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PHYTOPHTHORA ROOT ROT

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As this is ongoing research, this report should be read in conjunction with that presented at last year's symposium as well as reports emanating from the CSFRI on this subject over the last 10 years.

With the advent of effective fungicides and tolerant rootstocks, however, it would appear that *Phytophthora's* stranglehold on the avocado industry has been broken, and it will be relegated to relatively minor importance in the foreseeable future.

The plant pathology section at the CSFRI has approached the *Phytophthora* problem from 3 different angles:

Chemotherapy;

Soil amelioration; and

Resistant or tolerant rootstocks.

It is envisaged that in the foreseeable future all three of these aspects will be combined in the control of *P. cinnamomi.*

I. CHEMOTHERAPY

The last few years have seen the emergence of several new fungicides which are effective against the phycomycetes and while certain problems were initially experienced, such as non-availability of sample materials and withdrawal of products due to their toxicity, a number of products have been tested and it would seem that some of them have distinct potential.

These tests have been divided into 4 aspects:

(a) *In vitro* **laboratory tests**

The fungicides were tested in petri dishes under controlled conditions to determine minimum concentrations required to inhibit or stop fungal growth. The tests were biased in a way, as one of the fungicides Aluminium ethyl phosphate would seem to work best after it is absorbed by the plant.

TABLE 1: Minimum concentrations of various fungicides required to stop growth of *P. cinnamomi* on CMA medium

Fungicide	% Active ingredient	PPM a.i. required for kill
Experimental fungicide SN 66752	70	No effect on fungus at 18500 ppm
Aluminium ethyl phosphate (Aliette)	80	700
Experimental fungicide NC 17878	50	30
D.P.X. 3217	50	200
Metaxanin (Ridomil)	10	50

The second set of *in vitro* laboratory tests was made to test the soil penetrating properties of the various chemicals. In this test the chemicals were applied as a drench to soil packed in a glass tube. Samples, soaked into filter-paper discs were removed at various intervals and tested against fungal growth. In this test DPX 3217 (200 ppm), Aluminium ethyl phosphate (700 ppm) and Metaxanin (50 ppm) were found to penetrate and exhibit activity to a depth of 28 cm. At a higher concentration only Metaxanin (1000 ppm) was capable of deeper action, still being highly active at 38 cm. Ethazole lost its activity beyond 18 cm.

(b) **Pot trials**

Pot trials are being carried out with various methods of applying the most promising fungicides. The tests are being carried out on Fuerte seedlings on artificially inoculated soils and results will be taken within the next month. These tests should show up any increase in the efficacy of certain chemicals such as Aluminium ethyl phosphate which are reputed to be more effective after being systemically absorbed.

(c) **Field trials**

There are five field trials running at the moment, and while several of these trials are now starting to yield data, others will have to continue for at least another year or two before conclusions can be drawn. To summarize the data from these trials:

(i) It would appear that Aluminium ethyl phosphate and Metaxanin applied to both cut-back and non-cut-back trees have an effect in halting the progress of infection.

(ii) Cutting back of infected trees prior to application of fungicide has a synergistic effect on the chemical action, the degree of recovery of the tree being proportional to the severity of the cut-back.

The overall condition of 180 trees was visually assessed. Two chemicals (Aluminium ethyl phosphate 80% WP @ 375 g/100ℓ water and Metaxanin 5% granules @ 200 g/tree) were applied after the trees had either been left, cut-back severely or cut-back lightly. The totals of the ratings for the various cut-back regimes were added up and compared.

TABLE 2: Overall condition of trees after application of different cut-back regimes and chemical treatments

Cut-back regime	Chemical	Total initially*	Total 1978*	% Differences
0	Aluminium ethyl phosphate	85	91	+ 7,06
	Metaxanin	84	92	+ 9,52
	Control	86	93	+ 8,14
LIGHT	Aluminium ethyl phosphate	74	42	− 43,24
	Metaxanin	82	33	− 59,76
	Control	85	63	− 25,88
HEAVY	Aluminium ethyl phosphate	79	38	− 51,89
	Metaxanin	84	29	− 65,48
	Control	87	52	− 40,23

*For the purpose of this table the trees rated 0 = healthy, to 8 = dead and each figure e.g. 85 represents the total score for 20 trees which received the same treatment in a randomized block.

The data in this table appear to contradict the statement made in 6a) above, that both chemicals were effective in non-cut-back trees, but what must be considered here is that the data reported in Table 2 was from very heavily infected trees with an average rating of 3 to 3 + on the 1 to 5 rating scale. This brings up the following point: Very little response can be expected from trees beyond stage 2+ (on the 1 to 5 system) if they are only chemically treated and not cut-back.

A trial to investigate the critical point beyond which treated trees must be cut-back is currently underway using 45 trees with varying degrees of infection, again using Aluminium ethyl phosphate and Metaxanin. It is, however, too early for this trial to yield meaningful data.

II SOIL AMELIORATION

This research is aimed at attempting to establish whether soil conditions (such as pH, base saturation, organic matter content, type of N^2 applied); if artificially manipulated, have an effect on the virulence of *P. cinnamomi.*

Laboratory experiments were used to determine the optimum and inhibitory pH and Ca^{++} ion levels of several isolates of *P. cinnamomi.* These experiments are now being carried further in plots where the soil pH and base saturation has been amended by the addition of agricultural lime. It is interesting to note that the laboratory trials showed variations in sensitivities of different isolates of the fungus.

A field trial to assess the separate and combined effects of green mulching, heavy liming and chemical applications was undertaken, with the co-operation of Westfalia Estate. Lime was applied at 2,5 tonnes/ha and 3 months later a further 2,5 tonnes/ha of gypsum. While there are indications of beneficial effects from the fungicide applications it is too soon to assess. Isolations from the roots of the trees, however, have shown a definite suppressive effect on the fungus where heavy lime dressings were applied.

III RESISTANT OR TOLERANT ROOTSTOCKS

With the possible exception of a very new cross, *Persea schiediana* x *P. americana* selection, we now have in South Africa all the promising resistant rootstocks. G6, however, is the only newcomer of any importance as Hunt alas is known to carry sunblotch.

Initial trial work has been aimed at familiarizing ourselves with the vegetative reproduction practices as used by Brokaw nurseries in California and several points of interest were noted.

a. Duke 6 is easier to work with than Duke 7, it seems to be easier to graft and lends itself more to etiolation, being a more vigorous grower.

b. Plants should be placed in the etiolation chamber as soon as the buds on the scion have burst and the first leaves are ± 1 cm long.

c. Temperature is critical inside the etiolation chamber and should be maintained at about 22 to 25°C.

d. Death due to fungal infection in the moist etiolation chamber can be a problem and a spray of a wide spectrum fungicide is advisable.

e. Depending on the container about 20 to 25 cm of etiolated growth is ideal before filling the bag and re-exposing the etiolated plant to sun.

In the 1978 season Duke 6, Duke 7, G6, G22 and Hunt alas clonal rootstocks will be produced and grafted to Mass, Fuerte and Edranol for large scale field evaluation trials at Tzaneen, Burger shall, Friedenheim and Nelspruit. If possible, similar plantings will be made in other production areas such as Natal and Rustenburg.

Further to this, 100 Duke 6 and Duke 7 seedlings have been raised and will be assessed for their resistance to *P. cinnamomi.* It is hoped that this trial will give an indication of whether the resistance of the parent is transmitted via the seed to the progeny.

There is also the possibility that this trial may yield further resistant clones as a spin off. To this end several hundred Duke seeds were irradiated to induce mutation and subsequently assessed for resistance to root rot of these seeds, 6 proved promising and are being tested further.

NURSERY PRACTICES

Another facet of the root rot research has been the investigation of soil sterilization techniques and the assessment of various chemicals for their efficacy in controlling *P. cinnamomi.*

Dazomet (Basamid) at 40 g/m^2 was compared with heated methyl bromide (MBr_2) as a seedbed sterilant. Pieces of infected roots in small bags were buried in soil at various depths after the Dazomet had been mixed in with a spade. The soil was then "sealed" by rolling and was watered. The results are shown in Table 3.

TABLE 3: Percentage recovery of *P. cinnamomi* from infected rootlets after soil treatment

Treatment	Depth		
	20—30 cm	35—45 cm	45—60 cm
MBr_2	0	0	0
Dazomet	10	24	27
Control	61	65	60

These results are contrary to those obtained in our initial trials. The poor performance of the Dazomet was ascribed to its being insufficiently mixed with the soil, and these results indicate that a thorough mixing by means of a rotavator is necessary where this chemical is used. It also gave the indication that heated methyl bromide may be a substantially better soil fumigant than unheated. The trial will be repeated to confirm these observations. The above trial was carried a step further to ascertain the effect of the various sterilization methods on seed germination and subsequent rate of growth of avocados. While germination was 100% throughout, the subsequent growth in soil treated with MBr_2 or steam was poorer than in untreated soil, indicating possible toxicity. Growth in Dazomet or Vapam -treated soil was almost twice as fast as that in soil treated with steam or MBr_2. This difference was so marked that one could not exclude the possibility that the 2 former chemicals actually had a stimulatory effect on growth and the increase was not solely due to the removal of pathogens.

TABLE 4: Comparison of seedling growth (measured in cm) of plants grown in soil sterilized by various methods

Method	Total growth of 5 replicates	Average
Steam	117,9	23,58
Vapam	201,8	40,36
MBr_2	96,5	19,30
Dazomet	199,0	38,80
Control	140,5	28,10

CONCLUSIONS

After reading the above report it is obvious why, at the Citrus and Subtropical Fruit Research Institute we are confident that the end of the road is in sight as concerns *Phytophthora* root rot on avocados. Its control will register as an expenditure for as long as there is an avocado industry, but the main point is that control is now possible.

It must be emphasized, however, that this chemical control is going to be costly and it will still be highly advisable to employ all possible preventative methods, as well as any measure which will lessen its effect on the trees.