

NEMATODE PESTS OF CASSAVA

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ABSTRACT

Amongst the various constraints facing cassava production are plant parasitic nematodes. Many nematode species have been reported associated with cassava but few are reported to have caused economic damage to the crop. *Meloidogyne incognita*, *M. javanica*, and *Pratylenchus brachyurus* are the species most associated with such damage. The majority of research on cassava nematodes has been concerned primarily with varietal screening for resistance and geographical distribution from diagnostic surveys. There is relatively little documentation on the effects of nematodes on yield, or the extent of damage they may cause in the field. Losses of up to 98 % in storage root yield have been recorded under heavy infestation by *Meloidogyne* spp. With an increase in large scale and monoculture cultivation and where pressure for land use has increased, nematodes may pose an increasing threat as constraints to cassava production. The most likely method of control appears to lie in the identification of resistant lines.

Key Words: Distribution, *Manihot esculenta*, *Meloidogyne* spp., *Pratylenchus brachyurus*, varietal screening, nematodes

RÉSUMÉ

Parmi les diverses contraintes auxquelles la production du manioc est confrontée, on trouve les nématodes phytoparasites. Beaucoup d'espèces de nématodes ont été trouvées en association avec le manioc mais peu d'entre elles ont été créditées de dégâts d'importance économique pour la culture. *Meloidogyne incognita*, *M. javanica* et *Pratylenchus brachyurus* sont les espèces le plus souvent associées à de tels dégâts. La plus grande partie des recherches sur les nématodes du manioc s'est principalement préoccupée du criblage des variétés, pour la recherche de résistances, et à la distribution géographique issue des campagnes de diagnostic. Il y a relativement peu de documentation sur l'incidence des nématodes sur la récolte ou sur l'étendue des dégâts qu'ils peuvent causer dans les champs. Des pertes de 98 pour cent de la récolte en tubercules stockés ont été enregistrées dans le cas d'une forte infestation par *Meloidogyne* spp. Avec une extension de la monoculture à grande échelle, là où la pression pour l'utilisation de la terre a augmenté, les nématodes pourraient constituer une menace de plus en plus grande pour la production du manioc. La méthode de contrôle la plus crédible semble résider dans l'identification de lignées résistantes.

Mots Clés: Distribution, *Manihot esculenta*, *Meloidogyne* spp., *Pratylenchus brachyurus*, criblage variétal, nématodes

INTRODUCTION

Many nematode species have been reportedly associated with cassava (*Manihot esculenta* Crantz) in many different geographical areas.

Comprehensive lists of the species found have been compiled, together with their distributions (Hogger, 1971; Caveness, 1980; McSorley *et al.*, 1983; Bridge *et al.*, 1991; D.L. Coyne and L.A.H. Talwana, unpublished). Although the lists are

extensive the majority of the nematode species are of limited importance and occur opportunistically on cassava. Others are of known importance but are often disregarded as possible cassava production constraints. One reason for this is the limited work that has been conducted in this area and its comparative lack of publicity. Kay (1987), in a manual on root crops for instance gives but a passing comment to nematode pests of cassava. This attitude is in part due to the fact that nematode damage and effects regularly go unnoticed. With cassava, this is almost certainly so, whereby the naturally 'knobbly' and rough texture of the roots can disguise nematode damage to casual observers. The long duration over which cassava can be left in the ground and the common 'piece-meal' method of harvesting, means that nematode-affected root systems may have decomposed in the ground or are not exposed at harvest for observation. Also, above-ground symptoms of reduced vigour and chlorosis of the leaves may resemble effects of poor soil fertility: - conditions in which cassava is regularly grown. Information on nematodes of cassava is in general scant in relation to those of other crops. Nevertheless, nematological work on cassava has recently been receiving more attention and this is justified given the great importance of the crop. With intensification of cassava production, the trend to monocultures and use of new and higher yielding cultivars, nematodes pose an increasingly greater threat, with the potential to be limiting factors in production. Furthermore, nematodes are becoming a greater problem as the use of agricultural land becomes more intense (Caveness, 1982).

ROOT-KNOT NEMATODES (*MELOIDOGYNE* SPP.)

Evidence indicates that root-knot nematodes (*Meloidogyne* spp.) are, by far, the most important group of nematodes affecting cassava (McSorley *et al.*, 1983). They are certainly the most widely reported nematodes occurring on the crop. Of the various species *M. incognita* (Kofoid and White) Chitwood and *M. javanica* (Treub) Chitwood are the most important (Jatata and Bridge, 1990), although *M. arenaria* (Neal) Chitwood and *M. hapla* (Chitwood) have been recorded (D.L.

Coyne and L.A.H Talwana, unpublished) but are not of major concern. Root-knot nematodes infest the feeder roots of cassava, causing small galls. As the females develop within the root tissue and reproduce, so the galls enlarge and coalesce. Nematodes disrupt the normal translocation of water and nutrients, where they form galls, breaking and deforming the vascular elements (Gapasin, 1980). These deformations and the physical damage caused by the nematodes to the roots also facilitate entry of secondary pathogens. The extent to which disease complexes occur, however, has been little investigated and information is scarce, though nematode-infested roots are known to be more susceptible to rot organisms (Th  berge, 1985).

Meloidogyne species have been recorded on cassava from many of the cassava-growing regions of the world, including Brazil (Ponte *et al.*, 1980), Venezuela (Crozzoli and Hidalgo, 1992), USA (McSorley *et al.*, 1983), Pacific (Bridge, 1988), Mozambique (Van den Oever and Mangane, 1992), Uganda (Bridge *et al.*, 1991), Malawi (Saka, 1982), Nigeria (Caveness 1979, 1982) and Niger (Sikora *et al.*, 1988). Many reports including those of Edwards (1953) and Luc *et al.* (1968), indicate only that the nematodes occurred on the crop, or have caused limited damage, generally in the form of galls. Other workers, including Gapasin (1980), Caveness (1982) and Nwauzor and Nwankwo (1989) have concentrated on the response of the different cultivars to root-knot nematodes, essentially under sterile or 'on-station' conditions. Few have documented serious damage to the crop in the field of the type reported by Bridge *et al.* (1991) in Uganda. Coyne and Namaganda (1994) also observed physical evidence of root-knot nematodes causing damage to cassava roots on 94 % of 88 fields examined in Uganda. Of the roots damaged, a substantial 17% were in the severely galled category, indicating that root-knot nematodes are prevalent pests of cassava in Uganda.

From the literature, the response of cassava to *Meloidogyne* is variable. Some observations have shown *M. incognita* and *M. javanica* to reproduce poorly on particular cassava cultivars (Diomande, 1982). Gapasin (1980) concluded that initial populations of root-knot nematodes sufficiently large to cause injury to cassava are unlikely to

occur naturally. By contrast, further reports have concluded that cassava cultivars differ in response to root-knot nematodes (Ponte *et al.*, 1980; Caveness, 1981, 1982; Nwauzor and Nwankwo, 1989; Crozzoli and Hidalgo, 1992; D.L. Coyne and L.A.H. Talwana, unpublished). Some cultivars were recorded as immune, whereas others were rated as highly susceptible. In one study, with 11 cassava cultivars, root-knot infection was unrelated to cyanide content (Freitas and Moura, 1986). The evidence is that under certain circumstances, root-knot nematodes can be serious pests of the crop. With more extensive observations from the field, the overall effect of nematodes on cassava may become clearer.

There is little information on the effects of root-knot nematodes on yield. Some substantial yield losses have, however, been demonstrated by Caveness (1982), who observed a storage root loss of 87 % under the heaviest nematode attack. Losses as much as 98 % have also been reported in an experimental plot under heavy infestation (Théberge, 1985). D.L. Coyne and L.A.H. Talwana (unpublished), investigated cassava yield under normal growing conditions at different farm sites. Although results were not significant ($P = 0.05$), yields were consistently lower at sites with greater root-knot damage. For the more susceptible cultivars, Bukalasa 11 and TMS30337 yield reductions of 38 and 24 % per plant, respectively, were recorded.

In addition to the direct losses of both quantity and quality of the cassava crop, there is the added effect of reduced stem height and weight associated with high *Meloidogyne* populations (Gapasin, 1980, 1981; Caveness, 1981, 1982). This decreases the quality of the planting material available for the following season.

LESION NEMATODES (*PRATYLENCHUS* SPP.)

Pratylenchus brachyurus (Godfrey Filipjev and Schuurmans Strehoven) is an important parasite of cassava, which is an excellent host and has been found to have infested many diverse locations around the world (McSorley *et al.*, 1983). *P. brachyurus* is probably the next most important nematode parasite of cassava after root-knot nematodes. It occurs frequently on cassava. In

Uganda, for instance, D.L. Coyne and L.A.H. Talwana (unpublished), found the nematode on at least 28 % of sites sampled, at high average densities, and *Pratylenchus* spp. occurred at 41% of sites. In their review of cassava nematodes, McSorley *et al.* (1983), report on the various negative effects of *P. brachyurus* on cassava production. Significant increases in total plant weight (tops and storage roots) were recorded from fumigated plots compared with untreated, at a site where the nematode occurred in high numbers, together with *Helicotylenchus erythrinae* (Zimmerman) Golden (de Guiran, 1965). An eight-fold population increase of the nematode was recorded after 3 months in a greenhouse test, and a gradual decline in production of cassava was observed over several years due to the nematode (Charchar and Huang, 1981). Zem (1979), however, reported *P. brachyurus* on cassava in Brazil but without obvious damage to the crop. Varietal differences in susceptibility to *P. brachyurus* occur (Corbett, 1976). Consequently and due to both the nematodes' wide host range and distribution, control of the nematode lies in the identification of resistant cultivars.

OTHER NEMATODES

Despite the frequent occurrence of many other nematode species on cassava, there is little evidence that any cause economic damage to the crop. McSorley *et al.* (1983) listed numerous records of a wide range of nematodes associated with cassava, some at high population densities, but without any supporting evidence of damage. Although these nematodes may not be pests of cassava, the fact that they often occur in high population densities raises the question, why? In Uganda, for example, *Scutellonema* species were regularly found associated with cassava roots in high densities (D.L. Coyne and L.A.H. Talwana, unpublished). These nematodes are commonly recognised as being able to cause considerable damage on root and other crops. Some nematodes, such as *Aphelenchus avenae* (Bastian), are fungal feeders and can be found in high densities around plant roots including those of cassava. Nevertheless, it must not necessarily be discounted that the presence of other known parasitic nematodes is totally benign.

DISCUSSION

Nematode parasites form an integral element in the production of cassava and need to be considered in any pest management strategy. They can decrease the yield and quality of cassava both alone but probably more importantly as an element of a disease complex. Their residual effect on succeeding crops needs also to be considered, especially for crops particularly susceptible to the nematodes in question. The impact of nematodes on the production of cassava is still to be understood. This overview is, therefore, but a brief introduction to the potential of nematodes as constraints to cassava production. With an increase in large scale and monoculture cultivation and where the pressure for land use has increased, resulting in reduced crop rotations and more continuous cropping of cassava, nematodes must be given increasing consideration as production constraints.

With the inherent restrictions associated with chemicals and the often unsuitability of alternative nematode management practices, the solution to controlling, and to preventing increased nematode problems on cassava lies in identifying appropriate resistant cultivars/lines. Hahn *et al.* (1989) indicated in their review of resistance breeding in root and tuber crops, that the most realistic and appropriate approach to controlling pests and diseases, including nematodes, is in the development of resistant cultivars. This would be appropriate on an international and national basis, but in localised situations, particular management practices of rotation systems, intercropping, fallowing, mulching and the use of nematicidal or antagonistic cover crops and by-products may be appropriate. For further and more detailed information on these various nematode management practices see Duncan (1991), and Minton (1986).

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REFERENCES

- Bridge, J. 1988. Plant parasitic problems in the Pacific islands. *Journal of Nematology* 20: 173-183.
- Bridge, J., Otim-Nape, W. and Namaganda, J. 1991. The root-knot nematode, *Meloidogyne incognita*, causing damage to cassava in Uganda. *Afro-Asian Journal of Nematology* 1:116-117.
- Caveness, F.E. 1979. Cowpea, lima bean, cassava, yams and *Meloidogyne* spp. in Nigeria. In: *Root-knot nematodes (Meloidogyne species); Systematics, Biology and Control*. Lamberti, F. and Taylor, C.E. (Eds.), pp. 295-300. London, UK: Academic Press.
- Caveness, F.E. 1980. Plant residue management and evaluation trial: nematology. In: *International Institute of Tropical Agriculture. Root and Tuber Improvement Programme. Nematology Subprogram Report*. IITA, Ibadan, Nigeria, pp. 69-89.
- Caveness, F.E. 1981. Root-knot nematodes on cassava. *Annual Report, IITA*, pp. 64-65.
- Caveness, F.E. 1982. Root-knot nematodes as parasites of cassava. *IITA Research Briefs* 3: 2-3.
- Charchar, J.M. and Huang, C.S. 1981. Circulo de hospedeiras de *Pratylenchus brachyurus*. 3. *Plantas diversas Fitopatologia Brasileira* 6: 469-473.
- Corbett, D.C.M. 1976. *Pratylenchus brachyurus*. *C.I.H. Descriptions of plant parasitic nematodes*. Set 6, No. 89. Commonwealth Agricultural Bureau, St. Albans, England. 4 pp.
- Coyne, D.L. and Namaganda, J.M. 1994. Root-knot nematodes, *Meloidogyne* spp., incidence on cassava in two areas of Uganda. *Roots Newsletter* 1:2-3.
- Crozzoli, P.R. and Hidalgo, S.O. 1992. Response of ten cassava cultivars to the nematode *Meloidogyne incognita*. *Fitopatologia Venezolana* 5: 20-22. (Abstract).
- DeGuiran, G. 1965. Nematodes associés au manioc dans le sud du Togo. Pages 677-680.

- In: *Comptes rendues des travaux du Congrès de la Protection Culture Tropicales, Marseilles*.
- Diomande, M. 1982. Root-knot nematodes on upland rice (*Oryza sativa* and *O. glaberrima*) and cassava (*Manihot esculenta*) in Ivory Coast. In: *Proceedings of the 3rd Research Planning Conference on Root-knot Nematodes, Meloidogyne spp., Regions IV & V (International Meloidogyne Project)*, pp. 37-45. Raleigh, USA: North Carolina State University Graphics.
- Duncan, L.W. 1991. Current options for nematode management. *Annual Review of Phytopathology* 29:469-490.
- Edwards, E.E. 1953. The root-knot eelworm on weeds and cultivated plants in the Gold Coast. *Journal of Helminthology* 27:181-184.
- Freitas, O.M.B.L. de and Moura, R.M. de 1986. Response of cultivars of cassava (*Manihot esculenta* Crantz) to *Meloidogyne incognita* and *M. javanica* (Nematoda, Heteroderidae) and comparisons with hydrogen cyanide content. *Nematologia Brasileira* 10:109-131.
- Gapasin, R.M. 1980. Reaction of golden yellow cassava to *Meloidogyne* spp. inoculation. *Annals of Tropical Research* 2:49-53.
- Gapasin, R.M. 1981. Control of *Meloidogyne incognita* and *Rotylenchulus reniformis* and its effect on the yield of sweet potato and cassava. *Annals of Tropical Research* 3:92-100.
- Hahn, S.K., Isoba, J.C.G. and Ikotun, T. 1989. Resistance breeding in root and tuber crops at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. *Crop Protection* 8:147-168.
- Hogger, C.H. 1971. Plant parasitic nematodes associated with cassava. *Tropical Root and Tuber Crops Newsletter* 4:4-9.
- Jatala, P. and Bridge, J. 1990. Nematode parasites of root and tuber crops. In: *Plant parasitic nematodes in subtropical and tropical agriculture*. Luc, M., Sikora, R.A. and Bridge, J. (Eds.), pp. 137-180. CAB International, Wallingford, UK.
- Kay, D.E. (revised by Gooding, E.G.B.) 1987. *Crop and Product Digest No. 2 - Root Crops. Second edition*. London, Tropical Development and Research Institute. 380 pp.
- Luc, M. 1968. Nematological problems in the former French African tropical territories and Madagascar. In: *Tropical Nematology*. Smart, G.C. and Perry, V.G. (Eds.), pp. 93-112. USA: University of Florida Press.
- McSorley, R., O'hair, S.K. and Parrado, J.L. 1983. Nematodes of cassava, *Manihot esculenta* Crantz. *Nematopica* 13:261-287.
- Minton, N.A. 1986. Impact of conservation tillage on nematode populations. *Journal of Nematology* 18:135-140.
- Nwauzor, E.C. and Nwankwo, O.C. 1989. Reaction of some cassava cultivars/lines to root-knot nematode, *Meloidogyne incognita* race 2. *International Nematology Network Newsletter* 6:40-42.
- Ponte, J.J. da, Torres, J. and Simplicio, M.E. 1980. Behaviour of cassava cultivars in relation to root-knot nematodes. *Trabalhos apresentados a IV Reuniao Brasileira de Nematologia, 16-20 de julho de 1979, Sao Paulo. Publicacao No. 4*. Lordello, L.G.E. (Ed), pp. 107-133; 7 ref. Piracicaba, SP, Brazil; Sociedade Brasileira de Nematologia. (abstract).
- Saka, V.W. 1982. International Meloidogyne project report in Malawi. In: *Proceedings of the 3rd Research Planning Conference on Root-knot Nematodes, Meloidogyne spp., Regions IV & V (International Meloidogyne Project)*, pp. 31-36. Raleigh, USA: North Carolina State University Graphics.
- Sikora, R.A., Reckhaus, P. and Adamou, E. 1988. Presence, distribution and importance of plant parasitic nematodes in irrigated agricultural crops in Niger. *Mededelingen van de Faculteit Landbouwwetenschappen, Rijksuniversiteit Gent* 53:821-834.
- Théberge, R.L. (Ed.). 1985. Common African pests and diseases of cassava, yam, sweet potato and cocoyam. International Institute of Tropical Agriculture, Ibadan, Nigeria. Pp. 26-29.
- Van den Oever, H.A.M. and Mangane, S.E. 1992. A survey of nematodes on various crops in Mozambique. *Afro-Asian Journal of Nematology* 2:74-79.
- Zem, A.C. 1979. New observations on nematodes and their hosts in the state of Bahia, Brazil. *Summa Phytopathologica* 5:19-20. (Abstract).

