07-10	Osogbo	180	14.1	18.0	84.4
AI07-11	Ikirun	123	6.1	12.3	64.6
AI07-12	Ado-ekiti	133	7.6	13.3	81.1
AI07-13	Ikole	130	8.6	13.0	79.9
AI07-14	Aramoko	148	27.7	14.8	88.6
AI07-15	Ifaki	94	9.0	9.4	63.6
AI07-16	Otta	121	11.6	12.1	69.3
AI07-17	Abeokuta	165	17.2	16.5	84.2
AI07-18	Sagamu	113	6.6	11.3	66.5
AI07-19	Ago-iwoye	139	5.7	13.9	78.4
AI07-20	Offa	114	9.1	11.4	72.8
AI07-21	Ilorin	128	12	12.8	68.4
AI07-22	Igbaja	126	10.9	12.6	68.5
AI07-23	Omu-aran	162	6.5	16.2	93.6
AI07-24	Ikorodu	126	5.8	12.6	73.7
AI07-25	Ipaja	148	7.17	14.8	74.7
AI07-26	Oshodi	161	7.97	16.1	79.9
AI07-27	Agege	147	12.97	14.7	81.7
AI07-28	Akure	190	11.17	19.0	111.6
AI07-29	Ore	181	9.9	18.1	116.2
AI07-30	Ikare	153	9.63	15.3	82.5
AI07-31	Ifon	185	10	18.5	114.9
NHV1-F	Ibadan	176	2.8	22.43	82.0
LSD (0.05)		62	3.9	6.2	38.0

Day to flowering was late in eight cultivars with a range of 181 to 192 days. These cultivars also recorded the highest number of fruits with corresponding heaviest fruit weights. Yield responses were significantly high in IA07-3 with moderate resistance (MS) (Table 3). This may have resulted from host responses to nematode infection. Nematodes feeding on susceptible hosts usually stimulates increased tertiary roots proliferation which results in enhanced absorption and nutrient- flow thus reflecting in enhanced yield of the plants.

The screening of germplasm for resistance to nematodes usually terminates at about six to eight weeks without taking the yield of the crop into consideration. The findings of Afolami (2000) have shown such assessment to be fraught with the danger of overestimating them where the plant is hypersensitive or underestimating them where the plant is hyper-susceptible. It therefore implies that the effect of these pests on some aspects of plant productivity would have been overlooked if yield had not been considered. Thus, the differences in the growth and yield responses of the cultivars to *M. incognita* and the degree of infection suggest a variability of tolerance to infection and consequently provide some scope for future breeding programs.

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