
Interaction of Phosphate Fertilizer and Cyst Nematode Infestation (Globodera pallida), in Two Potato Cultivars

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ABSTRACT

Effect of different phosphate fertilizer rates (10, 120, and 240 ppm) on the yield of two potato cultivars, 'Renacimiento' (potato cyst-nematode tolerant) and 'Revolucion' (nontolerant to potato cyst-nematode) inoculated with Globodera pallida pathotype P4A was investigated under greenhouse conditions.

Results indicate a significant yield increase in the cyst nematode-inoculated plants treated with phosphate application as compared to those in the treatments receiving either nematodes alone or no phosphate. Although nitrogen or potassium application increased yield, nitrogen effect was more significant than that of potassium application.

Introduction

The primary effects of potato cyst nematode infection are on root growth and function, with secondary effects on rates of haulm growth and senescence, which in turn affect tuber yield.

Various evidences suggest that nematodes affect, P, K, Mg, and Ca uptake and their translocation to the tops (Sher, 1957; Kirkpatrick, et al., 1964; Oteifa and El-gindi, 1962).

Trudgill et al., (1975) found that nematodes decreased significantly the amount of K in the haulm dry matter. Carpenter (1957) also suggested that heavily infected plants were chronically K-deficient and that the rate of K uptake limited haulm expansion. As nematode numbers increased, the amount of K, Mg, or P, in haulm decreased greatly. Amount of N was unaffected but Ca and Na increased two fold. These changes in concentration probably explain the results of Stelter and Mein (1969), who measured the total ash content of cyst-nematode infected potato plants and concluded that nematodes affected uptake of neither nutrients nor water. Other investigators have reached similar conclusions for different nematode/crop associations (Hunter, 1958; Jenkins and Malek, 1966; Bergeson, 1968).

As potato is the main crop in Peruvian Andean region and most of the soils are acid, poor in P, organic matter and nitrogen, and mostly infested with the potato cyst nematode, information on mineral nutrition related with nematode attack and damage is warranted.

Present study was to determine effect of P on potato cyst-nematode multiplication rate and plant behavior of a non-tolerant cultivar ('Revolucion') and a tolerant cultivar ('Renacimiento').

Materials and Methods

The experiment was conducted under greenhouse conditions in La Molina, Lima, Peru, during June to September, 1981. Treatments were arranged in completely randomized block design with a factorial disposition.

Fertilizers and cyst inocula (i.e. 20 eggs/g of soil) were incorporated and mixed with soil substrate before planting two tuber buds of the cultivars Renacimiento and Revolucion per pot.

The rates of nitrogen and potassium as potassium sulphate (50% K₂O) and ammonium nitrate (33% N) were constants (160 ppm of N and K₂O). However, levels of phosphorus as simple superphosphate (20% P₂O₅) varied (0, 120 and 240 ppm P₂O₅). Additional treatments were included only for the nontolerant cultivar Revolucion to cover the addition and/or deficiency of N, P and K. The last two additional treatments were used as potassium magnesium sulphate (32% K₂O + 8% Mg) and potassium sulphate (53% K₂O).

Pot moisture was maintained at field capacity. Three and a half months after planting the foliage was cut and tubers and roots removed from soil. Afterwards data on fresh and dry weight of roots, tubers and foliage were taken. Cyst of *G. pallida* were extracted from soil samples of nematode inoculated plants and final nematode density (pf) was determined and nematode multiplication rate (Pf/Pi) was calculated.

Results and Discussion

Renacimiento had less fresh matter weight in roots and tubers than Revolucion (Table 1). This probably is because Renacimiento is a "late" variety (5 to 6 months); as contrasted to Revolucion (4 months) and the time allowed for its full growth was short. However, compared to the control, reduction of fresh top weight due to nematode damage was higher in Revolucion (35.6%) than in Renacimiento (26.2%) in inoculated plants (Figure 1). This effect was even more dramatic with the tuber yield where Revolucion showed a greater yield reduction (59.0%) than Renacimiento (23.7%), indicating its poor capacity to tolerate root damage caused by nematode invasion.

Estimated nematode multiplication rate for these two cultivars indicate a higher multiplication rate in Revolucion than Renacimiento (29.9x and 23.7x, respectively). These results would reflect on slow development of Renacimiento, which did not allow a proper nematode multiplication. As level of phosphorus per plant was increased (0, 120 and 240 ppm of P₂O₅), weight of roots and total fresh weight of both cultivars also increased. However, response of Revolucion was better than Renacimiento (Figure 2a). This could be due to a more rapid root development in Revolucion and consequently higher phosphorus absorption.

Table 1. Effect of two potato cultivars on the fresh weight of haulm, roots and tubers.

Cultivar	Fresh matter weight (g/pot)			
	No infested			
	Foliar	Root	Tuber	Total
Revolucion	97.1	35.7	61.7	194.5
Renacimiento	99.6	27.5	13.9	141.0

Similarly, as the level of phosphorus was increased the number of cysts also increased in Revolucion (Figure 2b). However, when 240 ppm of P₂O₅ was applied, the final number of larvae per g of soil and nematode multiplication rate (680 and 34.3x) was lower than the application of 120 ppm of P₂O₅ (950 and 47.6x). Similar results in final nematode density and nematode multiplication rate were observed with Renacimiento. This reduction in the multiplication rate of the potato cyst nematode at the high rates of phosphorus would indicate either an inhibitory effect on the cyst viability egg content or on the root morphology since the number of cysts and fresh root weight were increased with this rate.

Although inoculated and noninoculated plants showed similar response to phosphorus levels, the fresh roots weights of the inoculated plants were lower than those without nematodes (Figure 3).

Results of additional treatments indicate that the total biomass (foliage, tubers and roots) increased as one of the nutrients was added to the fertilization (Figure 4a).

Tuber weight (Figure 4b) in noninoculated plants was significant, higher than inoculated (with and without nematicide) ones as single nutrients were added. Although infected and nematicide-treated plants showed similar response, yield was higher in the nematicide-treated plants. These results indicate a significant plant response to the three major nutrients, and no significant differences between sources of K.

Although nematode multiplication rate was increased as major nutrients were added, it was lower in nematicide-treated plants as compared to control (Figure 5), indicating a partial control effect.

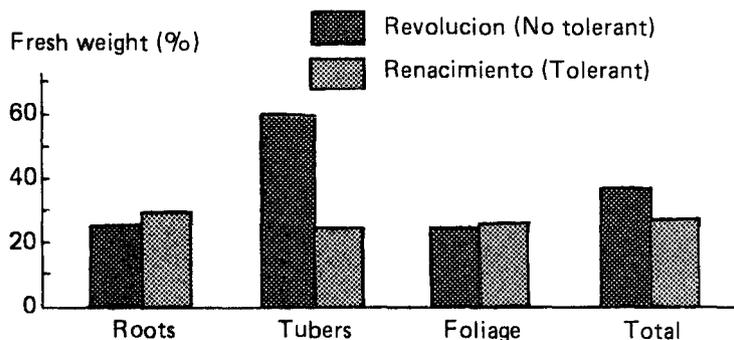


Figure 1. Percentage of reduction in fresh weight of two potato cultivars with different reaction to the potato cyst nematode *G. pallida*.

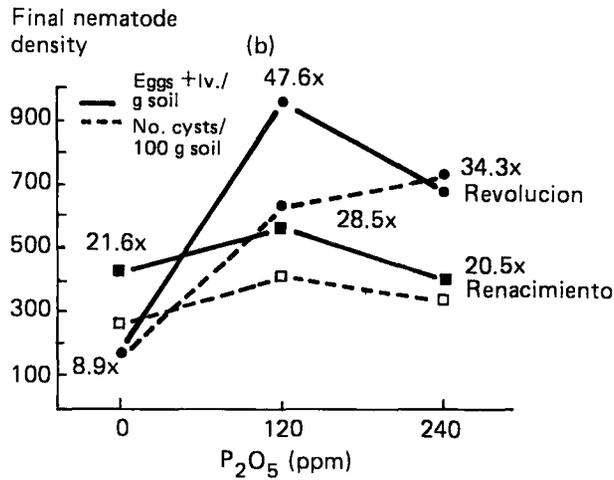
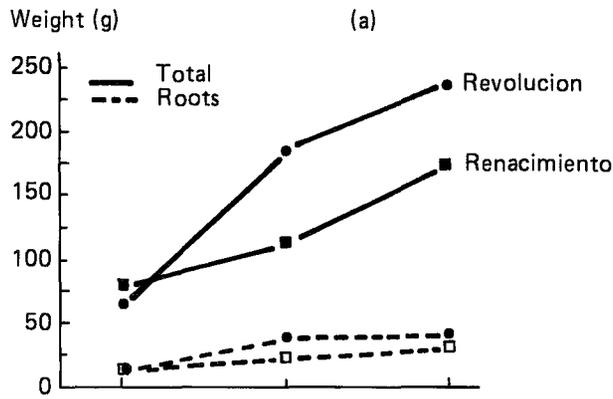


Figure 2. Effect of three phosphorus levels on: (a) the fresh weight and (b) potato cyst nematode multiplication rate in two potato cultivars.

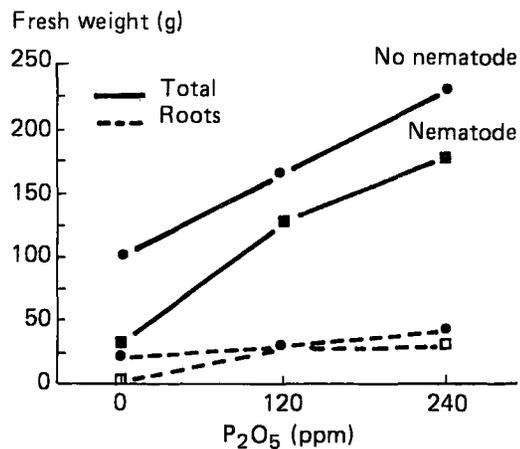


Figure 3. Comparative effect of three phosphorus levels on the fresh weight of potato cyst nematode infected and noninfected potato plants.

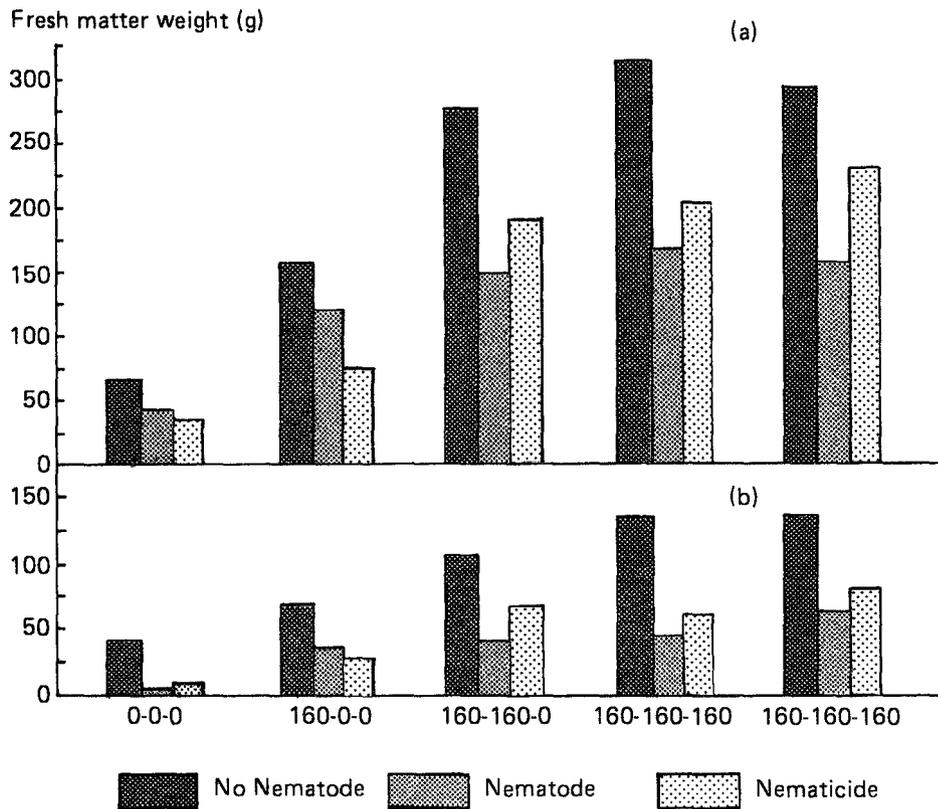


Figure 4. Effect of different rates of fertilizers and nematocides on: (a) total fresh weight and (b) tubers weight of *G. pallida*-infected and noninfected potato plants.

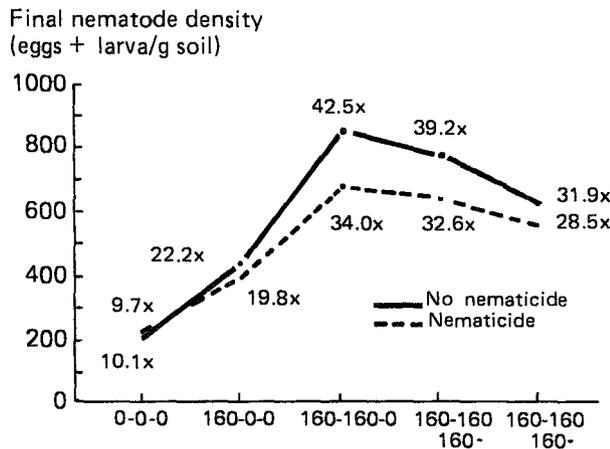


Figure 5. Effect of fertilizers and nematocides on the multiplication of the potato cyst nematode *G. pallida*.

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