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NEMATODES AND MAIZE GROWTH IN NIGERIA. III. EFFECTS OF COCOA POD HUSK SOIL AMENDMENTS ON POPULATIONS OF *PRATYLENCHUS BRACHYURUS* AND ON THE GROWTH AND YIELD OF MAIZE (*ZEA MAYS* L.)

by

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Because of the high cost of chemicals for the control of nematodes in Nigeria, a search was initiated (Egunjobi and Larinde, 1975) for cheaper cultural methods of control. Of three natural farm by products tested by Egunjobi and Larinde (loc. cit.) coca pod husk (CPH) decreased soil populations of *Pratylenchus brachyurus* (Godfrey) T. Goodey around maize roots by about 58% and increased yields. About 800,000 tons of dry CPH are available annually in Nigeria as a waste product (Ogutuga, 1974). Investigations were therefore undertaken on the use of CPH as a soil amendment to reduce nematode populations and to assess its fertilizing effects.

MATERIALS AND METHODS

Twenty-four microplots, each a rectangular bottomless box, 0.6m x 0.3m x 0.6m, were filled with 108 m^3 loamy sand soil of the Iwo series (Smyth and Montgomery, 1962) in which the two previous crops were maize. Analysis indicated that the soil was deficient in exchangeable potassium (K=0.094 me/100g) and total nitrogen (N=0.076%).

Each microplot was treated with 15 ml (600 l/ha) D-D. After 12 days, flakes of decayed, dry CPH were mixed with the soil in 18 of the microplots, a third of them at the rate of 90 mt/ha, a third

at 65 mt/ha, and the remaining third at 40 mt/ha. The remaining 12 microplots had no CPH added and half of these were left without nematodes (see below). The microplots were set out in a randomized block design in an open field where they were watered daily for two weeks and then each planted with 10 grains of maize (*Zea mays* L.) cv. Bulk 3. Fifteen days later the maize seedlings were reduced to 5 of uniform size per microplot, and after a further two days *P. brachyurus* were added to the rhizosphere of each seedling, except for the control, on finely cut maize roots which had previously been infested with the nematode. Four weeks after planting, the microplots were sprayed with azodrin as a protection against insect pests.

The maximum height of each plant (ground level to the base of the last leaf) was measured at tasselling. At harvest, 14½ weeks after planting, the mean fresh weights of the vegetative parts and the weight of shelled grains were taken for each plant. Roots in each microplot were pooled, washed, cut into small pieces and two 10g subsamples macerated in a Waring blender for 15 sec. before extracting for 24 hours by a modified Whitehead and Hemming's method. From each plot, 1,000 g soil was dug from around the maize roots and two 200 ml subsamples extracted for nematodes. The soil in each plot was analysed for some nutrients and pH was measured.

One week after harvest, all plots were replanted with maize as previously described, in order to investigate the residual effects of CPH. Plants were again sprayed with azodrin; growth measurements were made 12 weeks after planting, and yield were recorded at 13 weeks when the plants were harvested. Nematodes were extracted from roots and soil, as described above.

RESULTS

Grain yield

In both crops, grain yield was significantly greater on microplots receiving CPH than those without (Table I), but yield of the second crop was lower than the first crop in each of the relative treatments. Yields of nematode-free plants were significantly greater than the nematode-infested control plants in the second but not in the first crop.

Plant growth measurements

Plants in CPH-amended soil had stems of significantly greater diameter than non-amended treatments in both crops (Table I). Plants of the first crop were of relatively greater diameter but differences between amended and non-amended treatments were greater in the second crop.

Differences in the numbers of leaves per plant were significant only in the second crop between plants receiving 90 mt/ha or 65 mt/ha CPH and the control (Table I).

Fresh weights of the tops of plants were significantly affected by CPH amendments in both first and second crops (Table I). Roots of plants in plots with 90 mt/ha CPH weighed about x3 those of control plants.

Differences in the height of plants were significant only between 90 mt/ha and 65 mt/ha CPH treatments and the controls in the first crop, but between all CPH treatments and the controls in the second crop (Table I).

Table I - *Growth measurements and yield of plants exposed to different levels of Cocoa Pod Husk (CPH) with and without* P. brachyurus.

CPH amendment (mt/ha)	Dry grain yield (g/plant) ± SE	Fresh top wt (g/plant) ± SE	Mean no. Leaves/plant ± SE	Mean ht/plant (cm) ± SE	Max. girth (cm) ± SE	Mean root wt (g/plant) ± SE
1st Planting						
90 +	144 ± 6.5	601 ± 48	17 ± 0.7	235 ± 5	11 ± 0.5	— lost
65 +	113 ± 5.3	542 ± 31	18 ± 0.5	222 ± 7	9 ± 0.1	— lost
40 +	105 ± 5.9	470 ± 35	17 ± 0.6	205 ± 12	9 ± 0.3	— lost
0 +	64 ± 10.9	322 ± 26	16 ± 0.7	197 ± 6	8 ± 0.4	— lost
0 —	70 ± 4.2	349 ± 35	16.5 ± 0.2	209 ± 12	8.5 ± 0.3	— lost
2nd Planting						
90 +	76 ± 11	516 ± 91	16 ± 0.1	252 ± 8	8.5 ± 0.9	61 ± 4
65 +	73 ± 11	348 ± 61	16 ± 0.1	223 ± 11	7 ± 0.2	59 ± 8
40 +	63 ± 5	309 ± 126	15.5 ± 0.4	215 ± 4	6.7 ± 0.1	49 ± 8
0 +	19 ± 5	181 ± 50	15 ± 0.5	146 ± 22	5 ± 0.5	21 ± 8
0 —	42 ± 8	178 ± 22	15 ± 0.8	150 ± 15	5 ± 0.4	24 ± 6

\+ = with nematodes; — = without nematodes.

Nematode Populations

CPH amendments resulted in large reductions in soil populations of *P. brachyurus* in both crops (fig. 1b). However, numbers of *P. brachyurus* per 100g root were greater in soils receiving 90 mt/ha CPH than other treatments in the first crop, but in the second crop, there were generally fewer nematodes per plant with no significant differences between treatments (fig. 1a).

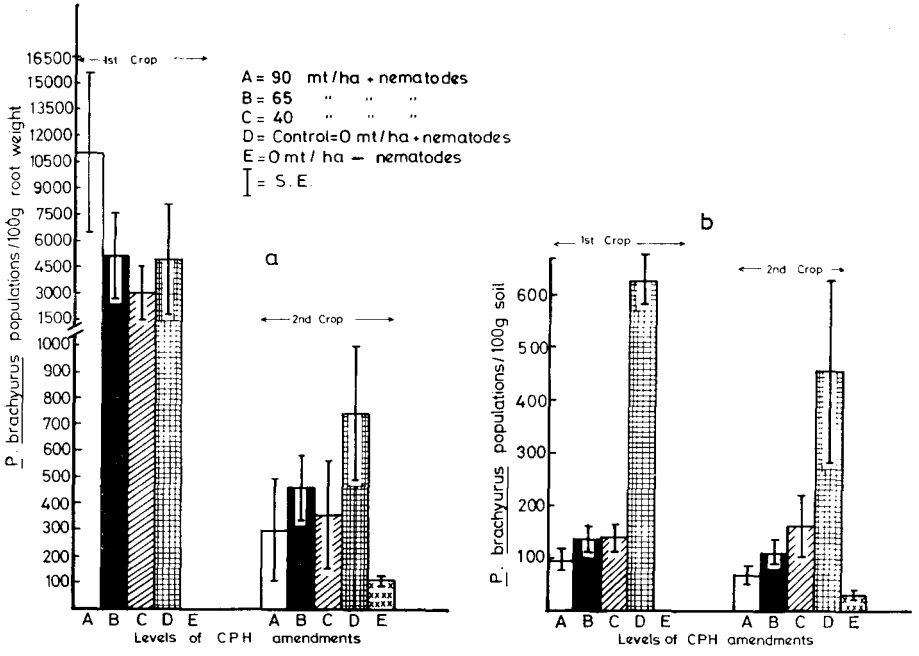

Fig. 1 - The effect of different levels of Cocoa Pod Husk (CPH) amendments on soil and root populations of *P. brachyurus*.

Soil Nutrients

CPH amendments increased the total nitrogen and organic carbon. Exchangeable potassium was linearly correlated with the rate of added CPH and significantly greater in all CPH treatments than in the untreated controls. Phosphorus was slightly reduced by CPH and soil pH was little affected (Table II).

Table II - *Status of soil nutrient and soil pH in relation to different levels of Cocoa Pod Husk (CPH) amendments after 1st crop.*

CPH amendment (mt/ha)	Exchangeable K (me/100g) ± SE	Total N (%) ± SE	Available P (Bray 1) PPM ± SE	Organic C (%) ± SE	Soil pH ± SE
90 +	0.98* ± 0.06	0.24 ± 0.01	11.55	2.1 ± 0.09	6.5 ± 0.1
65 +	0.66 ± 0.05	0.24 ± 0.01	11.48	2.2 ± 0.09	6.2 ± 0.1
40 +	0.47 ± 0.02	0.23 ± 0.02	11.14	1.9 ± 0.1	6.1 ± 0.1
0 +	0.19 ± 0.02	0.20 ± 0.00	12.38	1.8 ± 0.07	6.2 ± 0.1
0 −	0.19 ± 0.02	0.22 ± 0.00	10.33	1.9 ± 0.1	6.1 ± 0.1

+ = with nematodes; − = without nematodes; * = each value is the mean of six sample plots.

Residual Effects of CPH Amendments

Except for plant height, growth measurements and grain yield were generally less in the second crop than in the first in respect of each treatment. However, differences between amendment treatments and untreated controls were greater in the second crop for fresh top weight, plant height and stem girth. Generally, plants of the second crop were etiolated and many of the control plants failed to fruit. The numbers of *P. brachyurus* were slightly fewer in the soil for each of the treatments in the second crop.

DISCUSSION

Soil populations of *P. brachyurus* were considerably decreased in microplots receiving CPH and this effect was also carried over into the second crop. However, the numbers of nematodes in the roots were similar between treatments receiving CPH and the controls in the first crop, but the CPH appeared to have some effect in the second crop.

CPH amendments substantially improved various aspects of plant growth and in linear relation to the rate of application. Yield was significantly correlated with CPH rate of application ($r=0.98$ and 0.99 for first and second crops respectively when $y=ax^b$) and with numbers of *P. brachyurus* in the soil at harvest ($r=-0.94$ when

$y=ax^b$ and -0.99 when $y = a+bx$, in the second crop). Improvement in yield on CPH amended soils is possibly due partly to decrease in nematode numbers associated with the treatments, but largely to CPH acting as a fertilizer. Ogutuga (1974) has shown that CPH is rich in inorganic nutrients such as potassium, nitrogen and calcium. Greenwood-Barton (1965) observed its fertilizing effect. Soil nutrient analysis after the first crop showed significant increases in potassium, nitrogen and carbon in amended soils, and this is probably significant in view of the deficiency symptoms apparent three weeks after planting in non-amended treatments.

Difference between treatments observed in the first crop were not only maintained but became more pronounced in the second. While percentage increases in growth and yield increased substantially in the second crop compared with the first, percentage decreases in soil populations of *P. brachyurus* remained about the same. This indicates that CPH remained active in the soil after the first cropping. Higher percent increases in yield possibly were due to the probable fertilizing effect of CPH which was maintained in the amended plots while the control plots, originally deficient in nutrients, had deteriorated with subsequent cropping.

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SUMMARY

Incorporation of cocoa pod husk (CPH) at the rates of 90, 65 or 40 mt/ha increased the growth and yield of maize in soil with and without *Pratylenchus brachyurus* (Godfrey) T. Goodey. Soil populations of the nematode were decreased in the presence of CPH. Improved growth and yield of maize was considered to be due mainly to the fertilizer effect of CPH, but also in part to the decrease in nematode numbers caused by the direct nematicidal or nematostatic effect of the CPH amendment.

RIASSUNTO

Nematodi e sviluppo del Mais in Nigeria. III. Effetti degli emendamenti a base di polpa essiccata di frutti di Cacao sulle popolazioni di Pratylenchus brachyurus *e sulla crescita e la produzione di Mais* (Zea mays *L.).*

Incorporazioni al terreno di polpa essiccata di frutti di Cacao alla dose di 90, 65 e 40 t/ha hanno migliorato crescita e produzione di piante di Mais in

terreno infestato e non da *Pratylenchus brachyurus* (Godfrey) T. Goodey. Le popolazioni del nematode nel terreno sono diminuite in densità nelle parcelle emendate. Si pensa che gli incrementi di crescita e produzione siano dovuti soprattutto all'azione fertilizzante della sostanza emendante e solo in parte alle diminuite cariche del nematode.

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