RESPONSE OF FOUR KENAF (*HIBISCUS CANNABINUS* L.) PLANT INTRODUCTIONS TO *MELOIDOGYNE INCOGNITA* RACE 3[†]

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ABSTRACT

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Kenaf plant introductions (PI468074, PI468075, PI468076, PI468077) were evaluated in the greenhouse for their host response to *Meloidogyne incognita* (Kofoid & White) Chitwood race 3. Five-day-old seedlings were inoculated with 5 000 eggs and juveniles/500 cm^3 soil and maintained for 60 days. Uninoculated plants served as controls. Kenaf cv. Everglades 71, a parent of the PI's, was included for comparison. Plant height, shoot and root weights of PI468077 were significantly reduced by *M. incognita*. Plant growth of PI468075 was not reduced by the nematode. *Meloidogyne incognita* reproduced on all PI's and Everglades 71. Reproductive factors (Rf = final population/initial population) were greater than 14 for all PI's.

Key words: fiber crop, *Hibiscus cannabinus*, kenaf, *Meloidogyne incognita*, plant introductions.

RESUMEN

Lawrence, G. W., C. L. Webber y K. S. McLean. 1994. Respuesta de cuatro introducciones del cultivo Kenaf a *Meloidogyne incognita* raza 3. Nematrópica 24:95-101.

Las introducciones (PI468074, PI46875, PI468076 y PI468077) del cultivo Kenaf se evaluaron como hospedantes de la raza 3 de *Meloidogyne incognita* en condiciones de invernadero. Plántulas de 5 días se inocularon con 5 000 huevos y juveniles/500 cm^3 de suelo y mantenidas 60 días. Plátulas no inoculadas sirvieron como testigo. El cultivar de Kenaf, Everglades 71, un pariente de las introducciones se incluyó también para comparase. La altura y pesos de raíces y follaje de la PI468077 fueron significativamente reducidos por *M. incognita*. El crecimiento vegetal de la PI468075 no fue reducido en las introducciones como en el Everglades 71. Los índices reproductivos (Rf = Pf/Pi) fueron 14 veces más que en todas las introducciones.

Palabras clave: cultivo fibroso, *Hibisucs cannabinus*, kenaf, *Meloidogyne incognita*, introducciones vegetales.

Kenaf (*Hibiscus cannabinus* L.) is an annual fiber crop grown in several areas of the world for its soft bast fibers. Kenaf has been used to make ropes, fishing nets, backing for rugs, twines and cables (7). Kenaf fibers are of particular interest in the southeastern United States for use as a blend with wood pulp for paper products.

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Newsprint made from a blend of kenaf with pine-derived wood pulp is smoother and has better printability than newsprint made from wood pulp alone (12,14).

In the United States, a major emphasis on kenaf production is planned for the Mississippi Delta region on land currently in cotton and soybean production (12). A serious limitation to kenaf production is its susceptibility to plant-parasitic nematodes (4,8,10,11,12,13,16). *Meloidogyne spp.* are the most serious nematode pests to kenaf production (16). *Meloidogyne incognita* has been demonstrated to reduce kenaf growth and yield in both greenhouse and field tests (2,4,11,12,13). Additionally, kenaf is susceptible to all four races of *Meloidogyne incognita* (16).

In 1953, the U. S. Department of Agriculture initiated a kenaf breeding program to identify resistance to *Meloidogyne spp.* Kenaf selections, plant introductions and available cultivars were examined and all determined to be susceptible to *M. incognita* (15). However, the variability within the selections and cultivars was sufficient to initiate a breeding program designed to improve tolerance to *M. incognita.* Although researchers reported genetic material with some degree of resistance, much of the early work was conducted prior to the recognition of host races (16) and without a commonly accepted definition of host resistance. The objectives of this research were to examine 4 kenaf plant introductions for suitability as hosts of *Meloidogyne incognita* race 3 and to obtain an early indication of their tolerance to the nematode.

MATERIALS AND METHODS

A population of *M. incognita* (Kofoid & White) Chitwood race 3 was obtained from infected cotton plants (*Gossypium hirsutum*) and increased on tomato (*Lycopersicon esculentum*). Eggs and second-stage juveniles (J2) were extracted by cutting the roots into 0.5-cm pieces and placing them in 0.525% sodium hypochlorite for four minutes (9). The resulting suspension was passed through a 75-µm-pore sieve (200 mesh) nested over a 28-µm-pore sieve (500 mesh). Eggs and J2 were rinsed on the 28-µm-pore sieve and collected for use as inoculum.

Four kenaf plant introductions (PI) were obtained from the Southern Regional Plant Introduction Station, Experiment, Georgia, U.S.A. The plant introductions included PI468074, stated to be moderately resistant to *M. javanica*, and to a lesser extent, *M. incognita*; PI468075 and PI468076 with less resistance to these nematodes than PI468074; and PI468077, with resistance to the nematodes slightly less than the other PI's. Kenaf cv. Everglades 71, one parent of the PI's, was included for comparison.

Seed of each plant introduction were germinated for 72 hours on germination paper and transplanted into 12-cm-diam clay pots containing a 1:1 mixture (v:v) of steam-sterilized sand and Freestone fine sandy loam soil (72% sand, 16% clay, 12% silt; 0.6% OM, 14.9 CEC, pH 6.1). Each plant was inoculated with 5 000 eggs and J2/500 cm^3 soil 5 days after planting. Inoculum was delivered in 5 ml total volume of water into two 1.5-cm-diam × 3-cm-deep depressions in each pot.

The experiment was arranged in a split-plot design with 6 replications. Nematode inoculations (*M. incognita*-inoculated and non-inoculated plants) served as the main plots and cultivars as subplots. Plants were allowed to grow in the greenhouse 60 days prior to harvest. At harvest, plant heights and fresh and dry weights of shoots and roots were recorded. J2 were extracted from soil by a combined gravity screening

and sucrose centrifugation (3,5). Eggs were extracted by the sodium hypochlorite method (9) and counted.

Plant data and nematode numbers were subjected to analysis of variance and means were compared using Fisher's protected least significant difference test. Data from two repetitions of the experiment were combined for analysis of variance. Plant introductions with and without *M. incognita* inoculation were compared using Student's T comparison.

RESULTS AND DISCUSSION

Kenaf plant introductions differed in growth ($P \leq 0.05$) both in the absence and presence of *M. incognita*. In the non-inoculated controls, PI468076 showed significantly smaller shoot and root weights compared with the Everglades 71 parent. All other PI's were similar in growth to Everglades 71 in the absence of the nematode. In the presence of *M. incognita*, Everglades 71 growth was reduced ($P \leq 0.05$) except for fresh root weight. Inoculation of kenaf plants with *M. incognita* in the greenhouse usually results in a stimulation of root growth which is detected as an increase in fresh root weights. This effect has been observed for roots of various other plants infected with *Meloidogyne* spp., as well as kenaf (4). Dry root weights were reduced indicating this effect is due to cellular contents and not cell dry matter.

Everglades 71 has been reported to be the most productive kenaf cultivar in the United states under conditions free of root-knot nematodes (1). However, in the presence of *M. incognita*, Everglades 71 yields are reduced ($P \leq 0.05$) (Table 1). These data are consistent with results from greenhouse and field tests in which kenaf cultivars were screened for resistance to *M. incognita* (4).

Kenaf plant introductions varied in their reaction to *M. incognita* in comparison to both the noninoculated control and with the Everglades 71 parent. In general, although plant growth was reduced, most reductions were not significant. The height of PI468074 and PI468076 plants were reduced ($P \leq 0.05$) when inoculated with *M. incognita*; however, fresh and dry shoot weights and dry root weights were not significantly reduced (Table 1). PI468074 plants had greater shoot weights (fresh and dry) and dry root weights than Everglades 71. Growth of PI468076 was not different ($P \leq 0.05$) from Everglades 71.

All PI468077 growth parameters were significantly reduced when it was inoculated with *M. incognita*. There were no differences ($P \leq 0.05$) between PI468077 and the Everglades 71 parent in growth parameters except root weight (Table 1). This was the first test in which we have observed a reduction in fresh root weights by M. incognita when applied at an inoculum level of 5 000 eggs + J2/500 cm^3 soil. This inoculum level has previously been demonstrated to significantly reduce kenaf growth although root weights are generally stimulated in the greenhouse (4).

PI468075 was the only plant introduction in which all growth parameters were not significantly reduced when inoculated with *M. incognita* (Table 1). Although the height of PI468075 plants did not significantly differ from the inoculated Everglades 71, shoot and root weights were significantly greater.

All kenaf plant introductions and Everglades 71 served as good hosts for *M. incognita* race 3. The nematode increased to high levels on all PI's and Everglades 71. Reproductive factors (Rf = final population/initial population) of 14.1, 46.1, 24.5, 25.3, and 32.2 was observed in PI s 468074, 468075, 468076, 468077 and Everglades 71, respectively (Table 2).

Table 1. Growth of kenaf plant introductions in the greenhouse 60 days after inoculation with *Meloidogyne incognita* race 3.

Plant introduction	Plant height (cm)		Shoot weight (g)				Root weight (g)			
			Fresh		Dry		Fresh		Dry	
	Non-Inoc.	Inoc.[y]	Non-Inoc.	Inoc.	Non-Inoc.	Inoc.	Non-Inoc.	Inoc.	Non-Inoc.	Inoc.
PI 468074	125.7[z]	90.9	36.9	23.9	8.6	4.3	19.1	26.5	6.3	3.1
PI 468075	114.3	79.3	34.1	19.6	8.1	3.1	23.6	31.6	8.0	3.2
PI 468076	94.7	88.7	20.1	15.5	3.9	2.6	15.7	18.9	5.2	2.1
PI 468077	146.6	68.6	30.1	9.9	6.3	1.4	18.3	12.5	6.5	1.3
Everglades 71	128.8	76.9	31.4	10.6	7.2	1.7	23.9	23.7	7.2	1.8
FLSD ($P \leq 0.05$)	20.6	18.3	7.2	6.2	1.9	1.5	4.4	8.8	2.3	1.1

[y]Inoc. represent inoculation with 5 000 eggs and juveniles per 500 cm^3 soil.

[z]Data are means of 12 replications. Means compared using Fisher's protected least significant difference test.

Table 2. Reproduction of *Meloidogyne incognita* race 3 on kenaf plant introductions 60 days after inoculation.

Plant introduction	Nematode Reproduction per 500 cm^3 Soil			Reproductive Factor[y]
	J2	Eggs	Total (J2 + eggs)	
PI 468074	15 879[z]	54 504	70 383	14.1
PI 468075	107 721	122 742	230 463	46.1
PI 468076	55 363	166 950	122 313	24.5
PI 468077	52 788	73 817	126 604	25.3
Everglades 71	93 558	67 379	160 938	32.2
FLSD ($P \leq 0.05$)	30 055	41 876	85 972	11.8

[y]Reproductive factor = Final population/Initial population (Initial inoculum consisted of 5 000/500 cm^3 soil.
[z]Data are means of 12 replications. Means compared using Fisher's protected least significant difference test.

The number of J2 extracted from soil ranged from 15 879 to 107 721 J2/500 cm^3 soil (Table 2). Significantly fewer J2 were recovered from PI's 468074, 468076, and 468077 compared with Everglades 71. More eggs were recovered from PI468075 compared with all other PI's and Everglades 71. Total nematode population development (J2 + eggs) ranged from 70 383 to 230 463 nematodes/500 cm^3 soil for PI468074 and PI468075, respectively. Fewer nematodes were recovered from PI48074 compared with the Everglades 71 parent. PI488075 produced significantly higher nematode numbers than Everglades 71.

In these greenhouse tests all plant introductions and Everglades 71 were determined to be susceptible to *M. incognita* race 3. Although *M. incognita* increased to high levels on all kenaf plant introductions, several of the PI's appeared to exhibit a degree of tolerance to nematode infection. All plant growth parameters were not significantly reduced when compared with the untreated control. Although PI46805 supported the highest nematode numbers, plant growth was not reduced significantly. This, combined with producing higher shoot and root weights than the Everglades 71 parent, may indicate tolerance to *M. incognita.* Conversely, plant growth of PI468077 and Everglades 71 were reduced significantly by *M. incognita.*

Relative host sensitivity of plants characterized under greenhouse conditions, however, frequently differs from plant growth responses under field conditions (6). Under field conditions, where plants are grown longer than 60 days, reductions in shoot and root growth could easily result. This study defines the host suitability of these 4 kenaf plant introductions to *M. incognita* race 3, but also provides an indication of host suitability that may be useful to the kenaf plant breeders. However, further examination of each plant introduction under field conditions are warranted to establish a more definitive response.

LITERATURE CITED

1. ADAMSON, W. C., E. G. STONE, and N. A. MINTON. 1974. Field resistance to the Javanese root-knot nematode in kenaf. Crop Science 14:334-335.
2. ADAMSON, W. C., J. A. MARTIN, and N. A. MINTON. 1975. Rotation of kenaf and roselle on land infested with root-knot nematode. Plant Disease Reporter 59:130-132.
3. AYOUB, S. M. 1980. Plant Nematology, an Agricultural Training Aid. NemaAid Publications: Sacramento, California, U.S.A., 195 pp.
4. BARILLAS, J. R., G. W. LAWRENCE, and K. S. MCLEAN. 1993. Effect of initial population density of *Meloidogyne incognita* race 3 on the growth of kenaf (*Hibiscus cannabinus*). Nematropica 23:15-19.
5. BARKER, K. R. 1985. Nematode extraction and bioassay. Pp. 20-25 *in* K. R. BARKER, C. C. CARTER, and J. N. SASSER, eds. An Advanced Treatise on *Meloidogyne*, Vol. II. Methodology. Department of Plant Pathology, North Carolina State University, and the U. S. Agency for International Development, North Carolina State University Graphics, Raleigh, North Carolina, U.S.A.
6. BARKER, K. R., and J. P. NOE. 1987. Establishing and using threshold population levels. Pp. 75-81 *in* J. A. VEECH and D. W. DICKSON, eds. Vistas on Nematology: A Commemoration of the Twenty-fifth Anniversary of the Society of Nematologists, Society of Nematologists, Inc., Hyattsville, Maryland, U.S.A.
7. CRANE, D. C. 1947. Kenaf-fiber plant rival of jute. Economical Botany 1:334-350.
8. DEMPSEY, J. M. 1975. Fiber Crops. The University Presses of Florida, University of Florida, Gainesville, Florida, U.S.A., 457 pp.
9. HUSSEY, R. S., and K. R. BARKER. 1973. A comparison of methods of collecting inocula of *Meloidogyne* eggs, including a new technique. Plant Disease Reporter 57:1025-1028.
10. LAWRENCE, G. W., K. S. MCLEAN, and B. S. BRASHER. 1990. First report of *Hoplolaimus magnistylus* on kenaf in Mississippi. Plant Disease 74:828.

11. LAWRENCE G. W., and K. S. MCLEAN. 1991. Reproductive potential of plant-parasitic nematodes on kenaf. Research Report Volume 16, Number 2, Mississippi Agricultural and Forestry Experiment Station, Mississippi State, Mississippi, U.S.A, 5pp.
12. LAWRENCE G. W., and K. S. MCLEAN. 1992. Host status and response of kenaf (*Hibiscus cannabinus*) to *Meloidogyne incognita* race 4, *M. javanica, Hoplolaimus magnistylus* and *Rotylenchulus reniformis.* Nematropica 22:247-250.
13. MUELLER, J. D., and S. A. LEWIS. 1992. Evaluation of nematicides for controlling *Meloidogyne incognita* and *Hoplolaimus columbus* on kenaf (*Hibiscus cannabinus*). Nematropica 23:91-97.
14. SIJ, J. W. 1987.Kenaf production in southeast Texas. Texas Agricultural Experiment Station Report PR-4536, College Station, Texas, U.S.A.
15. SUMMERS, T. E., J. B. PATE, and F. D. WILSON. 1958. Extent of susceptibility within kenaf, *Hibiscus cannabinus* L., to root-knot nematode. Plant Disease Reporter 42:591-593.
16. VEECH, JOSEPH A. 1992. Reproduction of four races of *Meloidogyne incognita* on *Hibiscus cannabinus.* Supplement to Journal of Nematology (Annals of Applied Nematology) 24:717-721.

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