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NEMATODES AND MAIZE GROWTH IN NIGERIA. II. EFFECTS OF SOME AMENDMENTS ON POPULATIONS OF *PRATYLENCHUS BRACHYURUS* AND ON THE GROWTH AND PRODUCTION OF MAIZE (*ZEA MAYS*) IN NIGERIA

by

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The use of nematicidal chemicals is perhaps the most reliable method for a quick and effective control of nematodes infesting crops. However, in Nigeria, it is unrealistic to recommend such chemicals to farmers because most nematicides are toxic to humans and require skilled labour for a successful application; they are also too costly and the increases in yields obtained by their use may not be sufficient to cover costs (Caveness, 1967). Yet, an ever increasing human population demands the growth of more food on continuosly restricted area of available arable land. Other methods must, therefore, be found which can ensure increased crop yields either by killing or reducing nematode pests. The use of soil amendments may offer such a possibility (Walker, 1969; Mankau and Das, 1969; Tomerlin *et al.*, 1968). The present study describes a trial in which such organic amendments were used.

Materials and methods

The trial consisted of five treatments:

1. Farm yard manure consisting of cow dung with 5% elephant grass (*Pennisetum purpureum* Schumach) straw.
2. Partially decayed dry cocoa pods (fruit husks of *Theobroma cacao* L. var. Amelonado).

3. Partially decayed cassava peelings (peelings from roots of *Manihot utilissima* L.).
4. Aqueous leaf extract of neem (*Azadirachta indica* L.) prepared by boiling 2kg fresh leaves in 3l water for 1½ hr and properly cooled before use.
5. Untreated control.

Wooden boxes measuring 76 x 76 x 38cm were filled with 0.146 m^3 sandy loam soil. Because our main aim was to find a cheap and easily applicable field alternative to the chemical control method, soil used was not fumigated nor autoclaved, but was thoroughly mixed to ensure even distribution before filling the boxes. In the first three treatments, the soil had previously been mixed with 9.4kg (equivalent to an application of 84 metric ton/ha) of farm yard manure, dry cocoa pods or cassava peelings. The aqueous extract of neem was applied as a soil drench once weekly (200 ml per plant) as a substitute for water used for the other three treatments and the control. Each treatment replicated four times was watered once daily for one week previous to planting. On the seventh day, soil samples were collected from each box to determine the type and numbers of nematode present.

Each of the boxes was then planted to 15 maize (*Zea mays* L. cv. Lagos white) grains and the plants were thinned to 10 per box seven days after planting. The soil around each plant was inoculated with 600 *Pratylenchus brachyurus* (Godfrey) T. Goodey ten days after planting.

The following data were recorded weekly for each stand starting on the 21st day after planting: plant height, stem girth (10cm above ground), leaf numbers and leaf area index (LAI). Tasselling sequence of the plants was also observed daily, starting on the 40th day after planting. Fourteen weeks after planting, mature cobs were harvested sun-dried and shelled. Weights of dry grains (economic production) and plant remains including roots (Stubble = Dry matter production) were recorded. A 1l soil sample was collected from around the 10 maize stands in each box, mixed thoroughly and two 100g sub samples were then used for the extraction of nematodes using the modified Baermann method of Whitehead and Hemming

(1965). The roots in each box were collected, cut into small pieces, ando two 10g subsamples were mixed in a waring blender for 15 seconds; the nematodes in the root samples were then extracted for 24 hr using the same technique as for the soil samples. Counts were made of the numbers of *P. brachyurus* in each sample.

Results and discussion

Newman Keuls test (Winer, 1962) was used to compare several parameters measured from the five treatments (Table I).

Vegetative growth

Plants grown in soils treated with farm yard manure, cocoa pods and cassava peelings produced better vegetative growth as indicated by plant height, plant girth and LAI measurements, all of which were significantly greater than the control (Table I A, B and C).

Heights ranged between 264-267 cm in these treatments compared with 195-243 cm in the control. Generally, the plants appeared more vigorous and produced an average of 19 leaves per plant compared with 17 in the control. Mid day wilting was also regularly observed in the control treatment. Plants grown in the neem extract treated soil showed less wilting than the control but otherwise they did not differ significantly.

Leaf production and tasselling

Both the rate of leaf production and the final numbers of leaves per plant were greater in the farm yard manure, cocoa pod and cassava peeling treatments compared with the neem drench and the control (Fig. 1). Maize stands in soils amended with farm yard manure, cassava peelings and cocoa pods tasselled 3, 2 and 1 days respectively before plants in the control plots.

Dry matter production and yield

There was a substantial increase in stubble production and yield (Table I, D and E) of plants grown in soils amended with farm yard manure, cocoa pods and cassava peelings. Respectively, there were statistically significant increases of up to 111% and 50%, in stubble production from plants grown in farm yard manure and cassava peeling treated plots, compared with the control (Table I, D). In the cocoa pod treated plots, there was an increase of about 48% in plant weight over the control (Table I, D). Although this difference was not statistically significant, there was a two fold increase in yield in this plot compared with the control (Table I, D and E). Better vegetative growth is therefore not synonymous with increased yield.

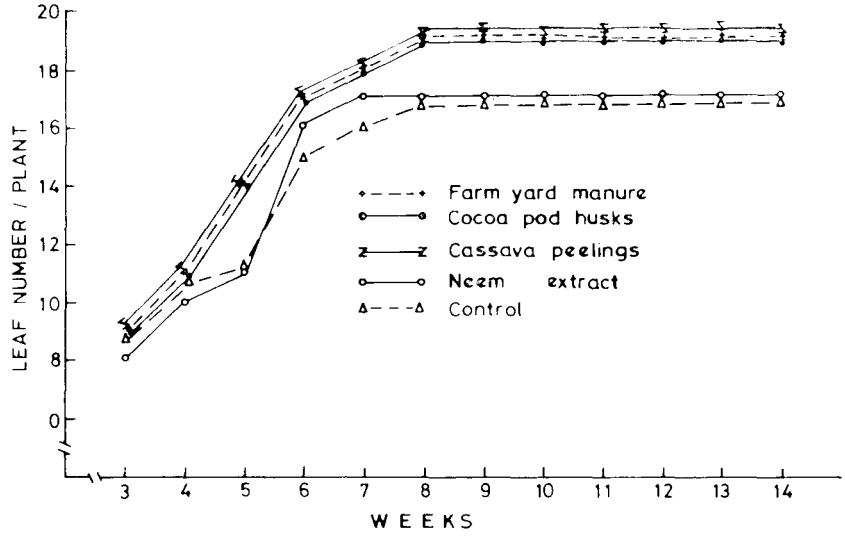

Fig. 1 - Effects of some amendments on mean number of leaves produced per maize plant. Each point represents the means for 40 plants.

Increases of up to 124% in yield and 50% in stubble production resulted from the application of cocoa pods and cassava peeling residues respectively, but not from plots treated with water extract of neem leaves. Nevertheless, the comparatively reduced soil and

root populations of *P. brachyurus* in plots treated with the extract demonstrate a nematicidal property. Possibly, the extract was too concentrated and therefore toxic to the maize plants, but further study is evidently necessary to elucidate this aspect.

Populations of P. brachyurus *in soil*

Highest populations were recorded in control plots with the following decreases in numbers in treated soils: farm yard manure, 35%; cocoa pods, 58%; cassava peelings, 75%; neem extract, 72%; (Table I, F). These results indicate that the amendments have nematicidal properties as also do some earlier results. Hutchinson *et al.* (1958) found decayed pumpkins suppressed soil populations of some phytophagous nematodes; Tomerlin *et al.* (1969) associated alfalfa meal, cotton seed meal and rice straw amendments with notable depression in populations of *Belonolaimus longicaudatus* Rau; Mankau (1969) recorded substantial decrease in infection and larval populations of *M. incognita* (Kofoid *et* White) Chitw. in chitin amended soils and Caveness (1967) also found that rotted cow manure reduced populations of *Helicotylenchus* sp. and eliminated root knot infection of cow peas in Ibadan; but no earlier trials with cocoa pods or cassava peelings or water extract of neem leaves are available for comparison.

The specific nature of the nematicidal properties in these amendments is unknown, but could be chemicals produced from microbial degradation of the organic amendments (Tomerlin *et al.*, 1969); toxic intermediate break down products such as ammonia (Vassallo, 1967; Walker, 1969); an increase in soil microfauna inimical to nematodes (Mankau and Minteer, 1962; Walker *loc cit*) or even other competitive nematodes (Johnson, 1970; Luc, 1968). Our experiments show that the control which had the highest soil population of *P. brachyurus* also had the least population of other nematodes. These nematodes, some of which increased in numbers about 20 times during the course of this investigation include some Rhabditid and Dorylaimid spp. This nemanode — nematode competition may be important in the population structure observed (Tobar-Jimenez, 1972).

Slight correlation occurred between soil populations of *P. brachyurus* and both yield ($r = -0.22$) and plant weight ($r = -0.04$).

Table I - *Vegetative growth, yield and nematode populations in relation to soil amendments.*

Yield data	Treatments: Farm yard manure	Cocoa pods	Cassava peelings	Neem extract	Control
A. Maximum height per plant (cm)	265*	267*	259*	222	222+
B. Maximum girth per plant (cm)	11*	10*	10*	8	8
C. Maximum L.A.I.	14*	14*	14*	13	13
D. Weight per plant (g)	1,177*	855*	875*	590	583
E. Weight of dry grains per plant (g)	141*	171*	92	75	77
F. *P. brachyurus* per 100 g soil	803	509	297	342	1,243
G. *P. brachyurus* per 100 g fresh roots	4,066	5,381	2,930	1,247	2,502

* Significantly greater (P = 0.05) than non-asterisked figures; in E, underlined figure is not significantly different from cither.
\+ Each figure in A - E represents the average of 40 observations and, in F and G, the average of 8 samples each of 100 g.

Populations of P. brachyurus *within maize roots*

Nematodes recovered from roots were usually 4-5 times those from soil. Root populations were most abundant in cocoa pod, farm yard manure and cassava peeling treatments and least in neem extract treated plots (Table I, G). Thus, a positive correlation exists between root nematode numbers and both maize yield ($r = +0.66$) and plant weight ($r = +0.40$). Van der Laan (1956) tried to explain a similar observation when he suggested that organic matter alters the host physiology such that the host is more resistant to the nematodes. Sayre (1971) explained that amended soils improve root growth which enhances better utilization of nutrients, thus neutral-

izing the effect of nematode damage. Both hypotheses seem plausible in explaining the fact that plants growing in soils amended with farm yard manure, cocoa pod and cassava peelings which had higher yields and biomass also maintained higher root populations of *P. brachyurus*.

Conclusion

These results show that remarkable gains in average yields could be obtained by using farm yard manure (83% increase) and plant residues of cocoa pod (124% increase) and cassava peelings (20% increase). Substantial improvement in vegetative growth and total biological productivity (i.e. stubble production plus yield) was also evident in maize plants grown in these treatments (Table I, A, B and C). Cocoa pods and cassava peelings constitute disposal problems for many farmers in many parts of Nigeria. Results outlined above indicate that, with further studies, these residues, could probably be gainfully utilized, most especially as the yields obtained here compare favourably with normal experimental farm yields where recommended imputs such as fertilizers and pesticides are used.

SUMMARY

Farm yard manure (rotted cow dung +5% elephant grass straw), water extract of neem (*Azadirachta indica* L.) leaves and plant residues in the form of partially decayed, dry cocoa pods (husks of *Theobroma cacao* L. var Amelonado fruits) and cassava peelings (root peelings of *Manihot utilissima* L.) were tried as soil amendments for the control of *Pratylenchus brachyurus* (Godfrey) T. Goodey and the improvement of maize (*Zea mays* L. cv. Lagos White) growth and yield. Compared with the control, soil populations of *P. brachyurus* at harvest, fourteen weeks after planting, were reduced as follows: 35% by farm yard manure; 72% by neem extract; 58% by cocoa pods and 75% by cassava peelings. Improvement in yield was as follows: 85% increase with farm yard manure; 124% with cocoa pods; 22% with cassava peelings and 1.3% with neem extract. Similar increases were also observed in vegetative growth and biomass of the maize plants.

RIASSUNTO

Nematodi e sviluppo del Mais in Nigeria. II. Effetti di alcuni emendamenti sulle popolazioni di Pratylenchus brachyurus *e sulla crescita e la produzione di Mais in Nigeria.*

È stato saggiato sulla crescita e sulla produzione di Mais (*Zea mays* L., var. Amelonado) in Nigeria l'effetto nematocida su *Pratylenchus brachyurus*

(Godfrey) T. Goodey di letame (escrementi bovini con paglia di *Pennisetum purpureum* Schumach), estratto acquoso di piante di « Neem » (*Azadirachta indica* L.), polpa essicata di frutti di Cacao (*Theobroma cacao* L.) e corteccia di radici di Cassava (*Manihot utilissima* L.). Alla raccolta, 14 settimane dopo la semina, le popolazioni del nematode erano ridotte nei confronti del testimone, del 35% nelle parcelle con letame, del 72% in quelle trattate con estratto di « Neem », del 58% in quelle nelle quali era stata somministrata polpa essiccata di frutti di Cacao e del 75% in quelle emendate con corteccia di Cassava. Gli incrementi di produzione rispetto al testimone sono risultati, invece, dell'85, 124, 22 e 1,3% rispettivamente per le parcelle trattate con letame, polpa essiccata di frutti di Cacao, corteccia di Cassava ed estratto di « Neem ».

RESUMÉ

Nématodes et développement du Maïs au Nigeria. II. Effets de quelques amendements sur les populations de Pratylenchus brachyurus *sur la croissance et la production de Maïs au Nigeria.*

L'effet nématocide de fumier (excréments bovins mêlés de paille de *Pennisetum purpureum* Schumach), d'extrait aqueux de plantes de « Neem » (*Azadirachta indica* L.), de pulpe séchée de cabosses (*Theobroma cacao* L.) et d'écorce de cassave [écorce de racines de (*Manihot utilissima* L.)] a été essayé pour lutter contre le *Pratylenchus brachyurus* (Godfrey) T. Goodey et pour l'amélioration de la croissance et la production du Maïs (*Zea mays* L., var. Amelonado). Comparée au témoin, la population de *P. brachyurus*, à la récolte, 14 semaines aprés l'ensemencement, était réduite: de 35% par le fumier, de 72% par l'extrait de « Neem », de 58% par la pulpe séchée de cabosses et de 75% par l'écorce de cassave. L'accroissement de production a été respectivement: de 85% avec le fumier, de 124% avec la pulpe séchée de cabosses, de 22% avec l'écorce de cassave et de 1,3% avec l'extrait de « Neem ».

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