

**CROP PROTECTION****Vegetative Growth and Yield of Tomato (*Lycopersicum esculentum* Mill.) in Response to the Systemic Insecticide Phorate**RAUL N. C. GUEDES<sup>1</sup>, NELSA M. P. GUEDES<sup>2</sup> AND MARCELO PICANÇO<sup>1</sup><sup>1</sup>Departamento de Biologia Animal, Universidade Federal de Viçosa,  
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An. Soc. Entomol. Brasil 27(3): 443-449 (1998)**Crescimento Vegetativo e Produção de Tomateiro (*Lycopersicum esculentum* Mill.) em Resposta ao Inseticida Sistêmico Forate**

**RESUMO** - O efeito do inseticida sistêmico forate no crescimento vegetativo e produção de tomateiros (*Lycopersicum esculentum* Mill.) foi estudado em casa de vegetação. Três dosagens de forate foram estudadas: 1,5, 7,5 e 13,5 mg i.a./1.5 L vaso e um controle (sem aplicação do inseticida). As plantas foram colhidas 17, 32, 51, 69 e 90 dias após o plantio. Análises de regressão não mostraram efeito significativo de doses do inseticida na altura da planta e no comprimento de raiz. Entretanto, efeito negativo genérico de forate foi observado na área foliar, no peso seco de raiz e parte aérea, e no peso fresco de frutos. Baseado em modelos de regressão múltipla, área foliar máxima foi conseguida com 6,7 mg i.a./vaso e máximo peso seco de parte aérea e raiz foram obtidos sem aplicação de inseticida e com 0,1 mg i.a./vaso, respectivamente. Dosagens de forate próximas ao limite inferior das dosagens recomendadas para tomateiro (1 kg i.a./ha) favoreceram o aumento da área foliar das plantas de tomate, mas este aumento não se traduziu em aumento de produção. Forate foi ligeiramente detrimental ao crescimento de parte aérea e raiz, o que levou a uma menor produção em plantas tratadas com este inseticida.

**PALAVRAS-CHAVE:** Tomateiro, inseticida sistêmico, crescimento vegetativo.

**ABSTRACT** - The effect of the systemic insecticide phorate on vegetative growth and yield of tomato (*Lycopersicum esculentum* Mill.) was studied in the greenhouse. Three dosages of phorate (1.5, 7.5, and 13.5 mg a.i./1.5 L pot) were applied along with a control (without insecticide application). The plants were harvested at 17, 32, 51, 69, and 90 days after tilling. Regression analysis did not show any significant effect of insecticide dosages in plant and root length. However, an overall negative effect of phorate was observed on leaf area, shoot and root dry weights, and fruit fresh weight. Based on multiple regression models, maximum leaf area was obtained with 6.7 mg a.i./pot and maximum shoot and root dry weights were obtained with no insecticide application and 0.1 mg a.i./pot, respectively. Higher fruit fresh weights were also obtained without phorate application. Dosages of phorate close to the lower range recommended for pest

control in tomatoes (1 kg a.i./ha) favored the increase in leaf area in tomato plants, but this increase did not cause higher yields. Phorate was slight detrimental to shoot and root growth, what led to a smaller yield in the phorate treated plants.

**KEY WORDS:** Tomato, systemic insecticide, vegetative growth.

Enhanced plant growth resulting from insecticide use, especially of the systemic type, has been reported for different crops (Pless *et al.* 1971, Barrigossi *et al.* 1988a, Guedes *et al.* 1996). Many authors have attributed part of the enhancement to factors other than insect control (e.g., Lee 1977, Barrigossi *et al.* 1988a). The plant response to the application of a systemic insecticide seems to be specific for each combination of plant and insecticide used (Olofindoba & Kozlowski 1982, Araya *et al.* 1988, Barrigossi *et al.* 1988b, Calafiori *et al.* 1988, Cranshaw & Thorton 1988). The application of systemic insecticides may also be detrimental to the plant in some other circumstances (Chandler 1977, Della Lucia & Chandler 1985).

The application of phorate is recommended and frequently used in Brazil against the thrips *Frankliniella schulzei* Trybom (Thysanoptera: Thripidae), the green peach aphid *Myzus persicae* (Sulzer) (Homptera: Aphididae), and the beetles *Epicauta atomaria* (Germ.) (Coleoptera: Meloidae), and *Phyrdenus divergens* (Germ.) and *Faustinus* sp. (Coleoptera: Curculionidae) (Gallo *et al.* 1988). Phorate 5G is recommended at rates of 20-40 kg c.p./ha (i.e. 1-2 kg a.i./ha) for insect control (Gallo *et al.* 1988). The concept of insecticide-induced growth of plants is not new, but nothing is known about the matter in tomato (*Lycopersicon esculentum* Mill.), vegetable crop commonly subjected to several applications of phorate in tropical areas. Therefore, the present study was carried out to evaluate the effects of phorate on tomato growth and yield.

### Material and Methods

An experiment was carried out from July

to September of 1993 under greenhouse conditions in Viçosa (MG) using tomato seeds cv. Santa Clara. Ten seeds were used per each 1.5 L pots and a mixture of soil and sand (3:1) was used as substrate. After emergence, only one plant per pot was left. Different dosages of phorate 5G (1.5, 7.5, and 13.5 mg a.i./pot, corresponding to 1, 5 and 9 kg a.i./ha) were applied right after tilling on the substrate surface surrounding the seeds of each pot. Nutrients were applied according to soil analysis. Ammonium sulphate ((NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>; 6.0 mg/pot) was used as nitrogen source and applied two days after tilling and again thirty days after tilling. Murashige & Skoog (1962) nutrient solution (50 mL/pot) was applied 22 days after tilling. The plants were irrigated every day.

The experimental design was a split-plot design with the dosages of phorate as the main plots and days of harvesting (days after tilling) as the sub-plots. There were three replicate for each treatment. After each harvest (17, 32, 51, 69 and 90 days after tilling), the root system of each plant was separated from the shoot and the average length of both was measured. The leaf area was determined using the leaf area meter LI-COR model LI-3000. The fruits were weighted at harvest. The root system as well as the shoot were air dried at 80°C, under air circulation, until constant weights were obtained. Regression analysis of the data were performed with the coefficient of the equations being tested at 10 % probability. The SAS procedure PROC GLM with stepwise selection was used to build the regression models (SAS Institute 1987).

### Results and Discussion

No significant difference in leaf and root length (Figs. 1) was detected among the in-

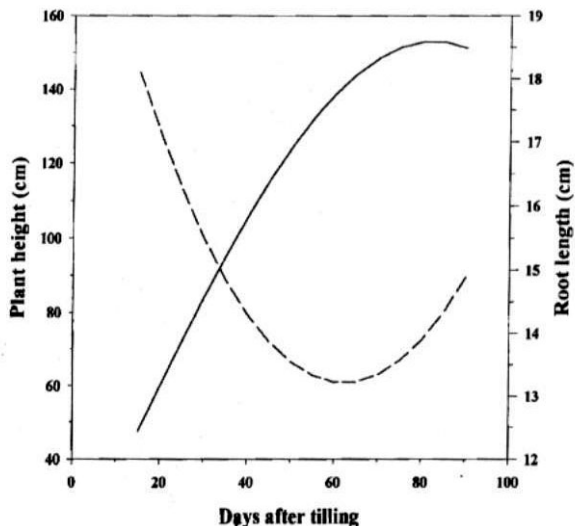


Figure 1. Increase in tomato height with time ( $Y = 8.39122 + 2.639744 X - 0.00013 x^3$ ;  $R^2 = 0.86$ ;  $p < 0.001$ ;  $Y$  = plant height,  $X$  = days after tilling; solid line) and increase in root length of tomato plants with time ( $Y = 21.70467 - 0.27247 X + 0.002187 X^2$ ;  $R^2 = 0.44$ ;  $p < 0.001$ ;  $Y$  = root length,  $X$  = days after tilling; dashed line).

secticide dosages for each harvest. Leaf area showed significant differences among doses and also among harvest (Fig. 2). According

to the multiple regression model obtained for estimating leaf area, the maximum leaf area was obtained with the application of 6.7 mg

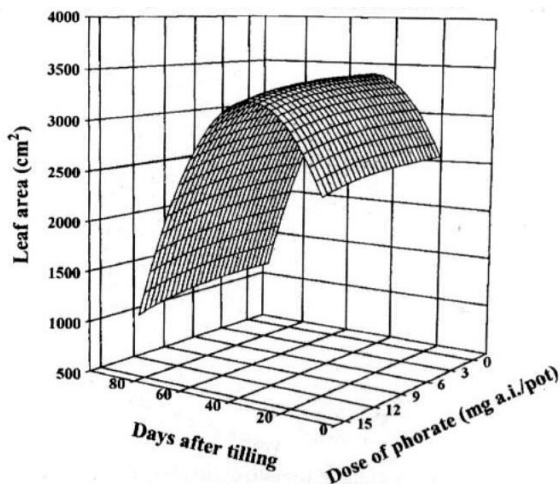


Figure 2. Increase in leaf area of tomato cultivated under different doses of phorate. ( $Z = 1469.56382 + 89.177058 X - 1.02545 X^2 - 0.06667 Y^3$ ;  $R^2 = 0.73$ ;  $p < 0.001$ ;  $Z$  = leaf area,  $X$  = days after tilling,  $Y$  = dose of phorate).

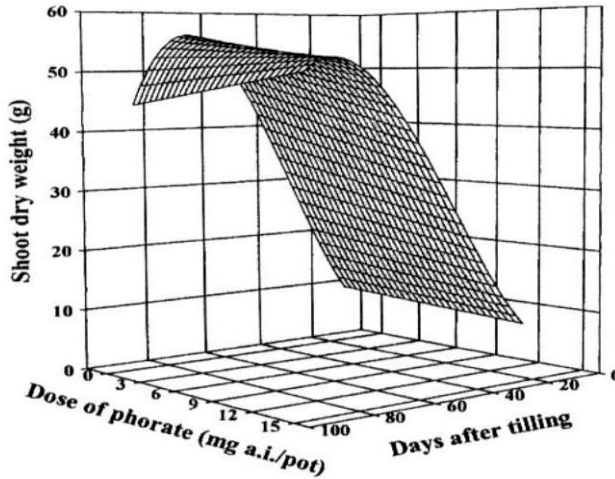


Figure 3. Increase in shoot dry weight of tomato cultivated under different doses of phorate. ( $Z = 3.79224 + 0.030394 X^2 - 0.000282 X^3 - 0.000596 X^2 Y + 0.0000072 X^3 Y$ ;  $R^2 = 0.89$ ,  $p < 0.001$ ;  $Z$  = shoot dry weight,  $X$  = days after tilling,  $Y$  = dose of phorate).

a.i./pot and the highest leaf areas were obtained 43.5 days after tilling. These results differ from those of Barrigossi *et al.* (1988a) that obtained the highest leaf areas in bean

plants treated with the highest dose of phorate.

Shoot dry weight (Fig. 3) also showed significant differences among dosages and among harvest time, as well as root dry weight

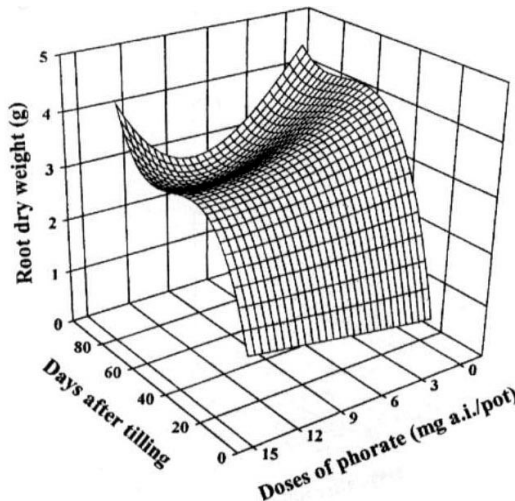


Figure 4. Increase in root dry weight of tomato cultivated under different doses of phorate. ( $Z = -4.06269 + 0.109785 Y + 0.391165 X - 0.006059 X^2 + 0.000030775 X^3 - 0.004619 X Y + 0.0000000021076 X^3 Y^3$ ;  $R^2 = 0.62$ ;  $p < 0.001$ ;  $Z$  = root dry weight,  $X$  = days after tilling,  $Y$  = dose of phorate).

(Fig. 4) and fruit fresh weight (Fig. 5). Higher shoot dry weights were obtained without insecticide application with higher values being obtained over 85 days after tilling. The detrimental effect of systemic insecticides has also been reported in other plants such as pine tree (*Pinus halepensis* Mill.) (Olofindoba & Kozlowski, 1982) and beans (*Phaseolus vulgaris* L.) (Della Lucia & Chandler, 1985), but

oat (*Avena sativa* L.) by Araya *et al.* (1988), but Guedes *et al.* (1996) verified a positive effect of carbosulfan in pineapple [*Ananas comosus* (L.) Merr.] root growth and Barrigossi *et al.* (1988b) reported a positive effect of phorate in root development of bean plants.

Higher fruit fresh weights were obtained without phorate application with maximum

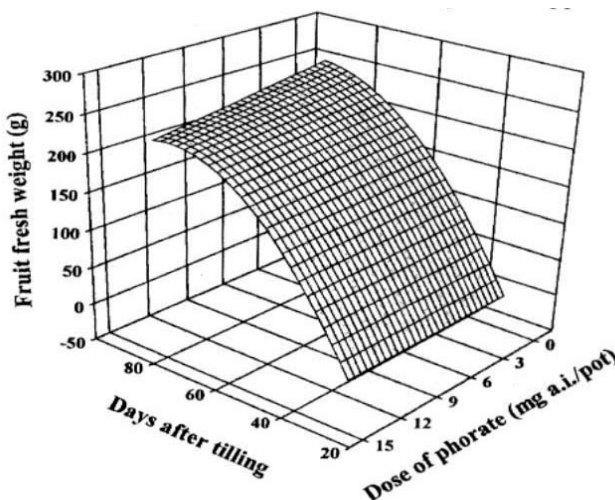


Figure 5. Fruit fresh weight produced by tomato plants cultivated under different doses of phorate. ( $Z = -298.702416 + 11.749622 X - 0.062685 X^2 - 0.000003708 X^3 Y$ ;  $R^2 = 0.65$ ,  $p < 0.001$ ;  $Z$  = fruit fresh weight,  $X$  = days after tilling,  $Y$  = dose of phorate).

beneficial effects of this compounds were more frequently found (Pless *et al.* 1971, Lee 1977, Barrigossi *et al.* 1988b, Cranshaw & Thorton 1988).

Higher root dry weights were obtained without insecticide application with the treatments used, but the maximum estimated root dry weight was obtained with the application of a very small dose of phorate (0.1 mg a.i./pot) according to our model. A peak of root dry weight was obtained at 57 days after tilling and a point of minimum was observed 74 days after tilling when intermediate doses of phorate were used. Negative effects of systemic insecticides in root dry weight have been reported in wheat (*Triticum aestivum* L.) and

values being obtained at the last harvest. Della Lucia & Chandler (1985) also verified a negative effect of carbofuran in yield of bean plants, but Barrigossi *et al.* (1988b) reported the opposite effect using phorate and hypothesized that the probable cause of the contradiction is the phytotoxic effect of systemic insecticides for beans under conditions of hydric stress. Our plants were not under hydric stress, but yet they suffered a slightly detrimental effect due to phorate application.

Pless *et al.* (1971) provided several theories of mechanisms of enhanced growth following application of systemic insecticides. Lee (1977) suggests a causal relationship between the inhibition of indole-3-acetic acid

(IAA) degradation and the enhancement of plant growth and yield seems to be quite variable depending on the plant species, the soil type and fertility, the insecticide used and dosage applied (Pless *et al.* 1971, Guedes *et al.* 1996). Here we provided further insights into the causal relationships between plant growth and the use of systemic insecticides using a new approach (i.e., multiple regression analysis) and an additional crop plant.

Dosages of phorate close to the lower range recommended for pest control in tomatoes (1 kg a.i./ha or 20 kg c.p./ha) favored the increase in leaf area, but this increase did not translate into higher yields. Phorate was slightly detrimental to shoot and root growth, what led to a smaller yield in the phorate treated plants. However, these effects were not very drastic and should be easily compensated by the benefic control of insect-pests attacking tomato plants. However, when infestations by these pests are unlikely, farmers should not use phorate, saving the cost of the insecticide with a possible slight increase in yield of tomato plants.

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