THE CONTROL OF FIELD AND STORAGE DISEASES OF TOMATOES[1]

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Abstract

Control of a severe outbreak of late blight of tomatoes was obtained with 6 applications, at 10-day intervals, of either maneb or zineb at 2 lb per 100 gal (Imp.). Twenty-eight and 33 per cent gray-mold rot, respectively, developed on the fruit sprayed with maneb and zineb. Satisfactory control of both diseases was obtained when 1 or 2 lb of either maneb or zineb was combined with either 1 or 2 lb. of thiram or 1 3/4 lb of Dyrene. The best control of storage rots followed when 2 lb of thiram was added to either maneb at 2 lb or tank mixed zineb, 1 qt nabam t 3/4 lb $ZnSO_4$.

Introduction

The commercial production of field tomatoes in Nova Scotia is largely confined to the Annapolis Valley where conditions are moderately favorable for ripening the fruit. In a previous report Harrison (1) showed that several carbarnate fungicides used to control late blight, Phytophthora infestans (Mont.) de Bary, resulted in a greatly increased amount of gray-mold rot, Botrytis cinerea Pers. ex Fr., on tomatoes and that some control of this disease could be obtained by adding 2 lb of thiram, or 1 3/4 lb of Dyrene to either maneb or sineb. Lockhart and Harrison (2) found that tank-mix zineb plus thiram was more effective in controlling storage rots than factory-mix zineb plus thiram.

This paper presents the results obtained in 1962 from a comparison of a number of mixtures of fungicides used to control field and storage diseases of tomatoes.

Methods

Tomato plants of the variety Stokesdale were set in 4 blocks and the treatments randomized. Eaeh of the 19 plots in a block contained 6 plants with the end plants serving as guards. Maneb, factory-mix zineb and tank-mix eineb were tested at the rates recommended by the manufacturers and compared with a number of mixtures of the same fungicides at full and half strengths with either thiram at 1 or 2 lb or Dyrene at 1 or 1 3/4 lb added, Blitox, a fixed copper, and ziram and Bordeaux 10-7-100 in a split program were also included because in past tests these fungicides have had very

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little effect on the incidence of gray-mold rot and gave reasonable control of late blight. Delan* was tested for the first time. Six fungicide applications were made at approximately 10-day intervals between July 27 and September 22. The final harvest was started October 3 and, due to wet weather, was not completed until October 12. Two pickings of 25 mature-green fruit were made from each plot, the first on September 12 and the second on October 1, for storage trials. These fruits were stored at 52, 5° F for 5 weeks in a single layer on trays (18" x 36") lined with brown paper. They were examined at weekly intervals and all fruits showing rot were removed from the trays. Isolation and identification of unknown rots were made on potato-dextrose-agar. A thermograph recorded the field temperatures during September and October,

Results and Discussion

Field Tests

The tomato plants grew vigorously but because of the cool wet season the fruit matured very slowly and was not ready for picking until September 27. The season was favorable for fungicide tests as both late and gray-mold rot were present in epidemic amounts.

The results of the field tests, given in Table 1, are the average of the 4 replicates of each treatment and are calculated from the total of all fruit picked during the season. Excellent control of late blight was obtained with all materials and combinations. Delan was the least effective. Stem rot, Sclerotinia sclerotiorum (Lib.) de Bary, was present in all plots. There was no evidence that any fungicide affected the amount of this disease. However, it is difficult to obtain accurate counts of other diseases of the fruit when late blight is as severe as it was in these plots. The percentages of gray-mold rot present in 1962 were the highest recorded since yearly tests were started in 1948. In 1962 the percentage of gray-mold rot was 33.0, 32.7 and 28.8 for factory-mix zineb, tank-mix zineb and maneb, respectively. The lowest percentage of gray-mold rot was obtained with a mixture of maneb and thiram.

It is interesting to note that the average per cent of the means of gray-mold rot from all plots treated with thiram at 2 lb was 5.9, at 1 lb, 10.1, and where Dyrene was used at 1 3/4 lb, 8.6 and at 1 lb, 12.0. The average per cent of the means of the 5 plots where maneb was used was 11.1, factory-mix zineb, 13. 1 and tank-mix 15. 5.

Storage Tests

Less rot developed in storage on tomatoes picked on September 12 than on those picked on October 1 (Tables 2 and 3). This difference was due to the increased numbers of Alternaria) gray-mold, late blight and other rots in the second picking (Table 3). The largest increase was due to Alternaria rots, indicating that some chilling injury had occurred when the minimum temperature dropped below 40° F on 3 different days prior to the second picking.

* 75% 2,3 dinitrilo-1,4-dithiaanthraquinone.

Table 1. Per cent field rots on tomatoes from spray plots.

Fungicide per 100 gallons	Per cent rots		
	B. cinerea	P. infestans	S. sclerotiorum
Maneb 2 lb.	28, 8 abc[1]	1.1	1.6
Maneb 2 lb. t thiram 2 lb.	4.2 h	0.0	0.5
Maneb 2 lb. t Dyrene 2 lb.	5.9 gh	0.1	0, 5
Maneb 1 lb. t thiram 1 lb,	9. 4 fgh	0.2	1.5
Maneb 2 lb. t Dyrene[2] 1 3/4 lb.	7. 1 fgh	0, 0	0.4
Zineb factory-mix 2 lb.	33.0 abc	1.2	1, 5
Zineb factory-mix 2 lb. t thiram 2 lb.	6.0 gh	0.9	0.9
Zineb factory-mix 2 lb. t Dyrene 13/4 lb.	8.1 fgh	0.1	0.5
Zineb factory-mix 1 lb, t thiram 1 lb.	6.9 fgh	1.0	1.5
Zineb factory-mix 1 lb, t Dyrene 1 lb.	11. 4 fgh	0.4	1.4
Zineb tank-mix 1 qt. nabam t 3/4 lb. $ZnSO_4$	32, 7 abc	0. 7	1.3
Zineb full strength t thiram 2 lb.	7.6 fgh	0.0	0.8
Zineb half strength t Dyrene 1 3/4 lb.	10, 5 fgh	0. 1	0.6
Zineb half strength t thiram 1 lb.	14.0 defg	0.1	0.3
Zineb half strength t Dyrene 1 lb.	12.6 efgh	0.6	2.5
Blitox[2] 3 lb.	24.3 abcd	0.3	0.8
Ziram 2 lb. Bordeaux, 10-7, split program	16.3 cdef	0.1	2.6
Delan[4] 1 lb.	23.5 abcde	4.1	1.4
Control	8. 5 fgh	45.4	0, 1

[1] Small letters indicate Duncan's Multiple Range grouping of treatments which do not differ significantly at the 1% level.

[2] 2,4-dichloro-6-o-chloroanilino-s-triazine.

[3] 50% copper as the oxychloride.

[4] 75% 2,3 dinitrilo 1, 4-dithiaanthraquinone.

Table 2. Storage in the first picking of Stokesdale tomatoes from spray plots at the end of 5 weeks in storage at 52. 5" F.

Fungicide per 100 gallons	Total per cent rots	Per cent rots caused by: C coccodes	A tenuis	B cinerea	P infestans	Others[1]
Maneb, 2 lb.	28.3 c[2]	14.1 abc	6.0 a	6.0 ab	1.0	1.0
Maneb, 2 lb. t thiram 2 lb.	10.0 ghi	9.0 abcdef	1.0 a	0.0 b	0.0	0. 0
Maneb, 2 lb. + Dyrene 2 lb.	13.0 efghi	6.0 cdef	3.0 a	3. 0 b	0.0	1.0
Maneb, 1 lb. t thiram 1 lb.	13.0 efghi	6.0 cdef	5. 0 a	2. 0 b	0.0	0. 0
Maneb 2 lb. t Dyrene 1 3/4 lb.	7. 0 i	2. 0 f	3. 0 a	0. 0 b	0.0	2.0
Zineb (factory-mix) 2 lb.	46.8 b	15.6 ab	12.2 a	12.4 a	5.1	1. 0
Zineb 2 lb. t thiram 2 lb.	16. 0 cdefghi	2.0 f	10.0 a	2.0 b	0.0	2. 0
Zineb 2 lb. t Dyrene 1 3/4 lb.	11. 1 fghi	6. 0 cdef	5. 0 a	0. 0 b	0.0	0.0
Zineb 1 lb. t thiram 1 lb.	19.0 cdefghi	9.0 abcdef	3. 0 a	5.0 b	0.0	2.0
Zineb 1 lb. t Dyrene, 1 lb.	15.0 cdefghi	7.0 bcdef	8. 0 a	0.0 b	0 0	0.0
Zineb (tank-mix nabam 1 qt. + 3/4 lb. $ZnSO_4$	25.0 cdef	13. 0 abcd	8.0 a	3.0 b	0.0	1.0
Zineb full strength + thiram 2 lb.	6. 0 i	2.0 f	4.0 a	0. 0 b	0.0	0.0
Zineb half strength + Dyrene 1 3/4 lb.	16.0 cdefghi	5. 0 cdef	7. 0 a	2.0 b	2.0	0. 0
Zineb half strength + thiram 1 lb.	16. 0 cdefghi	3. 0 ef	6. 0 a	5.0 b	0.0	2.0
Zineb half strength + Dyrene 1 lb.	23. 0 cdefg	10.0 abcdef	7.0 a	4.0 b	1. 0	1.0
Ziram 2 lb. Bordeaux 10-7, split program	28. 0 cd	7.0 bcdef	8. 0 a	5.0 b	2.0	6.0
Blitox 3 lb.	26. 2 cde	17.0 a	5. 0 a	1.0 b	0.0	3.0
Delan 1 lb.	22.0 cdefgh	7.0 bcdef	10.0 a	5.0 b	0. 0	0.0
Control	66.5 a	12. 0 abcd	3. 5 a	0. 5 b	47. 5	3.0

[1] Includes P. destructiva, S. sclerotiorum and bacteria.
[2] Small letters indicate Duncan's Multiple Range grouping of treatments which do not differ significantly at the 5% level.

Table 3. Storage rots in the second picking of Stokesdale tomatoes from spray plots at the end of 5 weeks in storage at 52.5° F.

Fungicide per 100 gallons	Total per cent rots	Per cent rots caused by				
		C. coccodes	A. tenuis	B. cinerea	P. infestans	Others[1]
Maneb 2 lb.	27.0 cdef[2]	9.0 a	6.0 b	10.0 abc	1.0	1.0
Maneb 2 lb. + thiram 2 lb.	16.0 f	3.0 a	7.0 b	0.0 e	0.0	5.0
Maneb 2 lb. + Dyrene 2 lb.	16.0 f	6.0 a	6.0 b	3.0 de	1.0	0.0
Maneb 1 lb. + thiram 1 lb.	21.0 ef	4.0 a	6.0 b	7.0 abcd	0.0	4.0
Maneb 2 lb. + Dyrene I 3/4 lb.	20.2 ef	8.0 a	8.0 b	0.0 e	0.0	4.0
Zineb (factory-mix) 2 lb.	40.4 cd	11.0 a	9.0 b	12.0 ab	0.0	6.0
Zineb 2 lb. + thiram 2 lb.	25.0 cdef	5.0 a	9.0 b	2.0 de	0.0	5.0
Zineb 2 lb. + Dyrene 1 3/4 lb.	17.3 f	8.3 a	6.0 b	2.0 de	0.0	0.0
Zineb 1 lb. + thiram 1 lb.	25.0 cdef	8.0 a	11.0 b	4.0 cde	1.0	1.0
Zineb 1 lb. + Dyrene 1 lb.	25.0 cdef	8.0 a	9.0 b	5.0 abcde	0.0	3.0
Zineb (tank-mix nabam 1 qt. + 3/4 lb. $ZnSO_4$	37.0 cde	7.0 a	8.3 b	17.0 a	0.0	4.0
Zineb full strength + thiram 2 lb.	18.3 f	5.1 a	8.0 b	3.0 de	0.0	2.0
Zineb half strength + Dyrene 1 3/4 lb.	23.0 def	5.0 a	11.0 b	4.0 bcde	2.0	1.0
Zineb half strength + thiram 1 lb.	21.0 ef	4.0 a	8.0 b	7.0 bcde	1.0	1.0
Zineb half strength + Dyrene 1 lb.	28.0 cdef	6.0 a	15.0 b	2.0 de	1.0	2.0
Ziram 2 lb. Bordeaux 10-7, split program	59.0 b	12.0 a	40.0 a	2.0 de	0.0	2.0
Blitox 3 lb.	40.8 cd	20.3 a	15.3 b	4.0 bcde	0.0	0.0
Delan 1 lb.	42.0 bc	11.0 a	13.0 b	8.0 abcd	5.0	4.0
Control	76.5 a	9.6 a	5.0 b	2.0 cde	59.4	0.0

[1] Includes Penicillium sp., S. sclerotiorum, spotted wilt and bacteria.

[2] Small letters indicate Duncan's Multiple Range grouping of treatments which do not differ significantly at the 5% level.

The dominant causes of rots of stored tomatoes were Colletotrichum coccodes (Wallr.) Hughes, Alternaria tenuis Nees, B. cinerea and P. infestans. Microorganisms of lesser importance were Penicillium spp., Phoma destructiva Plowr., S. sclerotiorum, spotted wilt and bacteria.

Thiram combined with the higher rates of maneb or tank-mix zineb gave the most consistent control of rots (Tables 2 and 3). This agrees with the results obtained previously (2). The alternating program of ziram and bordeaux resulted in a high incidence of Alternaria rots in the second picking (Table 3). Blitox was unsatisfactory for the control of anthracnose. Botrytis rots increased when zineb and maneb were used alone, agreeing with the field results.

Recommendations

As a result of these tests growers in Nova Scotia are advised to use a fungicide mixture, made up of either maneb or zineb at 1 lb to 100 gal (Imp.) plus 1 lb of thiram as a field spray for the control of tomato diseases, Dyrene at 1 3/4 lb can be used in place of thiram. When weather conditions favor a severe outbreak of either late blight or gray mold the amount of each fungicide should be increased to 2 lb. If fruit is to be harvested in the mature-green state for storage there would be some advantage in using tank-mix zineb instead of factory-mixes.

Literature Cited

1. HARRISON, K.A. 1961. The control of late blight and gray mold in tomatoes in Nova Scotia. Can, Plant Dis. Survey 41:175-178.
2. LOCKHART, C. L. and K. A. HARRISON, 1962. The control of storage rots of mature-green tomatoes in Nova Scotia. Can. Plant Dis. Survey 42:107-110.

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