**South African Avocado Growers' Association Yearbook 1984. 7:91-92**

# THE EFFECT OF CALCIUM ON AVOCADO ROOT GROWTH AND AVOCADO ROOT ROT CAUSED BY PHYTOPHTHORA CINNAMOMI

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## *OPSOMMING*

*Die effek van kalsium in oplossing op avokado wortelgroei en wortelvrot veroorsaak deur* Phytophthora cinnamomi *is ondersoek. Toename in kalsium konsentrasie tot by 200 dpm net wortelgroei gestimuleer en wortelvrot onderdruk by Edranol-saailinge.*

## *SUMMARY*

*The effect of calcium in solution on avocado root growth and root rot caused by* Phytopthora cinnamomi was *studied. Increasing calcium concentration up to 200 ppm Ca stimulated root growth and suppressed root rot of Edranol seedlings.*

## INTRODUCTION

Work done by Broadbent, Baker & Butterworth (1971) led to the interest in the contribution of calcium to the suppression of root rot caused by *Phytophthora cinnamomi.* They showed that suppressive soils contain as much as 4,000 ppm calcium. Obbink & Alexander (1976) found that a deficiency of calcium resulted in similar symptoms as caused by *P. cinnamomi* root rot. The effect of $CaCO_3$ on root rot of Jarrah *(Eucalyptus marginala)* was studied by Boughton et al. Root rot was significantly reduced with the calcium treatment. Halsall & Forrester (1977) showed that an optimum concentration of calcium is needed for maximum sporangium formation of *P. cinnamomi.* At higher calcium concentrations sporangium production decreased. Lee (1979) found that $Ca(NO_3)^2$ could control root rot. Additions of CaCI, CaO and $CaSO_4$ to *P. cinnamomi* infected soil reduced wilting of infected *Persea indica* plants.

This study reports on the effect of calcium in solution on avocado root growth and root rot caused by *P. cinnamomi.*

## MATERIALS AND METHODS

Edranol seeds were germinated in sand and planted in washed quarts sand in plastic bags. Seedlings were grown in the glasshouse (15°C-30°C) until symptoms of nutrient deficiency were obvious. At this stage treatments were started.

To determine at what concentrations $Ca^{++}$ affected root growth, five levels of $Ca^{++}$ were used. Nutrient solutions consisted of a 25% Hoagland solution (Hoagland & Aron, 1938) incorporated with 1, 10, 100, 200 and 400 ppm Ca in the form of $Ca(NO_3)^2$. The nitrogen balance was maintained by equivalent additions of $NH_4NO_3$.

To determine the effect of $Ca^{++}$ on root rot, three levels of $Ca^{++}$ were used (1 ppm, 10 ppm and 200 ppm). Seedlings were watered with the three nutrient solutions until all the leaves turned green and the nutrient deficiency symptoms disappeared. At this stage half of the seedlings receiving Ca were inoculated with *Phytophthora cinnamomi* inoculum.

Inoculum was prepared by growing *P cinnamomi* in V8-juice medium at 25°C for three weeks. The mycelium was washed and macerated in deionised water. Equal amounts of inoculum (containing clamydospores in abundance) was added to a planting bag.

The seedlings were watered twice daily, receiving nutrient solution on weekdays and distilled water during weekends.

The dry mass of lateral roots of the Edranol seedlings was used as criterium for root growth. Roots were dried in an oven at 70 °C.

## RESULTS

From Table 1 it is evident that trees watered with nutrient solution containing 1ppm $Ca^{++}$ had a lower dry mass of lateral roots than seedlings watered with nutrient solution containing 100,200 and 400 ppm $Ca^{++}$. As the $Ca^{++}$ content of the nutrient solution increased the dry mass of lateral roots increased. This increase in root mass gradually decreased as demonstrated in Fig 1. From Fig 1 it seems as if the graph levels off at the 200 and 400 ppm Ca-levels.

Table 1. Mean dry mass of lateral roots of Edranol seedlings grown at three levels of soluble calcium.

| Calcium level (ppm Ca) | Dry mass of lateral roots |
|---|---|
| 1 | 8.20 b |
| 10 | 10.61 ab |
| 100 | 11.77 a |
| 200 | 12/10 a |
| 400 | 12.37 a |
| CV | |

Means followed by the same letter do not differ significantly (Duncan, P = 0.05).

Leaves of seedlings watered with nutrient solution containing 400 ppm $Ca^{++}$ developed yellow spots indicating poor uptake of iron. This was probably caused by the high (400 ppm) $Ca^{++}$ content of the solution. All other trees looked perfectly healthy. No visual differences could be observed between seedlings watered with nutrient solution containing the different calcium-levels.

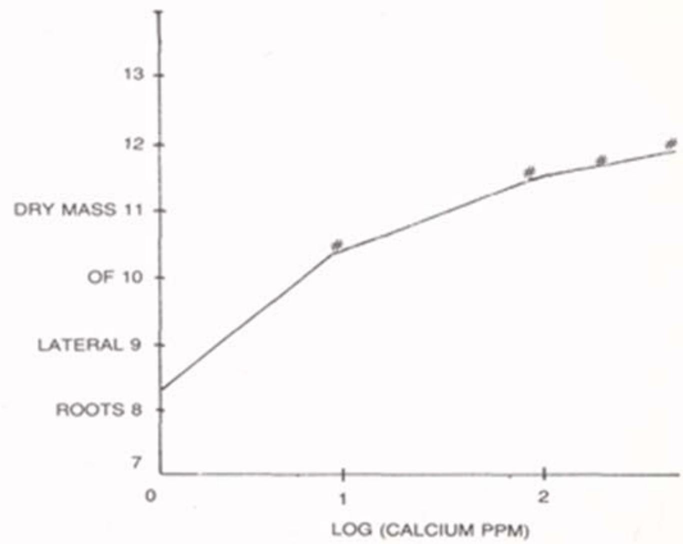


**FIG 1. The effect of calcium on root growth of Edranol seedlings in sand medium.**

From Table 2 it is clear that the same trend as observed in Table 1 was followed by the dry mass values obtained for lateral roots of uninoculated seedlings. With inoculated seedlings a different reaction was observed. A slow increase in dry mass of lateral roots for the low Ca-levels was followed by a faster increase in dry mass of lateral roots for the higher Ca-levels. This effect is demonstrated in Fig 2.

Table 2. Mean dry mass of lateral roots of Edranol seedlings grown at three levels of soluble calcium.

| Calcium level | Dry mass of lateral roots | |
|---|---|---|
| (ppm) | uninoculated | inoculated |
| 1 | 23.68 a | 19.98 f |
| 10 | 27.88 a | 20.58 fg |
| 200 | 27.65 a | 26.22 g |
| CV | 32.64% | 21.64% |

Means followed by the same letter do not differ significantly (Duncan P = 0.05).

Uninoculated seedlings watered with nutrient solution containing 1 ppm Ca had a significantly lower dry mass of lateral roots than inoculated seedlings watered with nutrient solution containing 200 ppm $Ca^{++}$.

## DISCUSSION

From the result (Table 1 and Table 2) it is evident that available Ca increased avocado root growth. Increase in calcium content of above 100 ppm Ca had a less marked effect

(Figure 1).

It is also evident that available $Ca^{++}$ in solution has an effect on root rot. Root yield of inoculated seedlings watered with nutrient solution containing 200 ppm $Ca^{++}$ significantly higher than root yield of seedlings watered with 1 ppm Ca (Table 2).

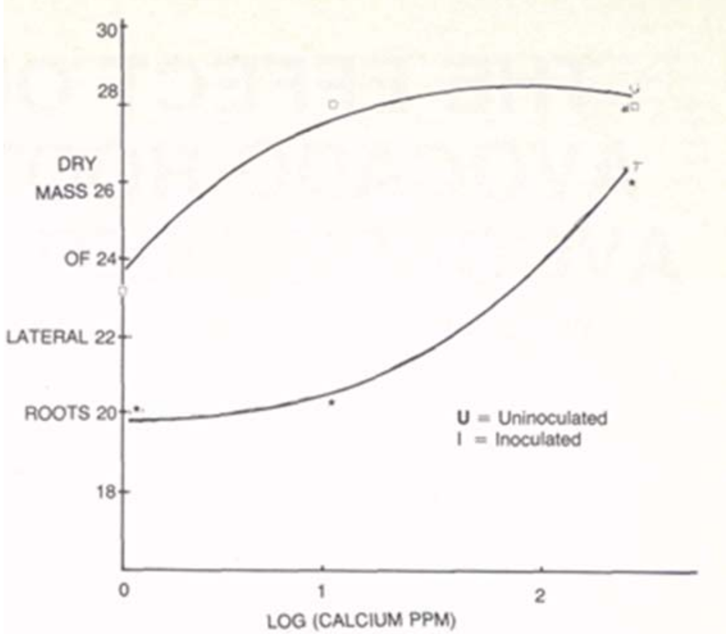


**FIG 2. The effect of soluble calcium of Phytophthora root rot of avocado.**

If the graph (Fig 2) for uninoculated seedlings was parallel to the graph for inoculated seedlings, the difference between the two graphs would have been caused by the effect of inoculation alone (eg the difference in height of the graphs would equal the reduction in root mass due to root rot). That would have indicated that root rot was unaffected by Ca.

This, however is not the case. At the low (1ppm) Ca level the difference between the root mass of uninoculated seedlings and the root mass of inoculated seedlings is small (3,7 g). The damage was already done by the low Ca-level, leaving few roots to rot. At the 10 ppm Ca-level root growth of uninoculated seedlings was stimulated by the available Ca and a high root mass yield was observed. The 10 ppm Ca was too low to have an effect on root rot and inoculated seedlings suffered severe root rot. The difference in root yield between uninoculated seedlings and inoculated seedlings was 7.3 g. At the high (200 ppm) level of available $Ca^{++}$ the increase in root yield for uninoculated seedlings was less marked. In contrast a high root yield for inoculated seedlings was observed. At the 200 ppm level of Ca root rot was suppressed. The difference between uninoculated seedlings and inoculated seedlings was 1.43 g.

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