INSTITUT FRANCAIS DE RECHERCHE SCIENTIFIQUE POUR LE DEVELOPPEMENT EN COOPERATION (ORSTOM)

Assessment of the depressive effect of seven *Panicum maximum* cultivars on *Meloidogyne* spp.

A. ADIKO
Laboratoire de Nématologie
Centre ORSTOM d'Adiopodoumé

Février 1988

Introduction

In tropical regions where conditions are generally favorable for the development of plant-parasitic nematodes (warm climates, long growing season, great number of susceptible hosts...), *Meloidogyne* spp. appears as one of the major limiting factors of agricultural production (Sasser, 1979; Mai, 1985). Because of shortcomings associated with the use of chemical control such as outbreak of secondary pests and environmental contaminations, crop rotation and other cultural practices are increasingly considered as alternative management measures of these parasites (Egunjobi, 1985; Raymundo, 1985; Noe, 1988). Netscher (1983) observed at the experimental station of ORSTOM in the Ivory Coast that plots under the fodder gass, *Panicum maximum* Jacq., for several years were free of *Meloidogyne* . As a result, he suggested the use of *P . maximum* in a rotational scheme to minimize the incidence of root-knot nematodes.

Panicum maximum , like most of other tropical herbage graminaceae, is characterized by a poor seed production. Since the early 1960s, ORSTOM has launched a breeding program which lead to the release of eight cultivars with improved herbage and seed production (Noirot, 1983; Noirot et al. 1986; Noirot, 1988).

The purpose of this study was to determine both the depressive effect of these new cultivars on *Meloidogyne* spp. and the causes of that effect.

Materials and Methods

Grenhouse Studies

Eggs of *Meloidogyne* spp. were collected from roots of infested eggplants, *Solanum melongena* cv. Black beauty, in a vegetable garden.

Inoculum was increased on *Hibiscus cannabinus* in the greenhouse at 27°C. After 45 days, eggs were extracted from the roots of *H. cannabinus* by the NaOCl method (Hussey & Barker, 1973).

In order to assess the penetration rate of second-stage juveniles of *Meloidogyne* spp. in the roots of six *P . maximum* cultivars, 1A50, 2A5, 2A6, 2A22, C-1 and T-58, seven day old seedlings were transplanted singly in 5-cm-diam. plastic pots filled with autoclaved sand. The seedlings were allowed five days to establish; then, 400 eggs of *Meloidogyne* spp.were pipetted from a standardized suspension into a shallow depression made around the base of each plant. The depression was refilled with a little autoclaved sand and watered lightly.

Seven, fourteen and twenty eight days after inoculation, five plants of each cultivar were unpotted. The roots were carefully washed free of sand, stained in acid-fuschin lactophenol, cleared in lactophenol and examined microscopically for juvenile penetration.

In a second greenhouse study dealing with the reproduction of root-knot nematodes on *P . maximum* , cultivar 2A4 was used in addition to the six others mentioned above. Fifteen seeds of each cultivar were sown in 11-cm-diam. plastic pots containing autoclaved sand and soil mixture (1:1; v/v). Seven days following sowing, seedlings were thinned to ten per pot and inoculated with 5000 eggs of *Meloidogyne* spp.. Pots were arranged in a randomized complete block design with ten replications per cultivar. The experiment was terminated fifty days after inoculation. In order to determine Oostenbrinki (1966) reproduction factor (Rf = final eggs number/initial eggs number), roots were subjected to NaOCl (Hussey &Barker, 1973) for egg extraction. The old soil from each pot was mixed with a little autoclaved soil and sown with okra, *Abelmoschus moschatus* cv. Clemson spineless, as a bioassay (Godfrey, 1934).

Field study

Field study

A plot of a quarter of a hectar naturally infested with *Meloidogyne* spp., following a year of continuous cropping of vegetables, was sown with *Panicum maximum* cv. T-58. Fluctuations of plant-parasitic nematodes were monitored through monthly soil and root sampling. Standardized nematode extraction techniques were used for soil (Seinhorst, 1962) and roots (Seinhorst, 1950).

Results and Discussion

As shown in table 1, seven days after inoculation, the roots of three out of the six cultivars tested were penetrated by root-knot nematode juveniles; the level of infection measured as the percentage of *Meloidogyne* spp. in root tissues was very low, 2A5 (0,1%),2A6 (0,2%) and C-1 (0,4%). At 14 days after inoculation, all the cultivars were infected but the proportions of juvenile penetration were still low, 0,3 to 4%. Although infection took place anywhere along the roots, it was at the root tip that it occurred most frequently. At that period, a great number of juveniles in the roots appeared distorted, ill-stained which seemed to suggest an undergoing lysis process following the death of nematodes (Figure 1). In fact, only very few of the invading juveniles increased in size and started to initiate gall formation (Figure 2). At 28 days, up to 13% of inoculated nematodes invaded the roots. Invasion occurred rather more readily on *Panicum maximum* cv. C-1 (13%) than on the five other cultivars (2 to 6%). No adult stage of *Meloidogyne* was observed in the roots; all the invading nematodes were either in advanced state of degradation (Figure 3) or were still at the second-stage except one juvenile at the third -stage in root tissues of cultivar 2A5 (Figure 4). No apparent giant cells were visible around the feeding sites of established nematodes.

reproduce on all the cultivars but one, C-1; reproduction on the latter was very low (Rf= 0,001). The okra plants grown subsequently as a bioassay showed that the initial inoculum was greatly reduced by the seven fodder grass cultivars. Indeed, the average number of root galls recorded on the 15-day-old okra seedlings in pots previously planted with *P. maximum* cvs. 1A50, 2A4, 2A5, 2A6, 2A22 and T-58 was one and five in pots formerly with cultivar C-1 (Table 2).

In the field, soil populations of *Meloidogyne* spp. under *P. Maximum* cv. T-58 was depressed markedly two months only after sowing. Two months later, root-knot nematodes were barely detectable by the standardized Seinhorst elutriation method (1962). In the meantime, *Criconemella* sp. and *Trichodorus* sp. were building-up (Figure 5). In the roots, two nematode species, *Meloidogyne* spp. and *Pratylenchus* sp. occurred very sporadically and in low numbers (Table 3).

It stems from these studies that all the seven cultivars of *P. maximum* are resistant to *Meloidogyne* spp and can be used in a rotational scheme to reduce the incidence of these parasites. Netscher (1983) reported that the resistance of *P. maximum* to root-knot nematodes is exclusively pre-infectional. Our studies demonstrated clearly that resistance is instead both pre and post-infectional: the bulk of infective second-stage juveniles in the soil fails to invade the roots whereas some of the few which succeed in entering cannot establish and die then undergo lysis; it is likely that some of them come out of the roots. Part of those which establish and initiate gall formation does not complete its developmental cycle. Actually, it is only a limited number of the juveniles within root tissues which reaches the stage of adult females characterized by a very low reproductive rate. The subsequent nematode generations sustaining the same resistance reactions, *Meloidogyne* populations decrease progressevely in the soil. The failure of *P. maximum* cultivars to respond properly to root-knot nematode stimuli resulting from feeding, that is

formation of giant cells in root tissues, may be accountable for these post-infectional resistance reactions.

Many other grasses such as bermudagrass, *Cynodon dactylon* (L.) Pers. (Good *et al.* , 1965; Adeniji and Chheda, 1971), and pangola digitgrass, *Digitaria decumbens* Stent. (Haroon and Smart, 1983a) have been reported antagonistic to root-knot nematodes. With respect to the latter grass, the antagonistic effects were ascribed to root extracts which interfer with both egg hatch and juvenile survival (Haroon and Smart, 1983b).

During our field study, *Ageratum conyzoides* Linn, *Oldenlandia corymbosa* Linn and *Solenostemon monostachyus* (p. Beauv.) Briq. which were growing in areas of the pasture where *P. Maximum* cv. T-58 failed to established, appeared as alternate hosts of *Meloidogyne* spp; these hosts had to be controlled by sodding the areas to the fodder grass. Thus, a good weed management should be conducted within *P. maximum* pasture in order to achieve a rapid and effective eradication of root-knot nematodes. A pure stand of the grass providing an homogeneous ground cover could help suppress adventitious weeds.

Literature Cited

Adeniji, O. M. and Chheda, R. H. 1971; Influence of six varieties of cynodon on four *Meloidogyne* spp. J. Nematol., 3: 251-254.

Godfrey, G. H. 1934. Indicator plant for measuring soil populations of root-knot nematode, *Heterodera marioni* (Cornv.) Goodey. Soil Sci. , 38: 3-27.

Good, J. M., Minton, A. N. and Jaworski, A. C. 1965. Relative susceptibility of selected cover crops and bermudagrass to plant-parasitic nematodes. Phytopath., 55: 1026-1030.

Hussey, R. S. and Barker, R. K. 1973. A comparison of methods of collecting inocula of *Meloidogyne* spp., including a new technique. Plt. Disease Reptr., 57: 1025-1028.

Haroon, S and Smart, C. G. Jr. 1983a. Effects of pangola digitgrass on *Meloidogyne arenaria, M. javanica* , and *M. hapla* . J. Nematol., 15: 649-650.

Haroon, S and Smart, C. G. Jr. 1983b. Root extracts of pangola digitgrass affect egg hatch and larval survival of *Meloidogyne incognita* . J. Nematol., 15: 646-649.

Mai, F. W. 1985. Plant-parasitic nematodes: their threat to agriculture, pp 11-17 *in* Sasser, N. J. and Carter, C. C. eds. Advanced treatise on Meloidogyne. Volume 1: Biology and control. North Carolina State University Graphycs, Raleigh.

Netscher, C. 1983. Control of *Meloidogyne* in vegetable production by crop rotation in the Ivory Coast. Acta Horticultura, 152: 219-225.

Noirot, M. 1983. L'amélioration génétique des variétés apomictique de *Panicum maximum* . Lisboa, 10: 161-168.

Noirot, M., Messager, L. J., Dubos, B. Miguel, M. and Lavorel, O. 1986. La production grainière de *Panicum maximum* sélectionnées en Côte d'Ivoire. Fourragères, 106: 11-19.

Noirot, M. 1988. Diversité de mise en place des structures reproductives chez *Panicum maximum* ; logique d'une réponse optimale à des contraintes. Conséquences pour l'amélioration de la production semencière. Université de Paris-Sud, Centre scientififique de l'ORSTOM, Thèse Doc. d'Etat. 239 pp.

Noe, P. J. 1988. Theory and practice of the cropping systems approach to reducing nematode problems in the tropics. J. Nematol., 20: 204-213.

Ogunjobi, O. A. 1985. Cropping systems and pest control: the nematode story. International Nematology Network Newsletter, 2: 20-40.

Ogunjobi, O. A. 1985. Cropping systems and pest control: the nematode story. International Nematology Network Newsletter, 2: 20-40.

Oostenbrink, M. 1966. Major characteristics of the relation between nematodes and plants. Mededlingen voor Landbouwhogeschool Wageningen, 66: 3-46.

Raymundo, A. S. 1985. Cropping systems research and root-knot nematode control, pp 277-281 *in* Sasser, N. J. and Carter, C. C. eds. Advanced treatise on Meloidogyne. Volume 1: Biology and control. North Carolina State University Graphycs, Raleigh.

Sasser, N. J. 1979. Economic importance of *Meloidogyne* in tropical countries, pp 359-374 *in* Lamberti, F. and Taylor, E. C. eds. Root-knot nematodes (*Meloidogyne* species). Systematics, Biology and Control. Aademic Press, New York.

Seinhorst, J. W. 1950. De betekenis van de toestand de grond voor het optreden van aantasting door het stengelaatje (*Dytilenchus dipsaci* (Kühn) Filipjev). Tijdschr. Pl. Ziekt., 56: 291-349.

Seinhorst, J. W. 1962. Modification of the elutriation method for extracting nematodes from soil. Nematologica, 8: 117-128.

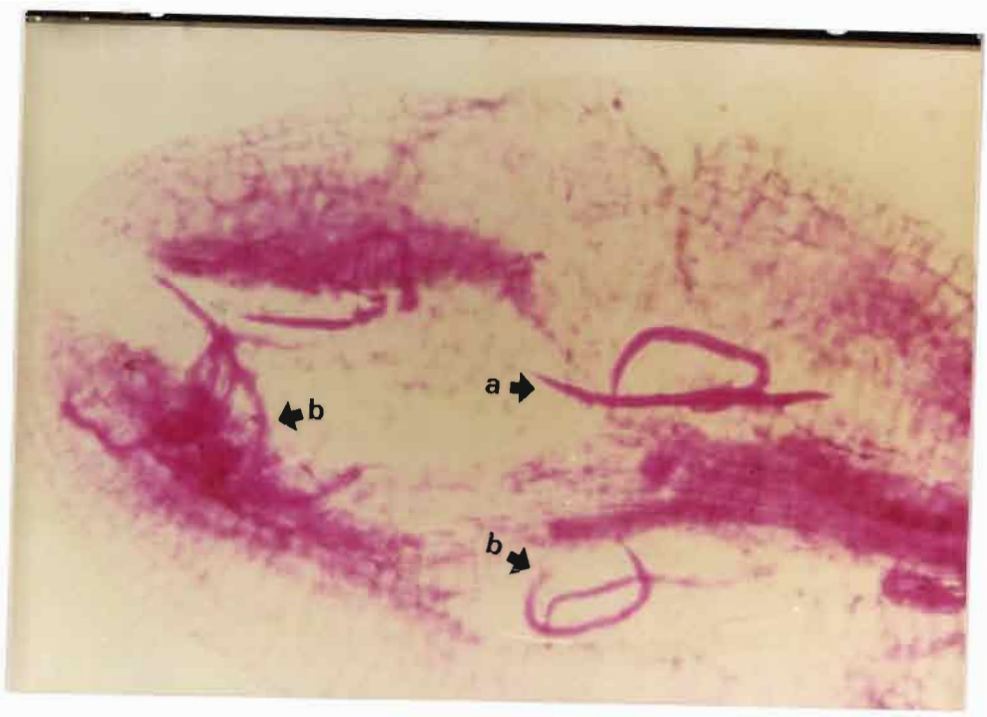

Figure 1: Root tip of Panicum maximum cv. 2A5 invaded by Meloidogyne juveniles, 14 days after inoculation;
a: second-stage juvenile in normal shape and well-stained;
b: distorted and ill-stained second-stage juveniles - probably undergoing lysis following death in root tissues -

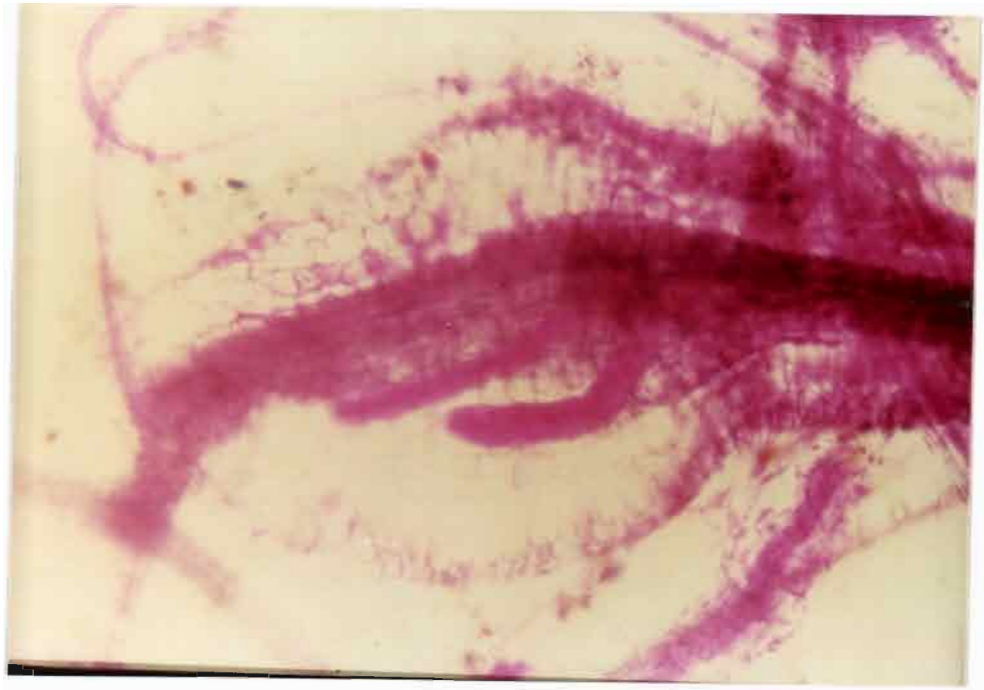

Figure 2: Second-stage juveniles of Meloidogyne spp. initiating gall formation in the root of Panicum maximum cv. C-1, 14 days after inoculation.

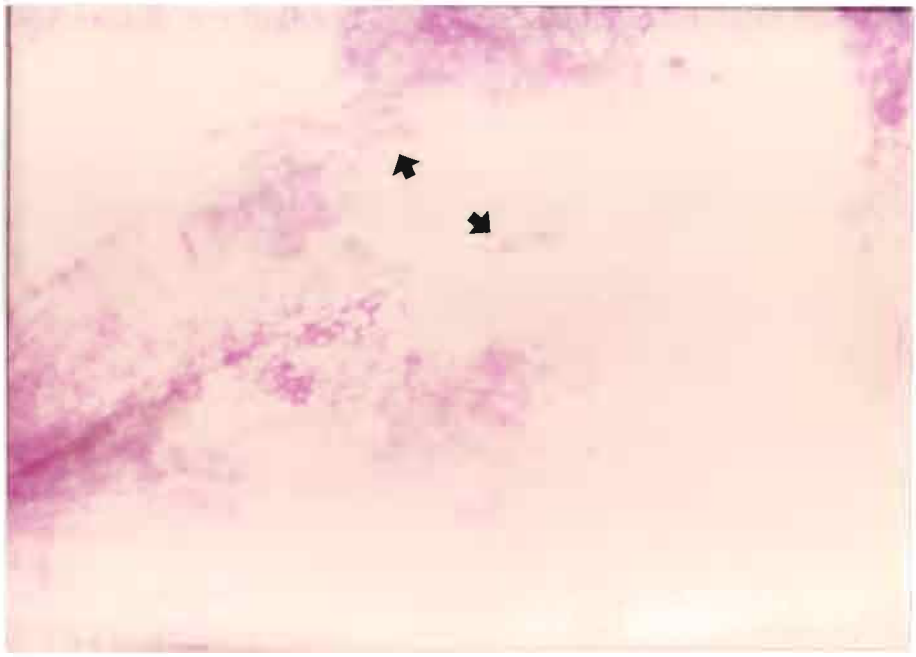

Figure 3: Second-stage juveniles of Meloidogyne spp. in the root of Panicum maximum cv. 2A5, 28 days after inoculation - nematodes probably in an advanced state of lysis.

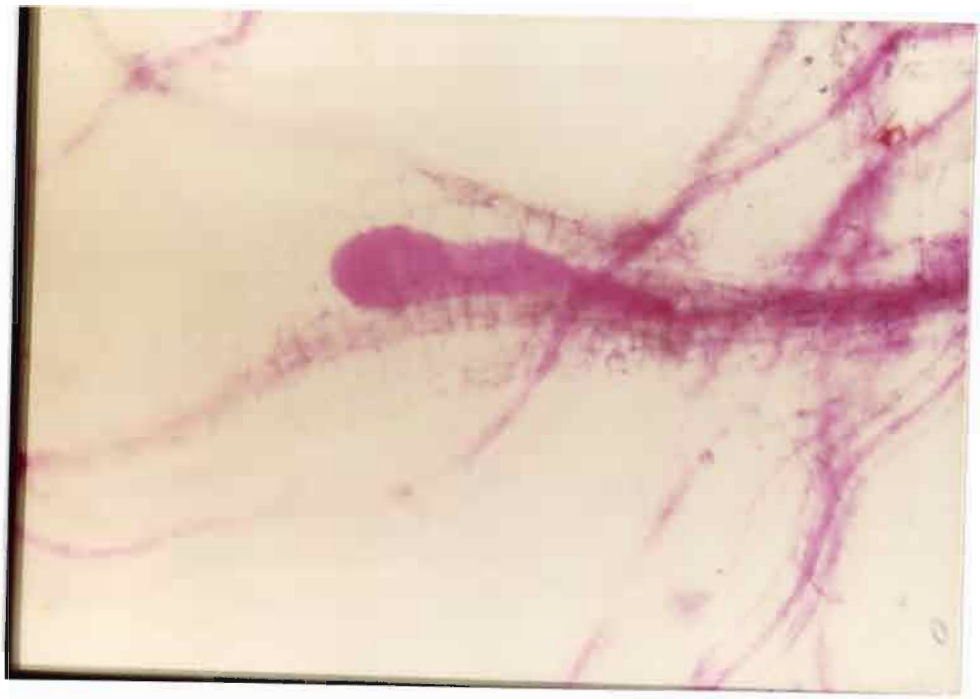

Figure 4: Third-stage juvenile of Meloidogyne spp. in the root of Panicum maximum cv. 2A5, 28 days after inoculation (the most advanced developmental stage observed during the study).

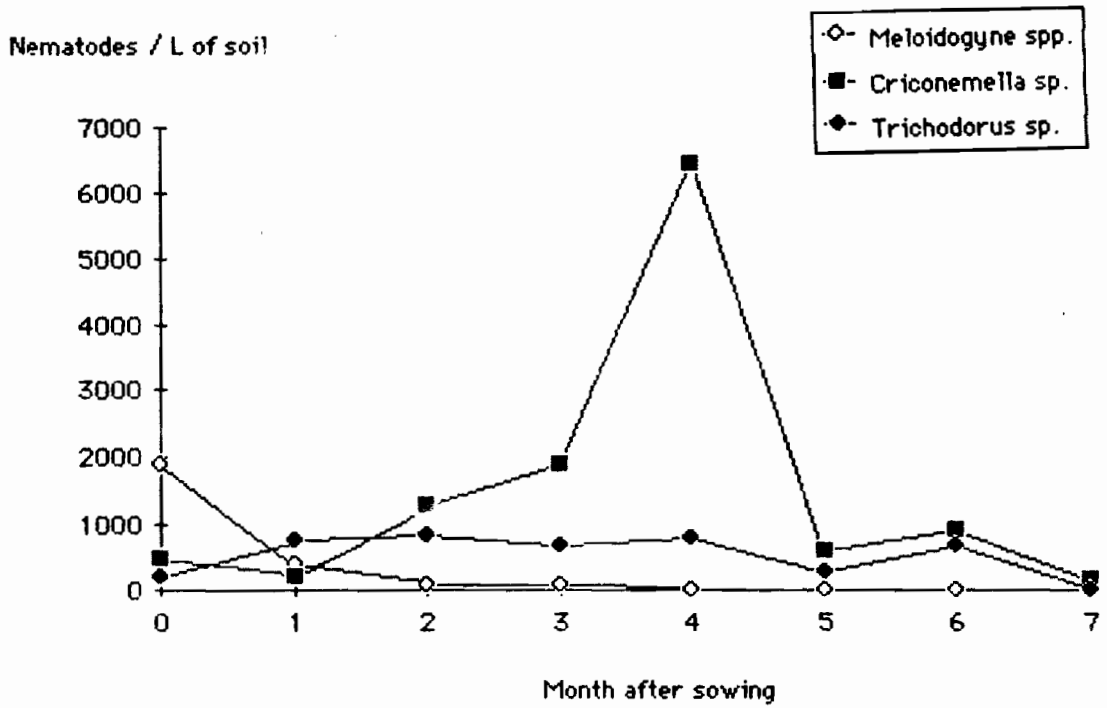

Figure 5: Fluctuations of plant-parasitic nematodes in soil under Panicum maximum cv. T-58 in the field.

Table 1: Penetration rate of Meloidogyne spp. in the roots of six cultivars of Panicum maximum.

PANICUM MAXIMUM Cultivars	% MELOIDOGYNE spp in roots @		
	7 days after inoculation	14 days after inoculation	28 days after inoculation *
1A 50	0 a	0,3 a	1,2 a
2A 5	0,1 a	4,2 b	1,7 a
2A 6	0,2 a	0,3 a	1,7 a
2A 22	0 a	1,9 ab	5,8 a
C- 1	0,4 a	2,5 ab	13,1 b
T- 58	0 a	0,2 a	3,5 a
L.S.D. (5%)	0,5	3,6	9

@ Proportions were subjected to arc sinus transformation before statistical analysis; proportions are means of five replicates; inoculum level = 400 eggs.

* None of the invading juvenile. reached the stage of adult female

Table 2: Effects of seven cultivars of Panicum maximum on Meloidogyne spp., after 50 days in the greenhouse.

PANICUM MAXIMUM CULTIVARS	MELOIDOGYNE spp. Rf. * @	N° of galls (Bioassay) ** @
1A 50	0 a	1 a
2A 4	0 a	1 a
2A 5	0 a	1 a
2A 6	0 a	1 a
2A 22	0 a	1 a
C-1	0,001 b	5 b
T-58	0 a	1 a
LSD (5%)	0,001	3

* Rf (Reproduction factor) = final egg number/initial egg number (5000 eggs)
** Number of galls of MELOIDOGYNE spp. on roots of 15-days-old okra seedlings planted in pots previously grown with P. MAXIMUM for 50 days.
@ numbers are means of 10 replicates.

Table 3 : Average density of plant-parasitic nematodes in the roots of *Panicum maximum* cv. T-58 in the field.

Month After Sowing	Nematodes/gr. of roots	
	Meloidogyne	*Pratylenchus*
1	0 a	0 a
2	0	0
3	1	0
4	0	0
5	1	1
6	1	3
7	4	0

a : numbers are means of 6 replicates.