

Final Report (January 1996)

Project number: PC 98

Title: Long-season protected tomato: control of stem botrytis
by treating young lesions

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Contract Report for
the Horticultural Development Council

**Control of tomato stem botrytis
by treating small lesions-1995
PC 98**

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APPLICATION

The objective of the project was to provide information on the efficacy of four paint treatments in preventing or delaying botrytis stem rot when applied to young lesions on tomato stems. Two treatments, Benlate plus Actipron and vinegar, both delayed lesion development and plant death compared to lesions left untreated.

SUMMARY OF RESULTS

The objective of the work was to provide information on the efficacy of selected paint treatments in preventing or delaying botrytis stem rot when applied to young botrytis lesions on tomato stems. Treatments were applied once, on 9 June 1995, in a crop of cv. Liberto in Norfolk, selecting plants each with one small lesion (1-3 cm in length) on the main stem. Samples of *B. cinerea* collected from the nursery at the start of the experiment were sensitive to benomyl. Treatment with Benlate plus Actipron or vinegar delayed lesion development and plant death. Treatment with Benlate plus water or Actipron was ineffective. Further work is needed to confirm these results.

ACTION POINTS FOR GROWERS

Consider painting young botrytis lesions with vinegar or Benlate (2 g) plus Actipron (3 ml) to delay the progress of botrytis stem rot causing plant death. Although there is no label or off-label recommendation for either treatment, both are currently permitted. Benlate + Actipron is permitted at growers own risk; the use of vinegar falls outside the Control of Pesticide Regulations.

INTRODUCTION

Grey mould (*Botrytis cinerea*) remains a major cause of stem rotting and plant death in some long-season tomato crops and can cause considerable yield losses at the end of the season. The disease often originates at wound sites left after de-leafing or side shoot removal where infection may develop to produce small, dark coloured lesions on layered stems. Some growers paint such botrytis lesions with a fungicide or other chemical in an attempt to delay or prevent the fungus causing extensive rot and premature plant death. One treatment suggested by growers was vinegar. This is a food grade product and treatment of tomato stem lesions with vinegar has been assessed by the Pesticides Safety Directorate and considered to fall outside the Control of Pesticide Regulations. The effectiveness of paint treatment is uncertain. The objective of this work was to evaluate the efficacy of selected paint treatments.

MATERIALS AND METHODS

Crop details

The project was conducted in a crop of cv. Liberto grown on rockwool slabs in a heated greenhouse in Norfolk. Botrytis stem rot was evident in the crop when the experiment commenced. Samples of botrytis were collected before treatments were applied and tested for their sensitivity to benomyl (Benlate WP) at 2 and 20 ug/ml on amended agar plates. The crop was grown according to usual practice on the nursery and included high volume sprays of chlorothalonil (Bravo 500) and iprodione (Rovral) for control of botrytis.

Treatments

1. Untreated
2. Benlate WP (1 g) + Actipron (3 ml)
3. Benlate WP (1 g) + water (3 ml)
4. Benlate WP (0.01 g) + Actipron (3 ml)
5. Vinegar

Treatment 4 is referred to hereafter as Actipron.

Plants with one small, sporing botrytis lesion on the main stem were selected; lesions which were more than 3 cm long or extended around more than 50 % of the stem were not included. Plants which were affected by botrytis elsewhere along the stem were not used. The position of each lesion was marked by attaching a coloured tape close to it so that the site could be readily found for subsequent assessments. Most lesions appeared to originate at a wound site following removal of a leaf (63 %) or a fruit truss (32 %); a small proportion (5 %) originated at sites of stem damage between nodes. Treatments were applied once, on 9 June 1995, using a 2 cm paint brush to cover the lesion and apparently healthy stem approximately 1 cm beyond the lesion edge. Dead plants were removed from the trial area as they occurred.

Experimental design

The experiment was a randomised block design with 26 replicate blocks. Each block consisted of five treatment plots; each plot consisted of one plant with one small sporulating lesion. Treated plants were located in 12 adjacent double rows at one end of the greenhouse. Results were examined by Chi-squared tests.

Assessments

Lesions were assessed at the beginning of the experiment and on 7 further occasions at 2-4 week intervals (22 June, 7 July, 25 July, 2 August, 17 August, 12 September, 12 October). Lesions were examined to determine length and whether or not sporing botrytis was evident on the lesion. Position of lesions from the stem base was recorded by counting nodes; the mean internode distance was 9 cm. Plant death was also recorded.

RESULTS

Position of lesions

Lesions were located at distances from the stem base ranging from node 6 (0.5 m) to node 62 (5.6 m). The mean position was node 34 (3.1 m) and most occurred between nodes 14 to 54 with a peak around nodes 33 to 36 (2.9 to 3.3 m) (Fig 1).

Plant death

Dead plants were evident in all treatments four weeks after application of lesion paints. The number of dead plants at this time (7 July) was reduced by Benlate plus Actipron and by vinegar but not by other treatments (Fig 2). On plants where lesions were left untreated, there was little further increase in the number of dead plants during July, August and September. Benlate plus water and Actipron appeared to increase the rate of plant death and the final number of dead plants. At the final assessment on 12 October, the incidence of dead plants following treatment with Benlate + Actipron was 25 %, compared with 38 % for untreated plants.

Lesion length

The mean lesion length when the experiment commenced was 2.7 cm (S.E. 0.21 cm) (Table 2). Lesion length increased during June but little thereafter. Effect of treatment on lesion length was most accurately determined in the first three weeks, before any plant death had occurred. Over this period, the increase in length of untreated lesions was 4.0 cm, compared with 1.8 cm for lesions treated with vinegar. Other treatments had little effect on lesion length. Occurrence of girdling lesions is shown in Table 4.

Effect on sporulation

The occurrence of spring botrytis on untreated lesions declined during the hot weather in June, July and August, and then increased slightly in September (Table 3). There was no significant difference between treatments at the first assessment, three weeks after application. At the final assessment on 12 October, the incidence of sporulation was greatest on untreated lesions (25 %) and least on those treated with Benlate + Actipron (6 %); Actipron and vinegar also appeared to reduce the incidence of spring lesions.

Phytotoxicity

Treatment of stem tissue with Benlate plus Actipron or Actipron resulted in a grey to black lesion. This was not evident with the Benlate plus water paint or with vinegar.

Fungicide sensitivity

Ten isolates of *B. cinerea* collected from the crop in June 1995 and tested for sensitivity to fungicides were all found to be sensitive to benomyl at both 2 and 20 ug/ml; most of the isolates were resistant to iprodione at 2 ug/ml

Fig 1. Occurrence of botrytis lesions on tomato stems
Norfolk 1995

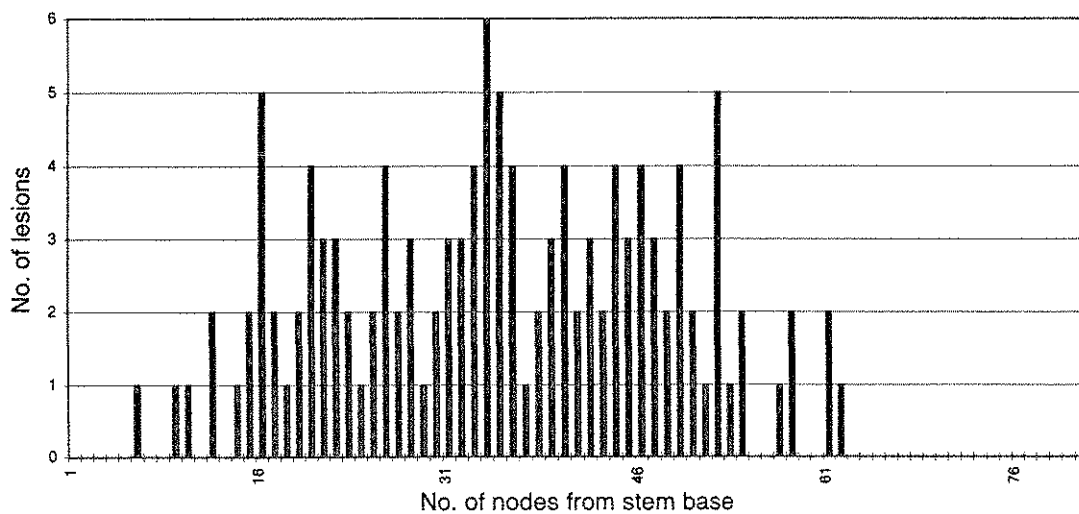
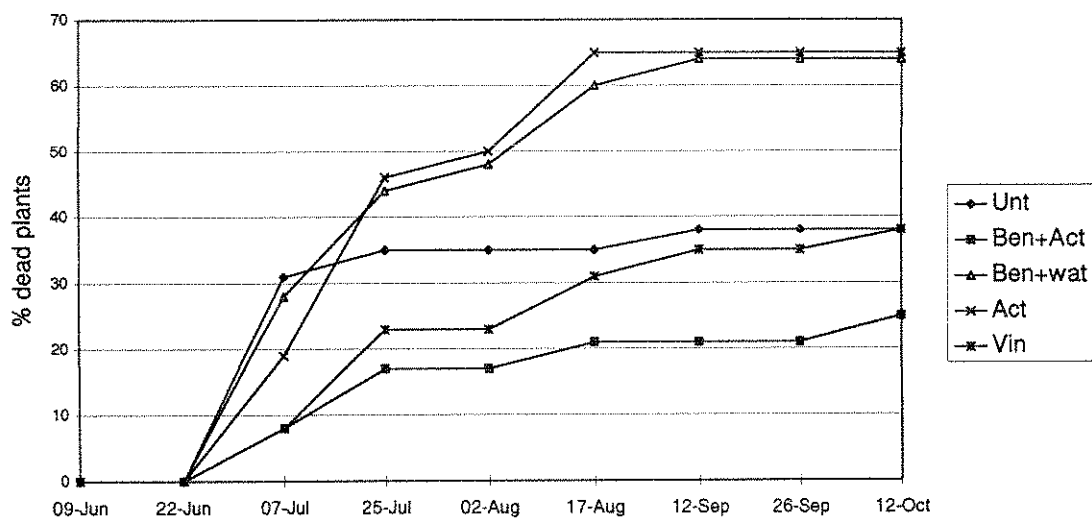


Fig 2. Effect of stem lesion paint treatments on plant death
Norfolk 1995



DISCUSSION

Treatment of small botrytis lesions on tomato stems with Benlate + Actipron or vinegar delayed plant death. Benlate + Actipron appeared to be slightly more effective than vinegar in the persistence of its effect. This result was obtained on a nursery where *B. cinerea* was found to be sensitive to benomyl (Benlate). Treatment with Benlate + Actipron may be less effective in crops where the fungus is resistant to benomyl.

Although Benlate + Actipron delayed lesion progress and plant death, Benlate alone and Actipron alone were ineffective. This result indicates an interaction between these chemicals; possibly the Actipron damages the stem surface and allows the fungicide to penetrate stem tissue more deeply than when Benlate alone is applied.

Treatment of tomato stem lesions with a fungicide, especially on layered stems, poses a risk that fruit may be directly contaminated (e.g. by dripping) with chemical. The promising result with vinegar, a food grade product, is therefore interesting. Further work is needed to confirm this result and examine the persistence of control in a season when conditions are more favourable to botrytis.

Table 1. Effect of stem lesion paint treatments on plant death-1995

| Treatment | % plants dead | | | | | | | |
|--------------------|---------------|--------|-------|--------|-------|--------|--------|--------|
| | 9 Jun | 22 Jun | 7 Jul | 25 Jul | 2 Aug | 17 Aug | 12 Sep | 12 Oct |
| 1. Untreated | 0 | 0 | 31 | 35 | 35 | 35 | 38 | 38 |
| 2. Benlate + Act | 0 | 0 | 8 | 17 | 17 | 21 | 21 | 25 |
| 3. Benlate + water | 0 | 0 | 28 | 44 | 48 | 60 | 64 | 64 |
| 4. Actipron | 0 | 0 | 19 | 46 | 50 | 65 | 65 | 65 |
| 5. Vinegar | 0 | 0 | 8 | 23 | 23 | 31 | 35 | 38 |
| Chi-squared | - | - | 7.62 | 7.48 | 9.64 | 15.44 | 15.26 | 12.62 |
| Significance | - | - | NS | NS | * | ** | ** | * |

NS-not significant

* Significant at P<0.05

**Significant at P<0.01

Table 2. Effect of treatment on mean lesion length on surviving plants

| Treatment | Mean lesion length (cm) | | | | | | | |
|--------------------|-------------------------|--------|-------|--------|-------|--------|--------|--------|
| | 9 Jun | 22 Jun | 7 Jul | 25 Jul | 2 Aug | 17 Aug | 12 Sep | 12 Oct |
| 1. Untreated | 3.0 | 7.0 | 6.4 | 6.5 | 7.1 | 5.5 | 5.2 | 5.6 |
| 2. Benlate +Act | 2.8 | 6.4 | 6.9 | 7.0 | 7.4 | 6.3 | 6.3 | 7.6 |
| 3. Benlate + water | 2.2 | 5.9 | 5.4 | 9.4 | 8.3 | 4.2 | 4.2 | 4.3 |
| 4. Actipron | 2.7 | 7.5 | 7.1 | 6.9 | 5.3 | 6.2 | 6.3 | 7.7 |
| 5. Vinegar | 2.6 | 4.4 | 5.2 | 4.4 | 4.9 | 3.3 | 4.1 | 3.5 |

Table 3. Effect of lesion treatment on sporulation

| Treatment | % lesions with sporing botrytis | | | | | | | |
|----------------------|---------------------------------|--------|-------|--------|-------|--------|--------|--------|
| | 9 Jun | 22 Jun | 7 Jul | 25 Jul | 2 Aug | 17 Aug | 12 Sep | 12 Oct |
| 1. Untreated | 100 | 66 | 50 | 24 | 18 | 12 | 19 | 25 |
| 2. Benlate + Act | 100 | 79 | 28 | 20 | 10 | 0 | 0 | 6 |
| 3. Benlate + water | 100 | 52 | 39 | 29 | 24 | 0 | 11 | 23 |
| 4. Actipron | 100 | 62 | 34 | 8 | 8 | 0 | 11 | 12 |
| 5. Vinegar | 100 | 65 | 50 | 25 | 25 | 6 | 18 | 13 |
| No. lesions assessed | 127 | 127 | 103 | 85 | 83 | 73 | 70 | 68 |

Table 4. Effect of lesion treatment on cumulative number of girdling lesions

| Treatment | Cumulative number of girdling lesions | | | | | | | |
|-----------------------|---------------------------------------|--------|-------|--------|-------|--------|--------|--------|
| | 9 Jun | 22 Jun | 7 Jul | 25 Jul | 2 Aug | 17 Aug | 12 Sep | 12 Oct |
| 1. Untreated | 0 | 7 | 10 | 11 | 11 | 12 | 12 | 13 |
| 2. Benlate + Actipron | 0 | 4 | 8 | 8 | 8 | 8 | 9 | 10 |
| 3. Benlate + water | 0 | 5 | 10 | 16 | 16 | 16 | 16 | 18 |
| 4. Actipron | 0 | 5 | 10 | 15 | 18 | 18 | 18 | 20 |
| 5. Vinegar | 0 | 3 | 6 | 8 | 8 | 8 | 10 | 11 |

Contract between ADAS (hereinafter called the "Contractor") and the Horticultural Development Council (hereinafter called the "Council") for a research/development project.

1. TITLE OF PROJECT

Contract No: PC98

LONG-SEASON PROTECTED TOMATO: CONTROL OF STEM BOTRYTIS BY TREATING YOUNG LESIONS

2. BACKGROUND AND COMMERCIAL OBJECTIVE

Botrytis remains a major cause of plant death in some heated long-season tomato crops. Stem infection usually occurs at wound sites left after de-leafing or following leaf dieback. In recent years it has become evident that old fruit trusses are also an important infection site in crops affected by botrytis; this problem was particularly apparent in the late summer and autumn months of 1992 and 1993. Some growers paint small botrytis lesions with Benlate + Actipron paste, in an attempt to delay or stop botrytis causing plant death. The commercial objective of this project is to reduce plant death caused by botrytis stem lesions.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

Reducing plant death due to stem botrytis will increase yield and may also increase fruit quality by reducing the risk of ghost spotting. Information on the extent of stem botrytis on 60 long-season tomato crops was collected by ADAS in 1992. 40 nurseries reported final plant losses to stem botrytis of more than 5% and 6 had losses of more than 40%. Assuming an average of 5% of plants died in early September; expected yields of 24 and 19 t/acre in September and October with returns of £430 and £600/tonne and 50% compensation from adjacent plants, lost production during September and October would be worth £543/acre, or approximately £500,000 for the UK industry (130ha). If 10% of plants died in early September the loss would be approximately £1,000,000.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

To evaluate the efficacy of Benlate, with and without Actipron, applied to small, non-girdling botrytis stem lesions to delay or prevent lesion spread.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

The proposer is not aware of any current or recently completed work investigating stem lesion paint treatments for control of stem botrytis in tomato. Work is in progress at Silsoe Research Institute (B Bailey) concerning climate control to prevent condensation on tomato fruit which is likely to influence botrytis ghost spotting (HDC Project PC72). A MAFF-funded study investigating the establishment and development of botrytis in selected protected crops and aspects of biological control commenced

in April 1994 (project leader: M McPherson). A proposal for work evaluating the effect of fruit truss removal on stem botrytis and a comparison of new and current fungicides on tomato botrytis has been submitted to HDC jointly by the proposer and M. McPherson.

6. DESCRIPTION OF THE WORK

The following treatments would be undertaken in a commercial crop in ~~Essex~~ East Anglia. Treatments would be applied to limited (non-girdling) lesions covering the lesion and c. 1cm beyond. There would be 50 replicate blocks. Blocks would consist of four plants affected by limited lesions; treatments within blocks would be randomised.

1. Untreated
2. Benlate (1 g) + Actipron (3 ml) paste
3. Benlate (1 g) + Water (3 ml)
4. Benlate (0.01 g) + Actipron (3 ml) slurry

Treated lesions would be examined 2, 4 and 8 weeks after treatment and assessed for:

1. Spring botrytis
2. Progress of lesion beyond treated area
3. Stem girdling

Isolates of *B. cinerea* from the experimental plants would be tested for resistance to Benlate at the start and end of the work.

7. COMMENCEMENT DATE, DURATION AND REPORTING

Start date 01.07.94; duration 6 months. The exact start date will be determined by the identification of a suitable crop and co-operating nursery. A written report will be prepared by 31 December 1994. The results will also be presented at the HDC Tomato Conference in October 1994.

8. STAFF RESPONSIBILITIES

Project Leader: Dr T M O'Neill, ADAS Cambridge
Key staff: D Pye, ADAS Cambridge

9. LOCATION

A commercial tomato nursery, probably in ~~Essex~~ or ~~Hertfordshire~~ East Anglia.

Contract No: PC98
Date: 27.7.94

TERMS AND CONDITIONS

The Council's standard terms and conditions of contract shall apply.

Signed for the Contractor(s)

Signature.....M.C. Heath.....

Position.....ACCOUNT.....MANAGER

Date.....5/8/94.....

Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Council

Signature.....[Signature].....

Position.....CHIEF EXECUTIVE.....

Date.....27.7.94.....

T. 2/2/95

Contract between ADAS (hereinafter called the "Contractor") and the Horticultural Development Council (hereinafter called the "Council") for a research/development project.

1. **TITLE OF PROJECT** **Contract No: PC98**
(Contract modified for delayed start date)

LONG-SEASON PROTECTED TOMATO: CONTROL OF STEM BOTRYTIS BY TREATING YOUNG LESIONS

2. **BACKGROUND AND COMMERCIAL OBJECTIVE**

As for PC 98

3. **POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY**

As for PC 98

4. **SCIENTIFIC/TECHNICAL TARGET OF THE WORK**

As for PC 98

5. **CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS**

As for PC 98

6. **DESCRIPTION OF THE WORK**

The experiments which were originally planned for 1994 failed to produce any meaningful results because a suitable infected crop could not be located. The experiment detailed in the original Contract for PC 98 will therefore be repeated in 1995.

7. **START DATE, DURATION AND REPORTING**

Start date: 01.07.95; duration 6 months.

The exact start date will be determined by the identification of a suitable crop and co-operating nursery. A written report will be prepared by 31 December 1995. The results will also be presented at the HDC Tomato Conference in October 1995.

8. **STAFF RESPONSIBILITIES**

Project Leader: Dr T M O'Neill, ADAS Cambridge
Key staff: D Pye, ADAS Cambridge

9. **LOCATION**

A commercial tomato nursery, probably in East Anglia.

10. COSTS

As for PC 98

TERMS AND CONDITIONS

The Council's standard terms and conditions of contract shall apply.

Signed for the Contractor(s)

Signature..... M.C. Heath.....

Position..... ADAS...ACCOUNT...MANAGER

Date..... 15.6.95.....

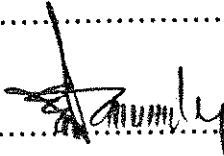
Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Council

Signature..... .....

Position..... CHIEF EXECUTIVE.....

Date..... 9.6.94'.....