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Pathogenicity of *Meloidogyne Incognita* Race I on Nigerian Pepper (*Capsicum spp*) Lines

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ABSTRACT

Twelve indigenous pepper lines (*UNS$_2$, UNS$_3$, NSKY-LP, Atanukwu, Sombe, NSKY-SE, Attarugu, Tatasai, Dangarawa, Oshosho, NSKY-RW* and a Hybrid between *Sombe* and *NSKY-RW*) were assayed for their reactions to *M. incognita* race 1 at Nsukka. Individual plants were inoculated with 2,000 eggs of the nematode species. Uninoculated plants served as the control. Infected plants were scored for galling and egg mass production on a 0-5 rating scale. The pepper lines differed significantly in their severity of galling. *NSKY-LP, NSKY-SE* and *Attarugu*, had significantly fewer gall and egg mass counts per root system and per gram fresh weight of root than the other lines and were consequently accorded resistant status. They had gall indices of less than 2. *UNS$_2$*,, *Dangarawa* and *Oshosho* were moderately susceptible (GI = 2.33). The rest of the lines were highly susceptible (GI > 3). The nematode infection decreased root and shoot growth, fresh and dry weights of root and shoot of *Atanukwu, sombe, Tatasai, Dangarawa, NSKY-RW* and the Hybrid when compared with the controls. The number of fruits set was significantly reduced in *UNS$_2$, Atanukwu, Sombe Tatasai, Oshosh and NSKY-RW.* Fruit yields were not significantly reduced in *NSKY-LP, NSKY*-SE and the Hybrid. Yield reduction ranged from 7% to 81% among the pepper lines. *NSKY-LP, NSKY-SE* and *Attaragu* could be used for resistance breeding programme. The hybrid could be utilised as a planting material in soils infested with *M. incognita* race I.

KEYWORDS: Pepper lines, *Capsicum, Meloidogyne incognita, Resistance*, Tolerance.

INTRODUCTION

Pepper (*Capsicum* Spp.) belongs to the family of Solanacae. There are both cultivated and wild species in the genus *Capsicum*. The two widely grown species are the bell or sweet peppers (*Capsicum annuum L.)* and the pungent or "bird eye" peppers (*Capsicum frutescens)*. Pepper is an important spice crop, highly cherished for its pungent flavour. It is rich in vitamins A and C (Yayock *et al.*, 1988).

The cultivation of pepper under field's culture, especially in the humid tropics is limited by pests and diseases (Williams *et al.*, 1991). Root-knot nematodes (*Meloidogyne* spp) are major constraint to global production of pepper (Judy *et al.*, 2002). Chemicals have been effectively used in the management/control of root-knot nematodes. However, their adverse effects on the environment, non-target organisms and prohibitive cost, have contributed to renew interest in alternative control methods. Host resistance appears to be the most economical alternative method of control. In less developed countries where chemical control is difficult to implement, plant resistance has been considered repeatedly as the most promising component of nematode pest management. Hare (1957) reported that resistance in pepper (*Capsicum annuum* L.) is controlled by a dominant gene *N*. It has also been shown that pepper lines in *Capsicum frutescens* L. differ in their reaction to the root-knot nematode, *Meloidogyne incognita acrita* (Hare, 1956). Sources of resistance to M. *incognita, M. javanica, M. arenaria* and *M. hapla* were found in lines of *C. frutescens* L., *C. chacoens* Hunz and *C. chinense* Jacq. by Di. Vito *et al.* (1991). Judy *et al* (2002) have recently developed and released root-knot nematode resistant bell peppers at the U.S. vegetable laboratory in Chaleston. They reported that, cultivars *Chaleston Belle* and *Carolina Wonder* were highly resistant to *M. incognita, M. javanica* and *M. arenaria* compared to their respective susceptible recurrent parents: *Keystone Resistant Giant and Yolo Wonder B.*

This experiment was carried out to assess the reaction of twelve indigenous pepper lines to infection by *Meloidogyne incognita* race 1 under greenhouse conditions.

MATERIALS AND METHODS

Two *Capsicum annuum L.* lines (*Tatasai*, and *Sombe)* and ten *C. frutescens* L. lines (*UNS$_2$, UNS$_3$, NSKY-LP, Atanukwu, NSKY-RW, NSKY-SE, Attaragu, Dangarawa, Oshosho* and a hybrid obtained from a cross between *Sombe* and *NSKY-RW)* were obtained from the Department of Crop Science, University of Nigeria Nsukka pepper germplasm and used for the study. Seedlings were raised in steam-sterilized soil mixture of sandy loam, compost soil, and river sand mixed at a ratio of 3:2:1 by volume. Nsukka population of *M. incognita* race 1 maintained on begonia plants (*Begonia rex-cultorum)* served as inoculum source. This population was multiplied on Indian Spinach (*Bassela rubra)* in the greenhouse. Root-knot nematode eggs were extracted from the heavily galled roots of the Indian Spinach using Sodium hypochlorite (NaOCl) technique (Hussey and Barker, 1973). Thirty millilitre of the inoculum suspension contained approximately 2,000 eggs by count. Four-week-old pepper seedlings were transplanted on 22nd December, 2003, into 15-cm diameter clay pots containing 1kg steam –sterilized soil mixture. Seedlings were inoculated with 2,000 eggs per pot by adding the inoculum in depression made in the soil round each young seedling. Uninoculated seedlings of each cultivar served as the control. The experiment was a Completely Randomized Design (CRD) with five replicates. The pots were watered twice daily. Twenty grams of a compound fertilizer N-P-K (15-15-15) was dissolved in 30 litres of tap water and was applied every other day through out the duration of the experiment (Oscar and Donald, 1988). Plants were grown at a mean day temperature of 29^0 C and mean night temperature of 20 ^{0} c for 125 days. Data were collected on the number of

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Table 1: Effect of *Meloidogyne incognita* race 1 on susceptibility of pepper lines.

Pepper line		Number of Galls per Root system wt.	Gram fresh Of root	*Gall index	Number Of egg masses	Egg mass index /Root system
UNS₂	U	-	-	-	-	-
	I	10.33	0.54	2.33	6.00	2.33
UNS₃	U	-	-	-	-	-
	I	83.33	3.35	4.67	40.66	4.00
NSKY-LP	U	-	-	-	-	-
	I	8.00	0.57	2.00	2.67	1.67
Atanukwu	U	-	-	-	-	-
	I	53.00	3.32	3.67	35.00	3.33
Sombe	U	-	-	-	-	-
	I	32.67	2.83	3.10	20.67	3.00
NSKY-SE	U	-	-	-	-	-
	I	4.33	0.17	1.33	1.33	1.00
Attaragu	U	-	-	-	-	-
	I	8.00	0.36	2.00	2.00	1.00
Tatasai	U	-	-	-	-	-
	I	69.33	6.44	4.00	45.33	3.33
Dangarawa	U	-	-	-	-	-
	I	7.00	0.38	2.33	6.33	2.33
Oshosho	U	-	-	-	-	-
	I	12.00	0.40	2.33	7.33	2.33
NSKY-RW	U	-	-	-	-	-
	I	27.66	1.69	3.33	18.33	3.00
Hybrid	U	-	-	-	-	-
LSD(0.05)				2.33	4.00	2.00
	I	9.00	0.75	1.34	24.73	1.19
		40.81	3.69			

U = Uninoculated Control
I = Inoculated.

*GI = 0 Immune
GI = 1 Highly resistant
GI = 2 Resistant
GI = 3 Moderately susceptible
GI = 4 Susceptible
GI = 5 Highly susceptible

galls per root system, number of galls per gram fresh weight of root, as determined by Khan and Khan (1995), fresh weight of root and shoot, number of fruits per plant, total weight of fresh fruit per plant and mean weight of fruit. For egg mass count, fresh root was stained with phloxine B (0.15g/l) for 15 minutes (Daykin and Hussey, 1985). Roots and shoots were dried in hot air oven at 60 ^{0}c for 48hr to determine dry weights. Root-gall or egg mass index was determined on a 0-5 scale rating used in the International *Meloidogyne* Project (IMP, 1978): 0= 0, 1=1-2, 2 = 3- 10, 3 = 11-30, 4 = 31-100 and 5 = > 100 galls or egg masses per root system. The data were statistically analysed using the analysis of variance (ANOVA). Means were tested using the F-LSD at 5% level of probability. The uninoculated controls were compared with the inoculated treatments using the t-test.

RESULTS

The pepper lines differed significantly in their severity of galling (Table 1). *NSKY-LP, NSKY-SE,* and *Attaragu,* had significantly fewer gall counts per root system and per gram fresh weight of root than the others. They had gall indices (GI) of less than 2. *UNS₂, Dangarawa* and *Oshosho* were moderately susceptible (GI = 2.33). The rest of the lines were highly susceptible (GI>3.0). Egg mass production followed the trend of galling. Generally, the nematode species reduced root and shoot growth of all the pepper lines when compared with their respective controls (Table 2). However, this reduction was not significant in *UNS₂, UNS₃, NSKY-SE* and *Attaragu.* Similarly, there was no significant decrease in fresh root and shoot weights in these pepper lines. The pepper lines inoculated with the nematode species differed significantly in their shoot growth, fresh root and shoot weights due to inherent genotypic differences. There was a general decrease in dry matter accumulation in the infected roots by the nematode species in all the pepper lines except, *NSKY-SE* and *Attaragu* (Table 3). Significant reduction in root dry weight occurred only in *UNS₃, Tatasai, Dangarawa* and *NSKY-RW.* Similarly, significant decrease in shoot dry weight was observed in *Atanakwu, Sombe, Tatasai Dangarwa, Oshosho, NSKY-Rw* and the hybrid. The nematode significantly inhibited fruit-set in the lines, *UNS₂, Atanakwu, Sombe, Tatasai Oshosho* and *NSKY-RW* when compared with their respective controls (Table 4). The nematode also caused a decline in total weight of fresh fruits per plant in all the inoculated plants when compared with their respective controls. Yields were suppressed by 7%, 16%,

Table 2: Effect of *Meloidogyne incognita* race 1 on growth and fresh weight of root and shoot of different pepper lines.

Pepper line		Root length (cm)/plant	Shoot length (cm)/plant	Root weight (g)/plant	Shoot wt. (g)/plant
UNS$_2$	U	20.00	56.67	19.32	45.30
	I	18.00	48.67	13.73**	41.32
UNS$_3$	U	19.33	59.33	26.91	41.31
	I	14.00	54.48	23.13	38.89
NSKY-LP	U	20.00	56.00	23.84	45.04
	I	15.67*	58.00	14.02*	42.08
Atanukwu	U	20.67	63.00	21.50	97.22
	I	15.67**	40.83**	17.58**	44.32**
Sombe	U	19.00	62.33	15.37	42.93
	I	13.33	45.20**	10.93*	29.07**
NSKY-SE	U	19.00	62.33	24.06	49.55
	I	18.67	61.33	20.71	44.25
Attaragu	U	19.33	70.33	24.16	74.53
	I	16.17	63.67	21.26	67.29*
Tatasai	U	19.00	51.67	19.71	50.18
	I	11.67**	34.33**	14.11**	33.50**
Dangarawa	U	21.67	73.67	28.26	66.18
	I	18.67	56.33*	24.49	41.35**
Oshosho	U	20.33	80.67	27.64	84.14
	I	14.00**	72.00	26.97	51.06**
NSKY-RW	U	21.00	65.67	16.92	77.10
	I	19.00	51.67**	15.54	49.92**
Hybrid	U	19.67	69.33	20.88	79.99
	I	16.33	59.00*	12.51*	44.95**
LSD (0.05)		Ns	13.52	6.24	15.58

U = Uninoculated control, I = inoculated. LSD compares the means of pepper lines inoculated with the nematode species.
*. and ** significantly different from their respective controls at 5% and 1% probability level, respectively, using the t – statistic.

Table 3: Effect of *M. Incognita* race 1 on dry matter production of different pepper lines.

Pepper line		Root dry weight (g)/Plant	Shoot dry wt. (g)/plant
UNS$_2$	U	6.43	11.86
	I	3.19	11.41
UNS$_3$	U	7.52	13.86
	I	6.43*	12.22
NSKY-LP	U	5.04	13.62
	I	4.80	11.84
Atanukwu	U	6.77	23.67
	I	5.15	11.64**
Sombe	U	3.51	11.14
	I	2.41	7.36**
NSKY-SE	U	4.22	17.33
	I	5.46	13.22
Attaragu	U	5.57	21.22
	I	6.09	20.00
Tatasai	U	3.63	11.66
	I	2.41**	7.85*
Dangarawa	U	5.07	18.95
	I	3.51**	10.89**
Oshosho	U	6.09	21.44
	I	5.74	17.73*
NSKY-RW	U	6.74	20.40
	I	5.57*	11.36**
Hybrid	U	6.03	21.65
	I	4.59	12.80**
LSD (0.05)		1.98	4.65

U = Uninoculated control I = inoculated. LSD compares the means of pepper lines inoculated with the nematode species. *and * significantly different from their respective controls at 5% and 1% level of probability, respectively, using the t-statistic.

Table 4: Effect of *M. incognita* race 1 on the yield of different pepper lines.

Pepper line		Number of fruits/plant	Total fresh wt. of fruit/plant (g)	Mean wt. of fruit (g)
UNS₂	U	29.67	75.67	2.56
	I	15.67*	39.69**	2.53
UNS₃	U	8.67	36.33	4.21
	I	7.00	19.71**	2.37*
NSKY-LP	U	10.00	35.90	3.57
	I	6.67	28.11	4.26
Atanukwu	U	25.00	164.51	6.55
	I	9.33**	67.01*	7.28
Sombe	U	13.00	82.63	6.38
	I	9.33*	55.42*	6.05
NSKY-SE	U	14.00	38.01	2.72
	I	11.00	35.50	3.27
Attaragu	U	22.33	126.27	5.64
	I	18.33	86.96*	4.72
Tatasai	U	7.33	107.56	14.65
	I	5.33*	68.36**	12.93
Dangaraw a	U	15.67	177.56	11.33
	I	11.67	144.68*	9.82**
Oshosho	U	16.00	104.25	6.52
	I	10.00*	57.19*	5.74
NSKY-RW	U	67.00	254.97	3.84
	I	15.33**	47.90**	3.13**
Hybrid	U	14.67	62.30	4.25
	I	13.33	52.36	3.92**
LSD (0.05)		2.45	13.59	1.14

U = Uninoculated control I = Inoculated
LSD compares the means of pepper lines inoculated with the nematode species.
* and ** significantly different from their respective controls at 5% and 1% level of probability, respectively, using the t-statistic

21%, 31%, 33%, 35%, 36%, 45%, 46%, 48%, 59%, and 81% in the lines, *NSKY-SE, Hybrid, NSKY-LP, Attaragu, Sombe, Dangarawa, Tatasai, Oshosho, UNS₃, UNS₂, Atanakwu and NSKY-RW,* respectively. Statistically, yields were not significantly reduced in *NSKY-SE, Hybrid* and *NSKY-LP.* The results of mean fruit weight showed no consistent trend when inoculated pepper lines were compared with their respective controls (Table 4). There was increased fruit size in nematode inoculated *NSKY-LP, Atanakwu and NSKY-SE,* while there was a decrease in the rest. However, there was a significant reduction in fruit weight in *UNS₃* , *Dangarawa, NSKY-RW* and the Hybrid.

DISCUSSION

Evidence from this study showed that amongst the twelve indigenous pepper lines tested, *NSKY-SE, NSKY-LP* and *Attaragu* were resistant to *M incognita race 1.* Although the rest of the lines were rated susceptible, *UNS₃, Dangarawa and Oshosho* were moderately susceptible. These findings agree with the reports of earlier investigators (Hare, 1956; Hare, 1957; Di Vito *et al*, 1991; Judy *et al; 2002).* It is possible that the resistant pepper lines had the resistance gene *N.* However, the genetic basis of resistance in these pepper lines should be ascertained by plant breeders. Plant resistance to nematode attack is influenced by various physical/biological factors. Failure of host to elicite a compatible response could come from synthesis of metabolic inhibitors, hypersensitivity at feeding site, or failure of host tissue to keep pace with the nutritive demands of the nematode. Various mechanisms of resistance are used by different species of plants (Giebel, 1982; Bajaj *et al;* 1983; Mote, 1988).

Dry matter production and yields were not significantly reduced in the resistant lines but were significantly reduced in the susceptible lines. The Hybrid, although rated susceptible, appears to have some innate attributes for tolerance as indicated by the high fresh fruit yield. A plant that survives and gives satisfactory yield at a level of nematode infection that causes economic loss on other varieties of the same species is tolerant (Fassuliotis, 1979). Canto-Saenz (1985) defines a tolerant plant as an efficient host that suffers no statistically significant growth and yield reduction. The discernible decline in fresh fruit yield of the other susceptible lines is an index of intolerance to the nematode species. Fox and Spasoff (1976) had shown that tolerance to attack by *Heterodera solanacearum* in tobacco was genetically independent of resistance and could be identified and selected. It follows then that, if pepper lines tolerant of root-knot nematode attack were identifiable and the trait inherited, tolerance could be incorporated in cultivars for commercial use. Therefore, the pepper lines, *NSKY-SE, NSKY-LP* and *Attaragu* could be used for root-knot nematode resistance breeding programme. The hybrid could also be judiciously utilised as a planting material in soils infested with *M. incognita* race I. The reaction of these pepper lines to other races of *M. incognita* may differ. Thus, the pepper lines evaluated in this trial should be assayed for their responses to other races of this nematode species.

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