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Expression of Resistance to *Meloidogyne incognita* in Kenaf Cultivars (*Hibiscus cannibinus*) under Field Conditions

A.A. Adegbite, G.O. Agbaje, M.O. Akande, N.A. Amusa, J.A. Adetumbi and O.O. Adeyeye

Institute of Agricultural Research and Training, Obafemi Awolowo University, P.M.B. 5029, Moor-Plantation, Ibadan, Nigeria

Abstract: Field studies were conducted in 2003 and 2004 to investigate the reaction of 10 varieties of kenaf to natural infestation of Meloidogyne *incognita*. Ten weeks after planting, ten randomly selected plants per variety were assessed for root galling. Plants were carefully uprooted soil adhering to roots was washed off under a gentle stream of tap water and roots then were observed using a stereo microscope. Eggs were extracted from the roots with sodium hypochlorite. The reproduction factor (P_f / P_i) was calculated. Data were collected on plant height, stem girth, days to maturity, number of seeds and seed yield and the final figures of these parameters were analyzed by of variance and mean separation by Duncan's Multiple Range Test. Gall index and nematode reproduction factor varied significantly among the kenaf varieties. AU 64 recorded the tallest height of 2.2 m followed by Ex-Funtua, Ifeken 100 and G 45 whereas the lowest height was recorded for Ifeken 400 and Cuba 108. Days to maturity ranged from 120 to 135 days. Based on gall index ratings, AU64, Ex-Shika, Ex-Giwa, G 45 and the local variety were susceptible to *M. incognita*. Tianung 1 and Cuba 108 were very susceptible, whereas Ifeken 100 and 400 were resistant. Based on reproduction factor, AU 64, Ex-Shika, Ex-Giwa, G 45, Ex-Funtua and the local variety supported greater nematode reproduction, were good host to root-knot nematode, Tianung 1 and Cuba 108 were very susceptible while Ifeken 100 and Ifeken 400 were poor host to *M. incognita*.

Key words: Field conditions % Kenaf % *Meloidogyne incognita* % resistance % screening

INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is a member of the family Malvaceae and the third largest fiber crop of economic importance after cotton and jute [1]. It is indigenous to Africa and the species *H. cannabinus* most likely originated from Sudan, although it is commonly cultivated for both food and fiber in West Africa. Fiber in both retted and raw forms is used in the manufacture of cordage and newsprint. Leaves and small branches have high digestibility when ground and can be used as a source of roughage and protein for livestock [2]. As a source of cellulose fiber for pulp production [3], the economic importance of kenaf is made more important due to diminishing stocks of hard wood and soft wood trees in the world. The consequence of forest reduction is gradual global desertification. Increases in global consumption of paper and paperboard materials also have increased the importance of kenaf as a wood substitute. It is estimated that kenaf is 3 to 5 times more productive per unit area of land than pulpwood trees and produces a pulp that is equal or superior to many woods [4]. Paper produced from kenaf has excellent ink-retention characteristics and it's tensile strength is ideal for printing with high speed presses [5]. Kenaf can be grown on a wider range of soils, is less labour intensive, requires little or no cultivation or thinning and produces high fiber yields with corresponding higher income per hectare as compared to most other pulp crops [6]. The advantages of kenaf as a source of pulp and papermaking include: 1) a short growing cycle of 120-130 days as compared to thirteen to sixteen years for trees; 2) the possibility of growing two crops per year under certain conditions; 3) less lignin than soft or hard woods; 4) good growth or yield with irrigation water in warm dry areas; 5) production costs that are half that of pulpwood and 6) use of kenaf in the newsprint industry will discourage the depletion of forests and importation of wood pulp from other countries to Nigeria [7].

One or more *Meloidogyne* species have been reported as pathogens of kenaf, but no other nematode species have been reported to damage the crop. Kenaf is

Corresponding Author: Dr. A.A. Adegbite, Institute of Agricultural Research and Training, Obafemi Awolowo University, P.M.B. 5029, Moor-Plantation, Ibadan, Nigeria

generally susceptible to *M. arenaria*, *M. javanica* and *M. incognita* [8, 9]. Summers and Seale [10] reported increased rates of kenaf seedling death in fields with high populations of *M. incognita* and surviving plants were stunted and yielded less dry matter than did non-infected plants. Infected plants developed large root galls. McSorley and Parrado [11] were able to relate amount of root galling to the growth (height) of kenaf in fields infested with *M. incognita* using Seinhorst's model. They obtained a tolerance value of 8 galls or egg masses per plant at two months after planting in a fine sandy loam soil. In spite of the contribution of kenaf to pulp making Industries and to livestock nutrition, it suffers notable damages from insect pests and pathogens. *Meloidogyne* species have been recognize as an important production constraint wherever kenaf is grown [8]. In a study to evaluate some commonly grown kenaf cultivars for resistance to *Meloidogyne* spp. Adeniji [8] documented that kenaf varied in their reaction to *Meloidogyne* species. Reports are available on annual kenaf yield losses attributable to *Meloidogyne* infection [9, 11, 12].

Recently developed breeding lines of kenaf are available in Nigeria, but little is known about the reaction of most of these lines to *Meloidogyne* species. In a depressed economy where exchange rates of foreign currencies are quite high, nematicidal control may be uneconomical in addition to being technically demanding and hazardous to man, his livestock and the environment. The use of resistant varieties is a labour saving and environmentally sounds management strategy for reducing production costs [1]. This research was conducted to assess the reaction of some kenaf germplasm to natural field infestation of the root knot nematode, Meloidogyne *incognita* and to provide information for breeders working on kenaf development.

MATERIALS AND METHODS

Field experiments were conducted in 2003 and 2004 at Institute of Agricultural Research and Training, Obafemi Awolowo University, Moor Plantation, Ibadan, Nigeria. Ibadan is located within the rain forest drier type ecology in Longitude 3° 54NE and Latitude 7° 30NN. The experimental site for the study had been previously cultivated for 2 years with kenaf in order to increase the population densities of *Meloidogyne incognita* race 2. The identity of the *M. incognita* was confirmed using perennial patterns as described by Eisenback *et al*. [13]. Low to moderate population densities of *Pratylenchus* spp., *Helicotylenchus* spp. and *Xiphinema* spp. were also present on the experimental site. The experiments were established on 2 July, 2003 and 5 July, 2004, respectively and arranged in a Randomized Complete Block Design with 10 cultivars screened. Out of the ten cultivars tested five were collected from Institute for Agricultural Research, Ahmadu Bello University, Zaria, two were collected from Cuba and the rest three were from Institute of Agricultural Research and Training, Moor-Plantation, Ibadan. Each kenaf cultivar was replicated four times and each plot size was four rows 2 m length. Five to ten seeds of each of the 10 cultivars were planted per hole at a spacing of 10 x 25 cm. After seeds germinated plants were thinned to one per site. The field was ploughed, harrowed and the seeds were planted on the prepared field by hand. The seeds were not treated with pesticides. Weeds were controlled manually at 3 and 6 weeks after planting. A basal application of fertilizer was applied at 2 weeks after planting using NPK fertilizer at a rate of 120 kg ha^{-1} of N, 50 kg ha^{-1} of P_2O_5 and 50 kg ha^{-1} of K_2O, without any irrigation.

Soil samples were taken from the treatment plots before and after harvest and analyzed for nematode population counts, in order to determine the initial and final population of the nematodes (P_i and P_f). On each sampling period, ten soil core samples were taken from the plot at a depth of 20 cm and thoroughly mixed to form composite sample. Composite samples were taken to the laboratory in sealed plastic bags where they were stored at 10°C for 24 h. The samples were then thoroughly mixed and 250 cm^3 soil sub-samples were processed using the tray method of Whitehead and Hemming [14].

Ten weeks after planting, ten randomly selected plant samples per plot were carefully uprooted and adhering soil washed off for assessment of root-galls and nodules using a stereoscopic microscope, i.e., 0= immune, 1=highly resistant, 2=moderately resistant, 3=moderately susceptible, 4=susceptible and 5=highly susceptible. Eggs were extracted from roots and estimated using the sodium hypochlorite method of Hussey and Barker [15]. Host status rating was determined using rating scheme developed by Sasser *et al*. [16] based on root gall and reproduction factor (R), where $R = P_f / P_i$ (Table 1).

At harvest, ten randomly selected plant per plot were measured for the following parameters; plant height in which the height of each plant was measured from the soil surface to the tip of the highest leaf, stem girth was measured using vernier calipers, days to maturity, number of seeds and seed yield (kg ha^{-1}) were determined also at harvest. Data were subjected to analysis of variance and means separated with the Duncan's Multiple Range Test [17].

Table 1: Rating scheme for plants associated with root knot nematode

Gall index [a]	Reproduction factor [b]	Degree of resistance
# 2	# 1	Resistant
# 2	$ 1	Tolerant
$ 2	# 1	Very susceptible
$ 2	$ 1	Susceptible [a]

Gall index: 0=no gall formation, 5=heavy gall formation

[b]Reproduction factor: $R=P_f / P_i$, where, P_i=initial inoculum level and P_f=final inoculum level

Table 2: Reaction of kenaf varieties to field infestation of *Meloidogyne incognita*

Varieties	Plant height (m)	Stem girth (cm)	Days to maturity	Gall index	Rating	Nematode reproduction factor $R=P_f / P_i$	Seed yield (kg)	No. of Seeds
AU 64	2.2^{a}	4.27^{a}	130^{b}	3.8^{b}	S	2.95^{a}	0.33^{a}	45.7^{b}
Ex-Shika	1.8^{b}	3.45^{b}	130^{b}	4.5^{a}	S	2.95^{a}	0.15^{c}	15.5^{e}
Ex-Giwa	1.9^{b}	3.43^{b}	130^{b}	4.5^{a}	S	2.95^{a}	0.16^{c}	17.3^{e}
G 45	2.0^{a}	3.37^{c}	135^{a}	3.8^{b}	S	2.69^{b}	0.28^{b}	23.8^{b}
Tianung 1	1.9^{b}	3.10^{e}	120^{c}	2.3^{c}	VS	0.60^{c}	0.28^{b}	18.8^{d}
Ifeken 100	2.0^{a}	3.15^{d}	121^{c}	1.6^{d}	R	0.55^{d}	0.27^{b}	19.4^{d}
Ex-Funtua	2.1^{a}	3.35^{e}	130^{b}	3.8^{b}	S	2.70^{b}	0.29^{b}	12.7^{f}
Ifeken 400	1.6^{c}	1.69^{h}	120^{c}	1.6^{d}	R	0.55^{d}	0.18^{c}	12.4^{f}
Cuba 108	1.6^{c}	1.93^{g}	121^{c}	2.3^{c}	VS	0.59^{c}	0.31^{a}	16.7^{e}
Local	1.9^{b}	2.48^{f}	123^{c}	4.5^{a}	S	2.95^{a}	0.29^{b}	49.5^{a}
Mean	1.9	3.02	126	3.27		1.95	0.25	23.2

Means followed by the same letter are not significantly different at ($p<0.05$) according to Duncan's Multiple Range Test.

Ratings: S= Susceptible, VS=Very Susceptible, R=Resistant

RESULTS AND DISCUSSION

Data collected in 2003 and 2004 were combined and analyzed because of the consistencies, which existed between the years. AU 64 recorded the greatest height, though it was similar ($p<0.05$) to G 45, Ifeken-100 and Ex-Funtua (Table 2). Ex-Shika, Ex-Giwa, Tianung 1 and the local variety had intermediate plant heights and the shortest varieties were Ifeken 400 and Cuba 108. Stem girth ranged from 4.27 to 1.69 cm with AU64 having the greatest girth and Ifeken 400 having the least. Days to maturity ranged from 135 to 120 days. G 45 matured 135 days after planting, which was significantly different from the other varieties. AU64, Ex-Shika, Ex-Giwa and Ex-Funtua matured 130 days after planting while Tianung 1, Ifeken 100, Ifeken 400, Cuba 108 and the local variety matured between 120 and 123 days after planting.

Based on host status ratings [16], AU 64, Ex-Shika, Ex-Giwa, G 45, Ex-Funtua and the local variety were susceptible to *Meloidogyne incognita* race 2 and had gall indices and reproduction factors greater than 2 and 1, respectively. Tianung 1 and Cuba 108 were very susceptible and had gall indices and reproduction factors greater than 2 and less than 1, respectively. Ifeken 100 and Ifeken 400 were resistant to *M. incognita* race 2 with gall indices and reproduction factors less than 2 and 1, respectively.

Seed yield per plot ranged from 0.33 to 0.15 kg. AU64 and Cuba 108 yielded 0.33 and 0.31 kg, respectively which were similar to each other ($p<0.05$) but different from the other varieties (Table 2). G 45, Tianung 1, Ifeken 100, Ex-Funtua and the local variety produced seed yield, which ranged from 0.29 to 0.27 kg, which were not significantly different from each other. Ex-Shika, Ex-Giwa and Ifeken 400 produced seed yield which ranged from 0.18 to 0.15 kg. The resistant varieties were better yielding and have good qualities that will promote acceptability among the farmers especially none itching mature of their leaves.

Repeated growing susceptible varieties, particularly on sandy soils, can lead to a rapid increase of *M. incognita* populations and substantial damage to crops. Genetic resistance and cultural practices, such as periodic fallows and rotation to non host crops, are the only practical means of managing these pests in Nigeria. The intensification of agriculture that is occurring in many developing countries will exacerbate root-knot nematode problems.

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