Review

Potentials of Organic Amendments in the Control of Plant Parasitic Nematodes

Ogechi N. AGBENIN

Department of Crop Protection, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria

Abstract

Agbenin O. N. (2004): **Potentials of organic amendments in the control of plant parasitic nematodes**. Plant Protect. Sci., **40**: 21–25.

An increasing number of researchers worldwide are showing interest in organic amendment of soil as means of nematode control. Numerous plant species with nematicidal compounds have been identified. Neem (*Azadirachta indica)* is considered the best-known example of plants with nematicidal properties and is available commercially in some parts of the world. Its efficiency has been proven locally, with the seed powder giving good control in both field and screenhouse. Several materials are in use as organic amendment. However, the choice of materials for amendment will determine its efficiency in control. The use of organic amendments that are disease-free and with a narrow C:N ratio will improve soil fertility while more efficiently reducing the level of nematodes and minimising the risk of increasing the level of another soil borne pathogens and pest.

Keywords: plant parasitic nematodes; control; organic amendments

For decades, the use of chemicals to control plant parasitic nematodes has been considered not only effective, but a sure means of control. Over the years, unsafe levels of nematicides used for control have been found in numerous wells in USA and Hawaii. Other chemicals have persisted for months in the soil (Bromilow 1983). Some of these pesticides suppress the activity of nitrifying bacteria, resulting in the accumulation of phytotoxic levels of nitrite-nitrogen (McKennay 1980). This setback in the use of chemicals led to intense campaigns against their use by environment friendly groups.

Research has, therefore, been geared towards alternative modes of control. An increasing number of researchers in Nigeria and worldwide are showing interest in organic amendment of soil as a means of nematode control.

Initial reports on the use of plant extracts in nematode control in Nigeria were those of Egunjobi and Afolami (1976). In recent years, the use of plant materials and animal dung in nematode control has been in the forefront of this research. However, a wrongly chosen amendment may result in the proliferation of new disease problems. This paper discusses the effectiveness of the use of organic amendments, problems and the role of extension staff in ensuring that farmers fully utilise the benefit of this mode of control.

Sources of organic amendment and mode of its application

Plant extracts. Numerous plant species have been identified locally to contain nematicidal compounds and i*n vitro* screening of these materials is being carried out. Water extracts of leaves of neem *(Azadirachta indica)*, *Acacia alatta, Borelia, Ocimum gratissimum, Acalypha ciliata, Tamarindus*

indica, Cassia siamea, garlic bulbs are some that have been identified locally to have nematicidal properties (Egunjobi & Onayemi 1981; Agbenin *et al*. 2002; Bello *et al*. 2002; Rotimi & Moen 2002). Numerous plant species belonging to 57 families have been shown to be nematicidal (Sukul 1992).

In vitro and pot trials have shown that extracts of *Calendula officinalis, Enhydra fluctans* and *Solanum khasianum* reduced galling and inhibit hatching (Goswami & Vijayalakshmi 1986). Sukul *et al*. (1974) identified the nematicidal properties of ginger (*Zingiber officinale)*, chilli pepper (*Capsicum annum*) and garlic (*Allium sativum*).

Plant extracts are applied either as soil drench (Sukul *et al*. 1974), root dip or as foliar spray (Egunjobi & Onayemi 1981). Most of the work on plant extracts were carried out *in vivo* or in micro-plots in the field.

Plant materials. Plant parasitic nematodes have been effectively controlled in various parts of the world using plant materials as source of amendment. In Nigeria, Egunjobi and Ekundare (1981) reported that partially decayed and dried cassava peelings composted for 24 day and incorporated into the soil reduced field populations of *Pratylenchus brachyurus* on maize (Table 1). In pot trials, populations of *Meloidogyne* were reduced following amendment of soil with neem leaves, and leaves of other plants (Fatoki & Oyedumade 1996). Neem seed powder incorporated into soil gave good control of *Meloidogyne* in the screenhouse and field. Amendment of soil with neem seed powder at 2 t/ha was found more effective in nematode control than the use of neem leaf powder. Neem is considered the best-known example of plants with pre-formed nematicidal constituents which are gradually released into the soil. Neem products prepared from leaves, seed, oil, saw dust and oilcake are effective in reducing the populations of several nematode species in the field (Akhtar & Alam 1991; Akhtar & Malik 2000).

A cultural practice among Indian farmers is to plough 1–2 t/ha of pressed neem cake into soil. This practice effectively protected eggplants from borers and tomato plants from nematodes and leaf spot disease (Radwaski & Wickens 1981). In addition to nematicidal effects the triterpene compounds in neem improve nitrogen utilisation in the soil (Akhtar & Alam 1993). In India, commercial preparations of neem products (Achook, Nimin, Jauzin, Suneem and Suneem G) used as seed coatings and bare-root dip treatment have been found effective in nematode control.

Organic amendments such as green manure, crop residues, cow dung and poultry manure used in improving soil fertility, have also been found to control root diseases including nematodes (Poswal & Akpa 1991). In Nigeria, the control of plant parasitic nematodes has been successful with poultry manure (Table 2), cow dung and sawdust (Babalola 1982; Chindo *et al*. 1991; Egunjobi & Larinde 1975). Waste of plant origin such as from vegetable and

Table 1. Response of maize yield, vegetative growth and populations of *Pratylenchus brachyurus* to CASP, DD and NPK treatments

Treatments	Grain yield (g/plant)	Ear weight (g/plant)	Root weight (g/plant)	Top weight (g/plant)	Plant height at 5 weeks (cm/plant)	Stem girth (cm/plant)	*P. brachyurus* per 10 g root	*P. brachyurus* 100 cm soil
+ CASP 15 000	35.4b*	42.4b	18.8ab	120.4b	31.4b	5.2b	869cd	837a
+ CASP 10 000	45.4a	88.0a	26.8a	144.2ab	36.5ab	5.5b	1642c	729a
+ CASP 5 000	32.6b	65.8b	24.0a	121.8b	29.9b	5.0b	1514c	475b
+ DD	56.0a	102.0a	31.2a	179.8a	42.5a	6.1a	59d	20c
+ NPK	48.4a	86.2a	26.2a	165.8a	39.3a	6.1a	2831b	434b
Control	33.4b	64.4b	16.8b	119.8b	28.8b	5.0b	4650a	673a

*Each value is the mean of 25 sample plants; values with the same letters are not significantly different according to Duncan's multiple range test ($P = 0.05$)

CASP = cassava peeling; DD = nematicide; NPK = fertilizer; Control = not treated; adapted from Egunjobi and Onayemi (1981)

Table 2. Effect of poultry manure on nematode population and yield of tomato cv. Enterprise infested with *Meloidogyne incognita*

Poultry manure (g)	Root gall index	Soil population at harvest	Fruit number	Fruit weight (g)
0	6	17 900	5.6	202.0
7.5	5.0	8 300	6.2	235.0
15	3.1	3 100	9.0	406.0
30	1.0	2 800	9.6	464.0

Adapted from Chindo (1986)

fruit processing and tobacco wastes were the most effective in reducing the incidence of root knot and the development of plant-parasitic nematodes on tomato compared with other sources. Amendments to soil with tea, wheat straw, paddy husk, paddy straw, sugarcane trash, domestic garbage, dead vegetation and pigeon pea stubble also gave some level of control (Akhtar 1993). Recent work showed that ricin, a protein derived from castor bean, is nemato-toxic (Rich *et al*. 1989).

Effectiveness of organic amendments and the role of extension staff

The effectiveness of organic amendments to control nematodes is a function of the C:N ratio and time of microbial decomposition of organic matter and subsequent release of nitrogen for utilisation by higher plants. With organic matter of a C:N ratio greater than 20:1, N will temporarily be immobilised in microbial tissue, creating a nitrogen deficiency (Akhtar & Malik 2000). The nematode management potential of an organic soil amendment is directly related to N-content or inversely related to the C:N ratio (Mian & Rodriguez-Kabana 1982).

Farmers understand the role of organic amendment, but do not know what effect the choice of material has on the efficiency of an amendment. This is where the extension staff can be of great help in improving the efficiency of this simple mode of disease control. Better knowledge will allow the C:N ratio to be manipulated in such a way as to increase the efficiency. Amendments with narrow C:N ratios such as animal manure, oil cake and green manure, result in better nematode control than those with wide ratios, especially grassy hay, stubbles and cellulosic materials such as paper and sawdust (Akhtar & Malik 2000).

An amendment has to be chosen wisely or else a new problem may arise. While it appears promising to plough back plant residue into the soil as amendment, some pathogens and disease conditions may increase, especially soil borne diseases. For example, residue from *Brassica* cultivars incorporated into the soil reduced the soil level of *Tylenchulus semipenetrans* by up to 76% compared to unamended soil whereas *Pythium ultimum*, a causative organism of damping-off, was isolated more frequently from roots and their propagules were significantly more numerous (Walker & Morey 1999). In most tomato growing fadama in Zaria, root-knot occurs in a complex with *Fusarium oxysporum* f.sp. *lycopersici.* Ploughing back such diseased vegetative parts of tomato would only increase the level of inoculum of *Fusarium* in the soil.

Conclusion

The positive role of organic amendments in nematode control is established. Organic amendments as means of control have great potential. Minimal finance and technical know-how is required. However, its effectiveness in control depends on the type of amendment, its C:N ratio, moisture content and time of decomposition.

References

Agbenin N.O. (2002): Effect of neem leaf and garlic bulb on Meloidogyne incognita in vivo. In: 30th Annual Conf. Nigerian Society for Plant Protection, University of Agriculture, Abeokuta, 1-4 Sept..

Agbenin N.O., Erinle I.D., Emechebe A.M., Marley P.S. (2000): Status of root-knot and *Fusarium* wilt diseases of tomato on Fadama farms in Zaria, Nigeria. Nigerian J. Agric. Extension, **12**: 38–44.

Agbenin N.O, Emechebe A.M., Marley P.S. (2002): Effect of neem leaf and garlic bulb on Meloidogyne incognita in vivo. In: 30th Annual Conf. Nigerian Society for Plant Protection, University of Agriculture, Abeokuta, 1-4 Sept.

Akhtar M. (1993): Utilisation of plant-origin waste materials for the control of parasitic nematodes. Bioresource Technol., **46**: 255

Akhtar M., Alam M.M. (1991): Integrated control of plant-parasitic nematodes on potato with organic amendments, nematicide and mixed cropping with mustard. Nematol. Medit., **19**: 169–171.

Akhtar M., Alam M.M. (1993): Utilization of waste materials in nematode control: a review. Bioresource Technol., **45**: 1–7.

Akhtar M., Malik A. (2000): Roles of organic soil amendments and soil organisms in the biological control of plant-parasitic nematodes: a review. Bioresource Technol., **74**: 35–47.

Babalola J.O. (1982): Effects of soil amendments in tomato cultivation. In: Proc. 5th Annual Conf. Horticultural Society of Nigeria, Ahmadu Bello University, Zaria, 21–25 Nov. 1982.

Bello L.Y., Chindo P.S., Marley M.D., Alegbejo M.D. (2002): Effects of some plant extracts on egg hatching of *Meloidogyne incognita*. In: 30th Annual Conf. Nigerian Society for Plant Protection, University of Agriculture, Abeokuta.

Bromilow R.H. (1983): Breakdown and fate of oxine carbonate nematicides in crops and soils. Ann. Appl. Biol., **75**: 473–479.

Chindo P.S. (1986): Studies on host-parasite relationships between the root-knot nematode (*M. incognita*) and tomato (*Lycopersicon esculentum*). [M.Sc. Thesis.] Dept. Crop Protection, Ahmadu Bello University.

Chindo P.S., Khan F.A., Erinle I.D. (1991): Reaction of three tomato cultivars to two vascular diseases in presence of the root-knot nematode *Meloidogyne incognita* Race I. Crop Protect., **10**: 62–64.

Egunjobi A.O., Afolami S.O. (1976): Effects of neem (*Azadirachta indica*) leaf extracts on population of *Pratylenchus brachyurus* on the growth and yield of maize. Nematologica, **22**: 125–132.

Egunjobi A.O., Larinde M.A. (1975): Nematodes and maize growth in Nigeria. II. Effects of some amendments on populations of *Pratylenchus brachyurus* and on the yield of maize (*Zea mays*) in Nigeria. Nematol. Medit., **3**: 65–73.

Egunjobi O.A., Ekundare G.O. (1975): Cassava peeling as a soil amendment and its effects on maize yield in soil infested with *Pratylenchus brachyurus*. Nigerian J. Plant Protect., **5**: 80–87.

Egunjobi A.O., Onayemi S.O. (1981): The efficacy of water extract of neem (*Azadirachta indica* L.) leaves as a systemic nematicide. Nigeria J. Plant Protect., **5**: 70–74.

Fatoki O.K., Oyedumade E.E.A. (1996): Controlling effects of some plant leaves on the root-knot nematode *M. incognita* attacking tomato, *Lycopersicon esculentum* Mill. Nigerian J. Plant Protect., **16**: 59–65.

Goswami B.K., Vijayalakshmi K. (1986): Nematicidal properties of some indigenous plant materials against root-knot nematodes *Meloidogyne incognita* on tomato. Indian J. Nematol., **16**: 65–68.

McKenny M.V. (1980): Nature, mode of action and biological activity of nematicides. In: Pimenten D.: CRC Handbook of Pest Management in Agriculture. Section D, 3, Cleveland, CRC Press: 59–73.

Mian I.H., Rodriguez-Kabana R. (1982): Organic amendments with high tannin and phenolic contents for control of *Meloidogyne arenaria* in infested soil. Nematropica, **12**: 71–84.

Poswal M.A.T., Akpa A.D. (1991): Current trends in the use of traditional and organic methods for the control of crop pests and diseases in Nigeria. Trop. Pest Mgmt., **37**: 329–333.

Radwaski S.A., Wickens G.G. (1981): Vegetative fallows of potential value of the neem tree in the tropics. Econ. Bot., **35**: 398–414.

Rich J.R., Rahi G.S., Opperman C.H., Davis E.L. (1989): Influence of the castor bean (*Ricinus communis*) lectin (Ricin) on motility of *Meloidogyne incognita*. Nematropica, **19**: 99–101.

Rotimi M.O., Moen M. (2002): The use of leaf extracts of some herbs in the control of *Meloidogyne incognita*. In: 30th Annual Conf. Nigerian Society for Plant Protection, University of Agriculture, Abeokuta.

Sukul N. C. (1992): Plant antagonistic to plant-parasitic nematodes. Indian Rev. Life Sci., **12**: 23–52.

Sukul N.C., Das P.K., De G.C. (1974): Nematicidal action of some edible crops. Nematologica, **20**: 187–191.

Walker G.E., Morey B.G. (1999): Effect of *Brassica* and weed manures on abundance of *Tylenchus semipenetrans* and fungi in citrus orchard soil. Aust. J. Exp. Agric., **39**: 65–72.

Received for publication August 18, 2003
Accepted October 17, 2003

Souhrn

Agbenin O. N. (2004): **Možnosti využití organických prostředků na zlepšení půdy v regulaci fytoparazitických nematod**. Plant Protect. Sci., **40**: 21–25.

Stále větší počet badatelů na celém světě věnuje pozornost organickým prostředkům na zlepšení půdy jako možnosti regulace nematod. Byla zjištěna celá řada rostlinných druhů, které obsahují nematocidní látky. Za nejznámější příklad rostliny s nematocidními vlastnostmi se považuje *Azadirachta indica*, která je komerčně dostupná v některých částech světa. Její účinnost byla lokálně prokázána při aplikaci rozemletých semen poskytujících spolehlivou regulaci nematod jak na poli, tak i ve skleníku. Některé materiály se používají jako organické prostředky na zlepšení půdy. Účinnost regulace je však určována volbou materiálů ke zlepšení půdy. Použití organických prostředků na zlepšení půdy, které nejsou zamořeny původci chorob a mají úzký poměr C : N, zvýší půdní úrodnost, přičemž účinněji sníží koncentraci nematod a minimalizuje riziko zvýšení hladiny jiných půdních patogenů a škůdců.

Klíčová slova: fytoparazitické nematody; regulace; organické prostředky na zlepšení půdy

Corresponding author:

Dr. Ogechi N. Agbenin, Ahmadu Bello University, Faculty of Agriculture, Department of Crop Protection, P.M.B. 1044, Zaria, Nigeria
tel.: + 234 69 550 681, e-mail: nnennayaogechi@yahoo.com