EFFECT OF SOIL PH ON DEVELOPMENT OF *PRATYLENCHUS BRACHYURUS* POPULATIONS IN PINEAPPLE ROOTS

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ABSTRACT

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In two field experiments conducted in Ivory Coast, *Pratylenchus brachyurus* populations developed most rapidly in pineapple roots in plots with the lowest soil pH. Differences between population levels associated with differences in soil pH decreased progressively during crop growth, and disappeared after flower induction, suggesting that soil pH influenced the plant-parasite relationships before or during penetration of the roots. The results with pineapple confirmed previous observations made in other food crops with *P. brachyurus* and could help explain the high impact of this nematode on pineapple, which is generally cultivated in low pH soils in Ivory Coast. Thus, soil amendments that modify soil pH may be alternatives for integrated control of *P. brachyurus* in pineapple.

Key words: Ananas comosus, plant-parasite relationships, integrated control, population dynamics, *Pratylenchus brachyurus*, soil amendments, soil pH.

RESUMEN

Sarah, J. L., B. Osséni y R. Hugon. 1991. Efecto del pH del suelo sobre el desarrollo de las poblaciones de *Pratylenchus brachyurus* en las raíces de la piña. Nematrópica 21:211–216.

En experimentos de campo en Costa de Marfil se encontró que las poblaciones de *Pratylenchus brachyurus* se desarrollaron más rapidamente en las raíces de la piña en las parcelas donde el pH del suelo era más bajo. Las diferencias de nivel de población asociadas con diferencias del pH disminuyeron progresivamente durante el crecimiento del cultivo, hasta desaparecer después de la inducción floral lo cual podría sugerir que el pH del suelo influyó sobre las relaciones planta-parásito antes de o durante la penetración en las raíces. Estos resultados confirman observaciones anteriores sobre cultivos de subsistencia, con *P. brachyurus*. También podrían explicar el gran impacto de este nematodo sobre la piña, la cual está cultivada generalmente en suelos de pH bastante bajo en Costa de Marfil. Eso sugiere que enmiendas para modificar el pH del suelo podrían ser alternativas para el control integrado de *P. brachyurus* en la piña.

Palabras clave: Ananas comosus, control integrado, dinámica de poblaciones, enmiendas, pH del suelo, *Pratylenchus brachyurus*, relaciones planta-parásito.

INTRODUCTION

In the beginning of the last decade, several field experiments were conducted to examine effects of soil pH in Ivory Coast on cassava (*Manihot* sp.), maize (*Zea mays*), and sweet potato (*Ipomoea batatas*) (12). Root samplings done in those experiments showed that populations of *Pratylenchus brachyurus* (Godfrey) were greatest in plots where soil pH was lowest (1). Considering the economic importance of this root parasite in pineapple (*Ananas comosus* Merr.) production and the high costs of nematicide treatments (2,14),it seemed necessary to study the influence of soil pH on *P. brachyurus* in pineapple roots so as to evaluate the possibilities of using amendments that alter soil pH as a part of an integrated control strategy.

MATERIALS AND METHODS

To determine the effect of soil Ph on *P. brachyurus* populations, two experiments were conducted at Anguédédou's research station, in the south of Ivory Coast, 20 km west from Abidjan. The soil was of ferralitic type (Acrisol) with a very low exchangeable cations ratio and with a sandy-clay texture (20% clay and 70-80% sand) (6).

The first experiment started on 19 March 1986 at the beginning of the rainy season. This time of the year is considered optimum for plant growth and nematode development. The experiment was of a randomized complete-block design with five pH levels as treatments, with five replicates each. Treatments had the following averages, and ranges of pH: 1) pH 3.85, 3.80–3.95; 2) pH 4.20, 4.05–4.30; 3) pH 4.60, 4.40–4.90; 4) pH 5.10, 4.95–5.40; 5) pH 6.20, 6.10–6.30.

The second experiment was initiated 2 years later on 5 July 1988 and was a repeat of the first, but with three pH levels and at a different time of the year, just after the peak rainy season (June) when growing conditions for pineapple are less favorable (1,2,14). The experiment was of a randomized complete-block design with four replications of three pH levels: 1) pH 385, 3.70–4.05; 2) pH 4.60, 4.30–5.05; 3) pH 5.70, 5.15–6.00.

To modify the soil pH, different amendments were applied to the plots (45 m^2 each) for several years: i) two applications of sulfur flowers, at 2 500 kg/ha on February 1974 and February 1976 on treatment 1 of experiments 1 and 2; ii) two to six applications of lime from 1968 to 1976 at doses varying from 1 650 to 6 600 kg/ha on treatments 3, 4, and 5 of experiment 1, and treatments 2 and 3 of experiment 2. Soil in treatment 2 of experiment 1 did not receive any amendment, and its pH (4.2 $\pm$0.15) was the natural soil pH in this area. Details concerning those treatments and their consequences on the chemical composition of soil have been given (7,8,10).

Each plot was planted with 220 suckers of pineapple cv. Cayenne Lisse at a density of 55 000/ha. Only the 120 center plants were considered for experimental observations. Flowering was forced ("forcing") with calcium carbide, ten months after planting.

On every tenth plant (i.e. on twelve plants per plot), pineapple roots were sampled monthly after the fourth and third month in the first and second experiment, respectively, using the non-destructive procedure described by Sarah (14) and Caswell et al.(2). Nematode extraction was made using the centrifugal-flotation method of Coolen and d'Herdes (3) with an aliquot part of 50 grams of roots per plot. For statistical analysis, nematode data were transformed by $Y = \log_{10}(N + k) - \log_{10}(k)$, where N = number of *P. brachyurus* per gram of roots, and k = 10.

RESULTS

Monthly changes in *P. brachyurus* populations in the pineapple roots depended on soil pH (Fig. 1A,B). The results in the two experiments were similar: the more acid the soil the faster the nematode population growth. Differences between early infestation levels associated with soil pH, decreased slowly during the vegetative growth and disappeared after forcing.

The nematode population development in the roots was slower and peaked at lower level in the second experiment than in the first. This was mainly due to climatic conditions. The first experiment

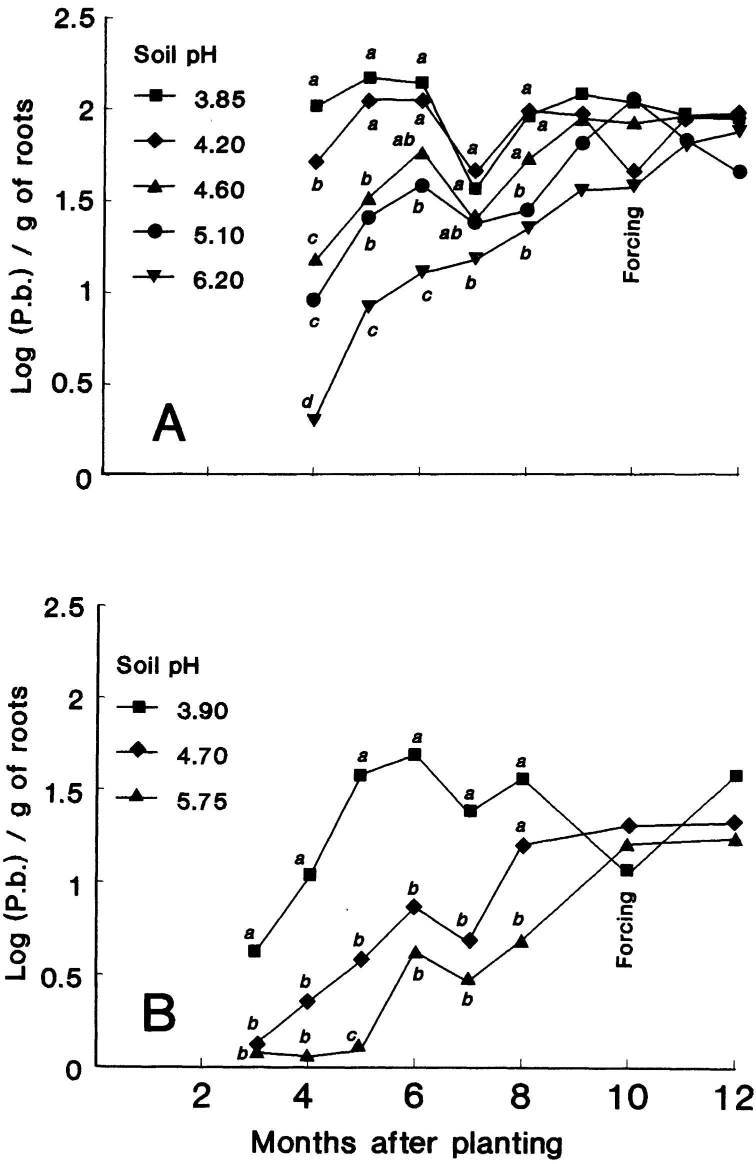

Fig. 1. Development of *Pratylenchus brachyurus* populations in pineapple roots during the pineapple crop cycle in soils at various pH levels: A) First experiment, March 1986 – March 1987; B) Second experiment, July 1988 – July 1989. Population levels with different letters at a given date are significantly different according to the Newman & Keuls test ($P < 0.05$).

started at the beginning of the rainy season with excellent climatic conditions for plant growth and nematode population development. The second experiment started just after the excess of rainfall that occurs in June and before the cool, cloudy season (August), when conditions are less favorable (1,2,14).

Figures 2 and 3 show the relationships between soil pH and the average nematode population in the roots at three different periods of the crop cycle: early vegetative growth; late vegetative growth; and after forcing. Each datum is the average nematode population level during a three month period: 4–6, 7–9 and 10–12 months after planting in the first experiment (Fig. 2A,B,C), and 3'—5, 6–8 and 10–12 months after planting in the second experiment (Fig. 3A,B,C). The relationship between pH and the log of population density was generally linear during the vegetative growth with nematode population inversely related to soil pH (Fig. 2A,B; 3B). In the first period of the second experiment, however, nematode population levels were close to zero in some of the plots with high soil pH (Fig. 3A). This first period of observation in the second experiment was one month earlier, relative to planting, than in the first experiment and climatic conditions were less favorable for plant and nematode. There was no correlation between soil pH and *P. brachyurus* population levels after forcing both experiments.

DISCUSSION

The two experiments clearly showed that the rate of *P. brachyurus* population development in pineapple roots was inversely related to soil pH. This confirms the observations made previously on food crop experiments with the same nematode species (1). These crops have quite different soil pH requirements for optimal growth (12); thus, a similar effect of pH on the nematode suggests that pH affects *P. brachyurus* independently from plant growth, whatever the mechanisms involved.

The decrease in differences between infestation levels associated with soil pH during pineapple growth suggests that soil pH influenced the plant-parasite relationships at a very early stage, possibly before or during penetration of the root. The nematode appeared to develop freely in the roots afterward, whatever was the soil pH.

There are relatively few reports on effects of soil pH on the nematode-plant relationships. Some references describe little or no effect except at extreme pH values (4,17). Other observations indicate an optimum soil pH for nematode population development: pH 7-8 for *Hoplolaimus indicus* Sher on tomato (*Lycopersicon esculentum*) (9), pH 5-6 for *Pratylenchus penetrans* (Cobb) on vetch (*Vicia* sp.) and strawberry *Fragaria* spp. (11,15). On citrus (*Citrus sinensis*), *Tylenchus semipenetrans* Cobb population growth is sharply reduced when soil pH is below 4.9 (16). On pineapple the optimum pH value for *Rotylenchulus reniformis* Linford & Oliveira reproduction was about 5 (13) which was close to the optimum pH for pineapple growth and development (7,10). In our experiments, the optimum soil pH for *P. brachyurus* development in pineapple roots was below the lowest pH tested, i.e. 3.8, and hence was far below the optimum pH for pineapple production (7,10). This observation further supports the interpretation that low pH favors population develoment of *P. brachyurus* for the most part independently of its effect on plant growth.

The mechanisms involved in the responses of the parasite-plant complex to soil pH variations are not known. The few studies that have been conducted to evaluate the direct effect of pH on nematodes produced negative results (4,17). It is generally recognized that soil pH can influence nematode development indirectly, through host reactions and by altering the chemical composition of soil or the antagonistic organisms present.

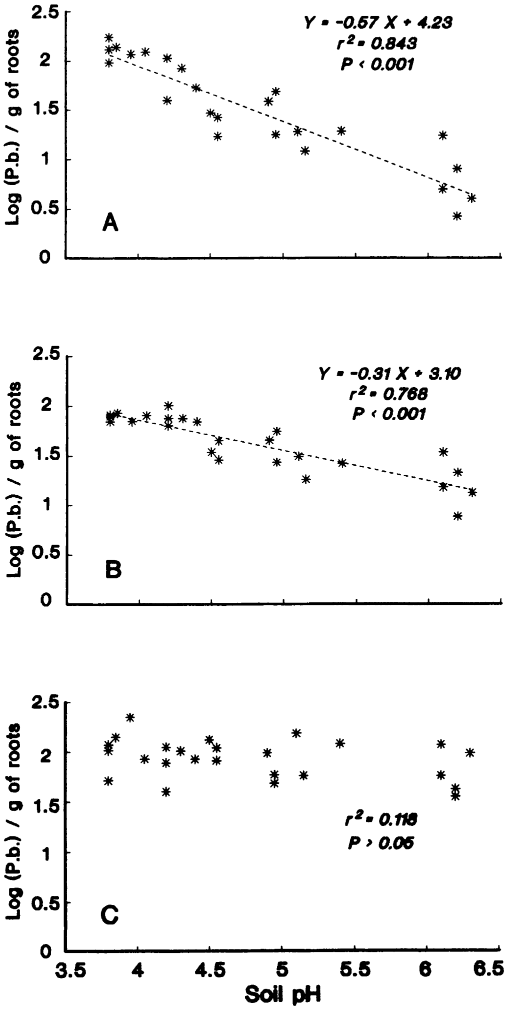

Fig. 2. First experiment (March 1986 – March 1987). Relationship between pH and the average population density of *Pratylenchus brachyurus* in pineapple roots during three phases of crop development: A) 4–6 months, B) 7–9 months, and C) 10–12 months after planting.

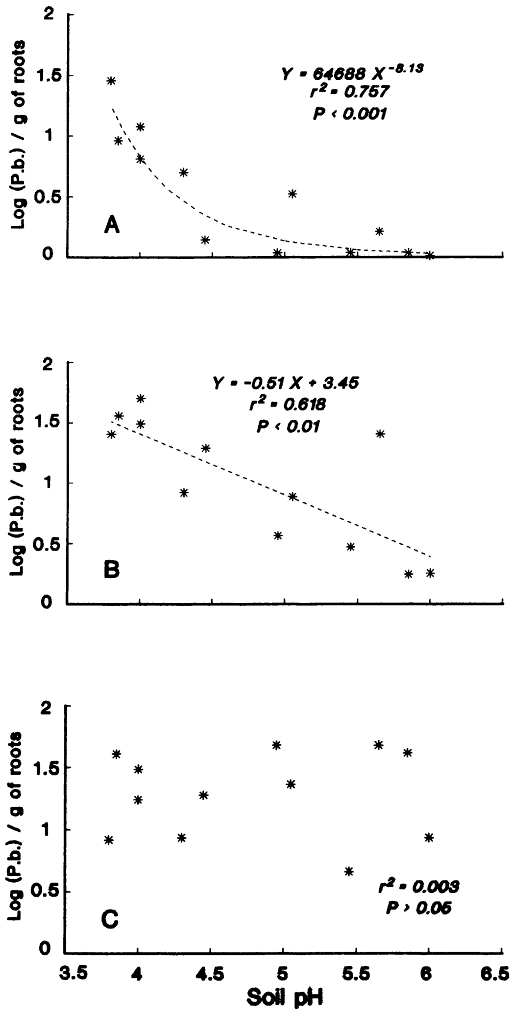

Fig. 3. Second experiment (July 1988 – July 1989). Relationship between pH and the average population density of *Pratylenchus brachyurus* in pineapple roots during three phases of crop development: A) 3–5 months, B) 6–8 months, and C) 10–12 months after planting.

The low soil pH requirement for maximal *P. brachyurus* population development in pineapple roots may partly explain the high impact of this parasite on pineapple crops under Ivory Coast conditions. In this country, many soils where pineapple is cultivated have rather low pH (6). These results also may open interesting ways for integrated control by choosing soils with a high natural pH level, or using lime amendments to increase pH. However, a soil pH of 5.5 should not be exceeded because higher pH can depress pineapple plant development (7,10) and sharply increase the risk of *Phytophthora* heart rot (5,7).

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