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TOMATOES: CONTROL OF PHYTOPHTHORA ROOT ROT

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Contents

Abstract

Artificially inoculating plants (cv Alicante) growing in rockwool slabs at the fourth truss flowering stage with a zoospore suspension of Phytophthora cryptogea to give 2 x 10^7 propagules per plant, severely affected rooting, retarded extension growth and significantly reduced fruit yield. Applying the non-ionic wetting agent 'Agral', containing alkyl phenol ethylene oxide condensate, to the slabs through the irrigation system at every watering at 1 or 10 ppm of the product, did not alter the effect of the pathogen on extension growth or rooting of inoculated plants measured at the end of the trial but these treatments did limit yield loss. A similar effect was achieved with propamocarb hydrochloride as 'Filex' as a drench at 2.5 ml of product in 10 l at 2 l per plant applied 13-14 days after inoculation and again 14-15 days later. All these treatments reduced frequency of recovery of the pathogen from roots of P. cryptogea inoculated plants as did 'Agral' treatment at 100 ppm. Agral at 100 ppm to uninoculated plants discolored roots, retarded growth and significantly reduced fruit yield. Adding 0.15 g per plant of a powder preparation ('Poligandron') containing oospores of Pythium oligandrum (a possible biological agent for control of P. cryptogea) to the popagation substrate 3 days before the plants were placed on the rockwool growing slabs had no effect on growth, rooting and cropping on plants whether or not they were inoculated with P. cryptogea.

Introduction

Much of the commercial UK tomato crop is now grown in rockwool slabs. The substrate is inert and the risk of attack from fungal root rotting pathogens such as Phytophthora cryptogea, should be small compared with growing the crop in border soil even when the latter is pasteurised before cropping. However, in practice the pathogen can be introduced from such sources as the water supply used for irrigation and diluting the nutrient solution, the floor of the propagation unit or cropping structure and contaminated equipment, fixtures or fittings and this can result in the pathogen becoming widespread and damaging.

The fungicide propamocarb hydrochloride as 'Filex' (Fisons Horticulture) has been the only MAFF Approved chemical for use on rockwool grown tomatoes against Phytophthora root rot. There is some evidence indicating that useful control of some Phytophthora species can be achieved in a hydroponic growing system with a low concentration of the non-ionic wetting agent 'Agral' (ICI Agrochemicals). 'Agral', which contains alkyl phenol ethylene oxide condensates, interferes with mobility and infectivity of zoospores which are the infective propagules of the fungus. At the concentration thought to possibly be effective, the chemical would be relatively inexpensive and could be precisely added to nutrient solution just prior to use. An experiment was undertaken on rockwool grown tomatoes to examine the effect of 'Agral' on growth and cropping and on root rooting caused by P. cryptogea and to compare this with 'Filex' treatment.

The fungus Pythium oligandrum, when used in the form of a preparation, 'Poligandron', containing oospores of the fungus, has been shown to give protection against seedling damping-off caused by other Pythium species. The effect of this preparation against closely related genera of plant pathogenic Phycomycetes has not been examined before and this too has been included as a treatment in the experiment now reported.

Objectives

To examine the effect of the non-ionic wetting agent 'Agral' in nutrient solution on growth and cropping of tomatoes in rockwool and on P. cryptogea and to compare this with the effect of treatment with prompamocarb hydrochloride as 'Filex'.

To examine the effect of 'Poligandron' (a preparation containing oospores of Pythium oligandrum) on growth and cropping of tomatoes in rockwool and on P. cryptogea.

Materials and Methods

Treatments:

Applied both to plants artificially inoculated with P. cryptogea and those not inoculated:-

'Agral' at 1 ppm applied at each watering through the irrigation system.

'Agral' at 10 ppm applied at each watering through the irrigation system.

'Agral' at 100 ppm applied at each watering through the irrigation system.

'Filex' at 2.5 ml in 10 l of irrigation solution, applying 2 l in 250 ml portions during 24 hour period. This was done 3 days after planting out and again a fortnight later.

'Poligandron' as a powder containing oospores of P. oligandrum applied at 0.15 g per plant to the surface of the propagation block and watered in with 25 ml of demineralised water 3 days before planting out. This application was repeated a further 14 days later.

Untreated

Layout:

Split plot design with 4 replicates for both main and sub treatments. Plot-size pair of adjacent 90 x 20 x 7.5 cm 'Grodan' rockwool slabs each containing 3 tomato plants.

Inoculum source and inoculation method:

Inoculum was prepared from an isolate of P. cryptogea obtained in 1987 from a tomato crop in Worcestershire (ADAS, Evesham, Plant Clinic reference 44/87).

Pure cultures of the fungus were grown on pea agar to rapidly produce large quantities of dense fluffy mycelium. After 5-10 days small strips of mycelium were peeled from the surface of the agar using forceps. The strips were floated in soil water overnight at 20°C. The mycelium was then separated out using a fine sieve and incubated once more in soil water overnight at 20°C. After this the mycelium was washed in dimeralised water and incubated in demineralised water at 20°C for three to five days to promote sporangial production. The floats were then chilled for an hour at 8°C and allowed to warm to room temperature to stimulate simultaneous zoospore release.

The mycelium was removed by sieving and the concentation of the zoospore suspension was assessed using a haemocytometer.

The suspension of zoospores was then diluted to the required concentration and promptly used for inoculation purposes. This method of zoospore production is based on that described by Kheng-Hoy Chee and Newhook (1964). Inoculation was carried out on 3 June to plants flowering on the fourth truss by adding 10 ml of a suspension of P. cryptogea to the top of the propagation block close to the stem base and a similar volume to the edge around the interface of the propagation block and slab. Each inoculated plant thereby received about 2×10^7 zoospores.

Propagation and growing of tomato plants:

Seedlings of cv.Alicante were initially grown in Grodan miniblocks which were then transferred to larger Grodan rockwool blocks to complete propagation. At the second truss flowering stage plants were placed out (21 May) on polythene sleeved rockwool growing slabs. Openings were cut in the polythene sleeving on the top of the slab to receive the plants. These slabs were supported on raised wooden platforms covered with polythene sheeting and slightly inclined to assist drainage of solution from the slabs directly to the floor and thus minimise the risk of cross contamination with P. cryptogea between the slabs.

Nutrient solution was supplied through 'spaghetti' type drip lines with a single outlet alongside each plant.

Encasia formosa was successfully introduced to control whitefly (Trialeurodes vaporarvorum) and spraying with fenbutatin oxide as 'Torque' effectively controlled red spider mite (Tetranchyus urticae).

Assessments of rooting, fungal root infections, growth and cropping:

At the end of the trial the extent and appearance of roots over the surface of the base of slabs and the base of propagation blocks was assessed. This was done using a 0-5 scoring system, both for amount of root which was present (0 = no roots visible: 5 = roots prolific over all the surface) and for the proprotion which was white (0 = no white roots visible: 5 = all roots white). These scores were combined to provide a measure, albeit approximate, of the quantity and quality of rooting present at the end of the experiment.

Roots were examined for infection with P. cryptogea and for the presence of Pythium oligandrum by taking 5 x 1 cm length root pieces with discoloration or with a leading edge of rot from the surface of each slab. Each piece was surface sterilized by immersion for 10 seconds in 5% chloros and was then placed onto cornmeal sand (CMS) agar and incubated at 20°C for 4 days. Additionally, for slabs receiving the 'Poligandron' preparation, 5 x 1 cm length root pieces were placed, without chloros sterilisation treatment, which might otherwise have destroyed any P. oligandrum present (Martin & Hancock, 1987) directly onto CMS agar and incubated for 3 days at 20°C. Growth was then sub-cultured onto PDA and incubated for a further 2 days before examining microscopically to look for typical spiny oospores of P. olingandrum. (N.B. midway through the trial, root samples were taken with a cork borer from the propagation blocks of guard plants inoculated with 'Poligandron'. More than 100 root pieces so obtained were placed on CMS agar, incubated and examined for growth of P. oligandrum. The fungus was recovered only from a single root piece and its identity was confirmed by Dr D J Stamps, Commonwealth Mycological Institute).

Extension growth was recorded weekly until plants reached or extended just beyond the support wires, by measuring from the top of the propagation block to the tip of the growing point.

Fruit yield was recorded by weighing and counting fruit from each of the bottom seven trusses.

Results

At the end of the experiment rooting in the slabs had been greatly reduced by inoculation with P. cryptogea and most remaining roots were brown. Treatment with 'Agral' did not alleviate this effect but increasing dose of the chemical reduced the frequency of recovery of the pathogen from roots. Rooting in the propagation block was less affected by inoculation with P. cryptogea. Roots treated with 'Agral' at 100 ppm were an orange-brown colour. Propamocarb hydrochloride and 'Poligandron' failed to alleviate the effect of P. cryptogea on rooting.

Apart from 'Agral' at 100 ppm, none of the treatments markedly affected rooting of plants which had not been incoulated with the pathogen.

Fruit yield was significantly reduced by inoculating plants with P. cryptogea but this reduction was smaller where Agral at 1 or 10 ppm or where propamocarb hydrochloride was applied. Fruit yield of uninoculated plants was unaffected by any treatment apart from 'Agral' at 100 ppm which caused a very marked reduction.

Differences in fruit yield were mostly the result of differences in fruit size but treatment of uninoculated plants with 'Agral' at 100 ppm significantly reduced fruit number.

Addition of 'Polygandron' did not affect yield of either uninoculated plants or those inoculated with P. cryptogea.

Table 1 Effects of treatments on fruit yield, fruits per truss, weight of individual fruits and plant height.

Treatment	Fruit yield (kg) per plant	Average weight (g) of single fruit	Average fruit no./truss	Plant height (m) 84 days after planting
P. cryptogea + 'Agral' at 1 ppm	2.967 cd	54 cd	7.9 abc	2.70 cdef
P. cryptogea + 'Agral' at 10 ppm	2.910 bcd	52 abcd	7.9 abc	2.67 bcdef
P. cryptogea + 'Agral' at 100 ppm	2.332 a	47 a	7.2 a	2.28 a
Uninoculated + 'Agral' at 1 ppm	3.247 d	56 d	8.4 bc	2.90 g
Uninoculated + 'Agral' at 10 ppm	3.073 d	54 cd	8.0 abc	2.79 ef
Uninoculated + 'Agral' at 100 ppm	2.468 ab	48 ab	7.3 a	2.42 ab
P. cryptogea + 'Poligandron'	2.589 abc	49 ab	7.5 ab	2.47 abc
Uninoculated + 'Poligandron'	2.890 bcd	52 abcd	8.0 abc	2.82 ef
P. cryptogea + propamocarb hydrochloride	2.824 bcd	51 abc	8.0 abc	2.58 bcde
Uninoculated + propamocarb hydrochloride	3.231 d	53 bcd	8.7 c	2.70 cdef
P. cryptogea	2.566 abc	47 a	7.9 abc	2.53 abc
Uninoculated	3.279 d	55 cd	8.5 c	2.74 def
SE	0.288	3	0.6	0.16
CV %	10%	6.4%	7.4%	6.1%

Treatments with a common suffix letter are not significantly different, P = 0.05

Table 2 Effect of treatments on rooting

Treatment	Slab base rooting amount (0-5 scale) x proportion white (0-5 scale) (max. score 5 x 5 = 25)	Propagation block base rooting amount (0-5 scale) x proportion white (0-5 scale) (max. score 5 x 5 = 25)
P. cryptogea + 'Agral' at 1 ppm	1.5 a	14.2 cde
P. cryptogea + 'Agral' at 10 ppm	3.0 a	13.3 cd
P. cryptogea + 'Agral' at 100 ppm	3.5 a	8.3 a
Uninoculated + 'Agral' at 1 ppm	16.0 b	18.7 fg
Uninoculated + 'Agral' at 10 ppm	15.3 b	17.5 efg
Uninoculated + 'Agral' at 100 ppm	5.0 a	9.5 ab
P. cryptogea + 'Poligandron'	0.9 a	12.4 bcd
Uninoculated + 'Poligandron'	14.8 b	20.4 g
P. cryptogea + propamocarb hydrochloride	2.5 a	15.3 def
Uninoculated + propamocarb hydrochloride	16.6 b	20.6 g
P. cryptogea	2.3 a	11.6 abc
Uninoculated	18.1 b	17.0 dfg
SE	2.9	2.3
CV%	35.2%	15.6%

Treatments with a common suffix letter are not significantly differenc, P = 0.05

Table 3 Roots infected with *P. cryptogea*

Treatment	% roots with *P. cryptogea* (40 examined)
P. cryptogea + 'Agral' at 1 ppm	45
P. cryptogea + 'Agral' at 10 ppm	33
P. cryptogea + 'Agral' at 100 ppm	8
Uninoculated + 'Agral' at 1 ppm	8
Uninoculated + 'Agral' at 10 ppm	0
Uninoculated + 'Agral' at 100 ppm	0
P. cryptogea + 'Poligandron'	40
Uninoculated + 'Poligandron'	3
P. cryptogea + prompamocarb hydrochloride	40
Uninoculated + prompamocarb hydrochloride	8
P. cryptogea	65
Uninoculated	5

N.B. No *Pythium oligandrum* was recovered.

Conclusions

1. Inoculation of rockwool grown tomato plants with P. cryptogea severely affected rooting, retarded extension growth and reduced fruit yield.

2. The effect on fruit yield was partly alleviated by using 'Agral' at 1 or 10 ppm or by applying propamocarb hydrochloride.

3. 'Agral' at 1 or 10 ppm applied to uninoculated plants had no significant effect on growth or cropping but at 100 ppm roots were damaged and fruit yield was significantly reduced.

4. P. cryptogea was recovered from fewer roots of 'Agral' treated inoculated plants than untreated ones; the effect being greater with increasing concentration of the product.

5. 'Poligandron' had no effect on rooting, growth and cropping of plants whether or not inoculated with P. cryptogea and Pythium oligandrum was not recovered from roots at the end of the experiment.

6. Some uninoculated plants became naturally infected with P. cryptogea, probably as a result of accidental contamination from adjacent artifically inoculated ones, but the levels appeared to be very low.

References

Kheng-Hoy Chee & Newhook, F J (1964). Improved methods for use in studies on Phytophthora cinnamomi Rands and other Phytophthora species. New Zealand Journal of Agricultural Research 8, 88-95.

Martin, F N & Hancock, J G (1987). The use of Pythium oligandrum for biological control of pre-emergence damping-off caused by P. ultimum. Phytopathology, 77, 1013-1020.

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