A COMPARISON OF TWO SYSTEMIC FUNGICIDES WITH NON-SYSTEMICS FOR CONTROL OF FRUIT ROT AND POWDERY MILDEW IN STRAWBERRIES

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Abstract

Fungicide 1991 (Du Pont), a systrmic fungicide, proved as effectivr as thr nonsystemics captan, dichlofluanid and DAC 2787 for preharvrst control of gray mold and powdery mildew fruit rot in 'Northwest' strawberries. Another systemic, Bay 33172, and Du-Ter, a nonsystemic, gave poor control. The addition of dimethyl sulfoxide to captan did not affect the efficacy of the fungicide. Both systemic fungicides proved less effective than the nonsystemics for the control of postharvest rot. Bay 33172 was the least effective of the fungicides. Fungicide 1991 proved more effective than sulfur for the control of powdery mildew on strawberry foliage and provided effective control of postharvest mildew up to 8 weeks beyond the last spray. The same result was obtained whether 5 or 7 sprays were applied. Bay 33172 proved ineffective for powdery mildew control.

Introduction

In a previous study, Fungicide 1991 (1-butylcarbamoyl)-2-benzimidazole carbamic acid, methyl ester), a systemic fungicide, showed considerable promise for the control of gray mold caused by Botrytis cinerea Pers. ex Fr., andpowdery mildew caused by Sphaerotheca macularis (Wallr. ex Fr.) Magn. in strawberries and raspberries (2).

Experiments were conducted in 1968 with strawberries to gain additional information on the efficacy of Fungicide 1991; to evaluate the systemic fungicide Bay 33172 [2(2-furyl)-benzimidazole] and the nonsystemic Du-Ter (triphenyltinhydroxide) for the control of fruit rot and powdery mildew in comparison with the nonsystemics captan, dichlofluanid, DAC 2787 (tetrachlorisophthalonitrile) and sulfur: and to determine whether the addition of dimethyl sulfoxide to captan would increase the efficacy of this fungicide.

Methods

Preharvest and postharvest fruit rot

Abbotsford trial - Fungicide 1991[3] and Bay 33172 were compared with captan, DAC 2787, and dichlofluanid for control of fruit rot at the Small Fruits Substation, Abbotsford. A 2-year-old planting of 'Northwest' strawberries was used in this trial. Dimethyl sulfoxide (DMSO) was also used with captan to determine its effect on the efficacy of the fungicide. DMSO is a good solvent for many chemicals, and it apparently aids in their absorption and translocation in plants (4). The treatment rates and times of application are listed in Table 1. The experiment was laid out in a randomized block design with six replicates. Each plot consisted of a single 30-foot row. The plots were grown by the matted row system.

The crop was picked four times between June 26 and July 9. Control of preharvest infection was determined by weighing infected, marketable, and cull fruit from each plot. The size index of sound fruit from each plot was determined at each picking. The effect of treatment on postharvest fruit rot was determined from a random sample of at least 4 lb of sound berries picked on June 27, July 2, and July 9 from each plot in each replicate. The berry samples were placed in common storage at Agassiz and the percentage of sound berries was recorded 24 and 48 hr after harvest.

Vancouver trial - A trial was conducted at the Vancouver Research Station to compare Fungicide 1991 and Bay 33172 with captan and Du-Ter for the control of preharvest fruit rot. The experiment was laid out in a completely randomized design with four replicates. A plot consisted of a single 10-ft row with plants grown by the matted row system. Fungicide 1991 at 0.25 lb active ingredient/acre, Bay 33172 at 0.5 lb active ingredient/acre, captan at

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3 Fungicide 1991 was supplied by Dupont of Canada Ltd.; Bay 33172, by Chemagro Ltd., Toronto: Du-Ter, by Green Cross Products, Montreal: and DAC 2787, by Diamond Alkali Canada Ltd., Toronto. Fungicide 1991 is now known by the trade name Benlate and the active ingredient by the common name benomyl.

Table 1. Influence of systemic and nonsystemic fungicides on preharvest and postharvest fruit rot of 'Northwest' strawberries

Fungicide	Rate (lb active ingredient/ acre)	Number of sprays*	Rotted fruit (lb/plot)	Sound fruit (lb/plot)	Increase over unsprayed (%)	Sound fruit (%) *** after picking: 24 hr	48 hr
Unsprayed		0	6.3 a**	26.7 e	0	90.5	49.4
Fungicide 1991	0.25	5	3.1 bc	35.4 ab	33	93.8	64.7
Fungicide 1991	0.25	7	3.8 b	35.9 ab	35	94.0	65.4
Bay 33172	0.5	5	5.7 a	32.6 bcd	22	92.4	57.5
Bay 33172	0.5	7	3.6 b	29.8 cde	12	92.1	58.4
Dichlofluanid	1.0	5	2.3 c	35.8 ab	34	97.2	74.2
Dichlofluanid	1.0	7	2.2 c	38.3 a	44	96.4	79.8
DAC 2787	1.5	5	2.3 c	33.7 abc	26	97.2	70.7
DAC 2187	1.5	7	2.5 bc	34.2 abc	28	97.4	78.3
Captan	1.5	5	2.8 bc	37.4 ab	40	95.8	74.6
Captan	1.5	7	3.4 bc	37.2 ab	39	96.3	81.0
Captan + 4% DMSO	1.5	5	3.5 bc	34.2 abc	28	94.5	67.6
Captan + 4% DMSO	1.5	7	2.8 bc	35.3 ab	33	97.0	84.6
Mean			3.4	34.4		95.0	69.7
S.E. Mean			0.42	1.45			

* Fungicide sprays were applied on May 8 (first bloom), May 17 (about full bloom), May 27, June 6 and June 17 (last spray before harvest). Plants receiving seven applications were also sprayed on June 27 and July 5.

** Means not followed by the same letter are significantly different at the 5% level (Duncan's Multiple Range Test).

*** Mean of three harvests.

1.5 lb active ingredient/acre, and Du-Ter at 0.75 lb active ingredient/acre were applied May 21 and 31, June 10 and 21, and July 1. The crop was picked seven times between June 13 and July 5. The number and weight of sound fruit was recorded at each picking. In addition, the amount of berry infection was determined by counting the number of berries affected by botrytis rot and powdery mildew. These figures were converted to a percentage of the total number of berries. Percentages were transformed for statistical analysis. The size index was determined on the entire harvest.

Postharvest powdery mildew

Fungicide 1991 and Bay 33172 were compared with sulfur (Magnetic 6) for the control of postharvest powdery mildew in a field test at the Small Fruits Substation, Abbotsford. A 2-year-old planting of 'Northwest' strawberries was used in this trial. The experiment was laid out in a randomized block design with three replicates. Each plot consisted of a single 30-foot row.

Preharvest treatments were applied five or seven times for mildew and gray mold control. followed by either four postharvest treatments for mildew control or no treatment. Preharvest applications were made on May 8, 17, and 21, June 6 and 17 (five sprays), and on June 27 and July 5 (seven sprays). Postharvest treatments were applied August 8 and 22, and September 5 and 19. Fungicide 1991 was applied at a rate of 0.25 lb active ingredient/acre and Bay 33172 at 0.5 lb active ingredient/acre and sulfur at 3.6 lb active ingredient/acre.

A random sample of 20 leaves was collected from each plot in each replicate on August 14 and 28 and September 11 and 27 to determine the percentage of mildew infection. The total area of mildew infection on each leaf was determined as a percentage, which was averaged for each replicate. Percentages were transformed for statistical analysis.

Table 2. Influence of Fungicide 1991, Bay 33172, captan, and Du-Ter on preharvest fruit rot of 'Northwest' strawberries

Fungicide	Rate (lb active ingredient/ acre*)	Rotted fruit rating**:	Sound fruit (lb/plot)	Increase over unsprayed (%)
Unsprayed		26.0 a***	6.98 b	0
Fungicide 1991	0.25	9.9 b	10.87 a	56
Bay 33172	0.50	27.3 a	8.60 ab	23
Captan	1.5	12.2 b	10.74 a	54
Du-Ter	0.75	26.1 a	8.64 ab	24
Mean		20.3	9.16	
S.E. Mean		1.60	0.93	

* Sprays were applied on May 21 and 31, June 10 and 21, and July 1.

** Arcsine transformations of mean percentages.

*** Means not followed by the same letter are significantly different at the 5% level (Duncan's Multiple Range Test).

Results and discussion

From the results of both the Abbotsford and Vancouver trials, Fungicide 1991 proved as effective as captan, dichlofluanid, and DAC 2787 for preharvest control of fruit rot (Tables 1 and 2). Similar results were obtained in 1967 at Abbotsford with raspberries *(2)*. Bay 33172 and Du-Ter both gave a low level of control. The addition of DMSO to captan did not affect the efficacy of the fungicide. Helton and Kochan (3), working with cytospora canker disease of prune trees, found that the effects of DMSO vary widely, sometimes enhancing the therapeutic effect of accompanying fungicides and sometimes aggravating the disease. Fruit size was not affected significantly by treatment, although there was a slight trend for fruit from plots sprayed with dichlofluanid and Bay 33172 to be smaller than fruit from other plots. In previous tests, dichlofluanid has caused a significant reduction in fruit size of both strawberries and raspberries (1, 2).

Five sprays appeared as effective as seven sprays for preharvest fruit rot control. Seven sprays, especially of the nonsystemics, gave added protection against postharvest rot.

Within 48 hours after picking approximately half of the unsprayedberries had rotted (Table 1). Both of the systemic fungicides proved less effective than the nonsystemics for the control of postharvest rot. Bay 33172 was the least effective. In 1967, Fungicide 1991 tended to be more effective for postharvest fruit rot control in raspberries than either captan, dichlofluanidor DAC 2787 (2). Perhaps Fungicide 1991 is absorbed and translocated more efficiently in the raspberry plant because of relatively large cane area.

Fungicide 1991 proved more effective than sulfur for the control of powdery mildew on strawberry foliage (Table 3). In previously unsprayed plots two sprays of Fungicide 1991 applied August 8 and 22 significantly reduced the mildew. To obtain comparable control with sulfur, a third spray was necessary on September 5. Similarly, in 1967 sulfur

Table 3. Influence of Fungicide 1991, Bay 33172, and sulfur on control of powdery mildew on 'Northwest' strawberries

Fungicide	Rate (lb active ingredient/ acre)	Number of sprays* FR	PM	Powdery mildew rating** on: Aug 14	Aug 28	Sept 11	Sept 27
Unsprayed		0	0	44.9 ab***	54.5 ab	52.1 abc	47.9 ab
Fungicide 1991	0.25	5	4	22.2 e	18.1 e	16.4 f	17.8 d
Fungicide 1991	0.25	5	0	27.9 cde	40.5 bcd	42.8 bcde	48.0 ab
Fungicide 1991	0.25	7	4	25.1 cde	21.7 e	19.4 f	12.6 d
Fungicide 1991	0.25	7	0	24.5 de	38.3 cd	39.3 cde	47.2 ab
Fungicide 1991	0.25	0	4	37.5 abcd	29.7 de	19.4 f	15.1 d
Bay 33172	0.5	5	4	35.0 bcde	57.3 a	36.5 de	36.9 bc
Bay 33172	0.5	5	0	48.6 ab	57.6 a	57.6 a	54.6 a
Bay 33172	0.5	7	4	37.8 abcd	46.7 abc	40.7 cde	42.5 ab
Bay 33172	0.5	7	0	49.3 ab	51.3 abc	56.3 ab	49.0 ab
Bay 33172	0.5	0	4	50.6 a	53.5 abc	43.7 abcd	37.4 bc
Sulfur	3.6	0	4	39.5 abc	42.8 abcd	28.4 ef	26.2 cd
Mean				36.9	42.7	37.7	36.3
S.E. Mean				4.51	4.68	4.43	4.40

* FR = fruit rot sprays; PM = powdery mildew sprays

FR sprays were applied on May 8 (first bloom), May 17 (about full bloom), May 27, June 6, June 17 (last spray before harvest), June 27 and July 5. PM sprays were applied on August 8 and 22, and September 5 and 19.

** Arcsine transformations of mean percentages of leaf surface affected.

*** Means not followed by the same letter (within column) are significantly different at the 5% level (Duncan's Multiple Range Test).

was found to be less effective than Fungicide 1991 for mildew control in strawberries (2). In 1968, applications of Fungicide 1991 for fruit rot control also provided effective control of postharvest mildew infection up to 8 weeks after spraying had ceased. This was equally true whether 5 or 7 sprays had been applied. Bay 33172 proved ineffective for powdery mildew control.

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