any tree of a cultivar, assuming that if one tree blighted to a certain degree, other trees of this cultivar have an inherent potential of being as susceptible under the same environmental conditions.

While ratings were made in a single orchard, some trees of the same cultivars but of different ages in neighboring plantings showed greater or less susceptibility than reported here. For example, in this study, 'Magness' scored 9, whereas in a nearby orchard, unusual trunk blight killed several trees (14). On the other hand, 'Maxine' scored 4 in this collection but no lower than 8 in a nearby orchard. This illustrates that the severity of blight damage in a particular cultivar can vary between plantings and tree ages.

Estimating the degree of resistance of a given cultivar on the basis of a single set of growing conditions may seem to be inconsistent, as some of the trees in our low resistance classes (scores 1 to 5), grown in a less severe fire blight environment or where control measures are practiced, suffered less damage. This is illustrated in a planting at Wooster, Ohio, where the use of streptomycin sprays, 'Old Home' interstocks, and the removal of blighted branches substantially reduced the amount of blight damage in many of these cultivars (10). The fact remains that trees grown at Beltsville sustained the amount of damage corresponding to their assigned scores, which should reflect their inherent susceptibility to the disease where conditions are highly favorable for infection.

The scores for cultivars in the moderate and highly resistant classes (scores 6 to 9) may not be a final assessment of their inherent resistance, for the possibility exists that with further progression of the disease some revision to lower scores may be forthcoming. However, the fact that the trees were able to withstand blight conditions that killed or severely damaged trees of many other cultivars, might indicate that they have a higher degree of resistance. Further observations will be required to verify this.

According to Table 1, none of the major pear cultivars grown in the United States and Europe have a high degree of blight resistance. Prior to 1957, Europe was free from fire blight, but in recent years the disease has been reported from various parts of Western Europe (13). As most of the cultivars grown there are also highly susceptible, fire blight may become a serious threat to the European pear industry. Although none of the cultivars that withstood the epiphytotic blight conditions at Beltsville are important commercial cultivars, some have fairly good quality attributes and may be promising sources of genes for future breeding work.

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Thiabendazole Control of Postharvest Apple Decay[1]

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Abstract. **2-(4-Thiazolyl) benzimidazole (thiabendazole or TBZ) applied as a postharvest treatment (1000-2000 ppm) significantly reduced decay of apples: intact (not skin punctured); skin punctured before or after TBZ treatment; mechanically harvested; waxed after TBZ treatment. TBZ was active against *Penicillium expansum*, *Botrytis* sp., but not *Alternaria* sp. New skin punctures were more susceptible to infection than old punctures.**

[1]Received for publication June 29, 1970. This research was supported by USDA NEM-33 funds and a grant from Merck and Company, Incorporated.

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The adoption of 30-32°F refrigerated storage greatly dimished the incidence of decay in stored apples in New York. Controlled atmosphere storage limited these losses to even lower levels by reducing the volume of ripe apples late in the storage season. Verbal reports received from several New York apple storage operators indicated that the introduction of 2 new handling practices may have reversed this trend. Dipping of apples into water tanks to apply storage scald inhibitors and to unload bulk boxes for grading, exposes skin punctures to inoculum washed from apples (1, 3) also mechanical harvesting substantially increases the incidence and the size of skin punctures in many instances.

We have published elsewhere on the relationship between level of inoculum, conc of TBZ, infection of punctured 'McIntosh' apples (2), and the relationship between duration of storage and infectivity (1). In this paper we report on experiments which were conducted to evaluate the performance of TBZ under partially simulated commercial conditions.

Inoculum of *Penicillium expansum*, *Botrytis* sp. and *Alternaria* sp. was obtained from decayed apples, single spored and then grown on potato-dextrose agar to furnish the spores used for subsequent inoculation. At the time of treatment the spores were harvested, suspended in water and counted with a haemocytemeter. Aliquots of the concd spore suspension were then added to the dip tank to obtain the levels of inoculum indicated in the text and tables. These levels of inoculum fell within the range of inoculum levels observed in commercial water tanks used to unload bulk boxes of apples (1).

TBZ was obtained from Merck and Company, Incorporated, Rahway, New Jersey. Calcium hypochlorite was used as the source of chlorine, another fungicide included in some experiments.

In experiments 1, 2, 4, 5, 8 and #9 apples were punctured with a nail to a depth of 1/8 inch. The nail was washed in water and then alcohol after 10 punctures. The apples were placed into a wire basket and dipped into the 25 gal capacity dip tank for ca. 15 sec. After treatment the apples were held in perforated poly bags at 70°F, except as noted.

The data were subjected to analysis of variance and treatment means were compared using Duncan's Multiple Range Test and Studentized Ranges (5% level). The term "commercial control of decay", used several times in this paper, means less than 5% decay.

TBZ awaits approval by the U. S. Food and Drug Administration for use on apple fruits.

Experiment 1. We previously reported (3) a marked reduction in decay of apples if there were 1 or 2 weeks between puncturing the skin and exposure to inoculum in a dip tank. At harvest 1969 'McIntosh' were composited into 7 lots. Apples were removed from storage, punctured and returned to storage on October 10, December 11, January 22, February 19, March 5 and 12. On March 19 the last lot was punctured, and sound, punctured fruit in all 7 lots were exposed to *Penicillium* inoculum (5,000 spores/ml) and held for 1 week at 70°F. Decay (%) was 100, 92, 50, 55, 47, 36 and 34 for the shortest through the longest period between puncture and exposure to inoculum. A delay of 2 weeks greatly reduced subsequent decay, but delays of more than 2 weeks did not appreciably further reduce decay. Although a short time period in storage may reduce the susceptibility to infection of skin punctures inflicted at harvest, the reduction is insufficient for the fruit grower who uses a water tank to unload bulk boxes of apples for grading. Other, more effective, control measures are needed.

Experiment 2. Many apple storage operators use recirculation flood-applicators to apply storage scald inhibiting materials to harvested apples before the fruit is placed into storage. This procedure was simulated for the application of TBZ to harvested 'McIntosh' apples. *Penicillium* spores and TBZ were added to the water in the 150 gal capacity reservoir tank. The solution was pumped (110 gal/min) over a box of punctured apples and returned by gravity to the reservoir. Single boxes of apples received the entire pump discharge for the durations of time shown in Table 1. TBZ significantly influenced subsequent decay of treated apples, but duration of application did not.

Table 1. Decay caused by *Penicillium* + *Botrytis* infection of punctured 'McIntosh' apples exposed to *Penicillium* inoculum (5,000 spores/ml) and flood treated with TBZ. Decay counts taken after 10 days at 70°F, December 1969.

TBZ conc (ppm)	Decay (%)[z] Duration of application (sec) 1	3	5	Avg
0	92	91	89	91 a
500	41	27	44	37 b
1000	28	26	19	24 c
2000	15	12	15	14 d
Avg	44 a	39 a	42 a	

[z]Avg for duration of application and TBZ conc followed by different letters are significantly different at the 5% level.

Table 2. Post-storage decay of 'Rhode Island Greening' apples exposed to *Penicillium* inoculum (10,000 spores/ml) and treated with TBZ before storage at 38°F, March 1969.

TBZ conc (ppm)	Decay (%)[z] Removed from storage	After storage + 12 days at 70°F
	Punctured	
0	98 a	100 a
500	6 bc	21 b
1000	3 cd	19 b
	Intact	
0	9 b	14 bc
500	2 cd	8 cd
1000	1 d	3 d

[z]Percentages in the same column followed by different letters are significantly different at the 5% level.

Experiment 3. When apples are handled in bulk boxes there are 2 points in the harvesting, handling, storage and packing operations at which skin puncturing frequently occurs: when the fruit is harvested and when it is dumped in consumer polythylene bags. To test the effectiveness of TBZ in controlling decay of punctures inflicted during the bagging operation, 'McIntosh' apples were dip treated with TBZ (1000 ppm), dried and then punctured with the stems of other similar apples. After 2 weeks of 70°F, 45% of the control and 8% of the TBZ treated apples were decayed.

Experiment 4. Many Northeastern packinghouses have recently incorporated apple waxers in the packing line. We reported that waxing did not appear to significantly influence the decay of apples (3). In experiment 4, TBZ was added to water samples taken from a commercial apple dump tank. Freshly punctured 'McIntosh' apples were dip-treated for 15 sec in the water samples, then waxed and dried under commercial conditions in the packinghouse. After 7 days at room temperature the average decay of 0, 500, 1000 and 2000 ppm TBZ was 83%, 24%, 19% and 5% respectively. All treatment averages were significantly different.

Experiment 5. In this experiment a comparison was made of effectiveness of TBZ in controlling decay of punctured and intact fruits. Harvested 'R.I. Greening' apples were divided into 2 lots before storage. One lot was punctured with a nail. The apples were then exposed to *Penicillium* inoculum, treated with TBZ, and placed into 38°F refrigerated air storage until March. Post-storage examination of the fruit showed skin puncturing significantly increased decay of fruit not treated with TBZ. TBZ (1000 ppm) significantly decreased decay of both punctured and intact fruits (Table 2).

Table 3. Decay of 'McIntosh' apples mechanically harvested, treated and stored on September 27, 1968.

Decay	Decay (%)[z] Air control	TBZ (ppm) 500	1000	2000
		Common storage until December		
Total	69 a	43 b	42 b	42 b
		Refrigerated storage until February		
Penicillium + Botrytis	65 a	17 b	12 bc	2 c
Other decay	2 a	10 b	9 b	8 b
Total	67 a	27 b	21 bc	10 c

[z]Percentages in the same row followed by different letters are significantly different at the 5% level.

Experiment 6. 'McIntosh' apples were mechanically harvested, treated and placed into 2 storage rooms in 1968. One storage room was held at 32°F (refrigerated storage); the other storage room (common storage) was insulated but was not refrigerated. Decay counts were obtained immediately upon removal from common storage in December. TBZ significantly reduced decay, but commercial decay control was not obtained (Table 3). When apples were removed from refrigerated storage in February, decay counts revealed TBZ treatment at 2000 ppm resulted in commercial control of *Penicillium* and *Botrytis* rot, but it did not control other decay organisms, primarily *Alternaria*. These data also show that when *Penicillium* and *Botrytis* are controlled the incidence of infection by other pathogens appears to increase.

Experiment 7. In 1969 mechanically harvested 'McIntosh' apples were again treated and stored in both common and refrigerated storage. Treatments included 2 conc of TBZ used with and without chlorine. The common storage apples were again evaluated immediately after removal from storage in December. Chlorine, when used alone or in combination with TBZ, resulted in significantly less total decay than the TBZ treatment without chlorine (Table 4). Chlorine treatment did not significantly reduce decay in refrigerated storage, where there was not an appreciable amount of infection by pathogens other than *Penicillium* and *Botrytis*.

The data presented in Tables 3 and 4 indicate a program for decay control of mechanically harvested 'McIntosh' must include refrigerated storage as well as application of effective fungicide(s).

Experiment 8 and 9. Data from experiments 6 and 7 indicated that TBZ was effective against *Penicillium* and *Botrytis* but not against *Alternaria*. This observation was confirmed by the data obtained in experiment 8 with 'Cortland' and experiment 9 with 'Melba' (Table 5). Although chlorine appeared to be active against *Alternaria* a higher conc of chlorine or a more effective fungicide is needed for commercial control.

Table 4. Decay of 'McIntosh' apples mechanically harvested, treated and stored on September 29, 1969.

Treatment	Conc (ppm)	Decay (%)[z] Common storage until Dec. 8: *Penicillium* + *Botrytis* rot	Other rot	Total rot	32°F air storage until Jan. 5: *Penicillium* + *Botrytis* rot	Other rot	Total rot
Air control	---	35 a	24 a	60 a	20 a	3 a	22 a
Cl_2	600	11 b	6 b	17 c	9 b	3 a	12 b
TBZ	1000	9 b	22 a	31 b	1 c	3 a	3 c
TBZ	2000	5 c	24 a	29 b	1 c	3 a	3 c
TBZ + Cl_2	1000 600	5 c	9 b	14 c	1 c	2 a	3 c
TBZ + Cl_2	2000 600	2 c	12 b	14 c	1 c	3 a	4 c

[z]Percentages in the same column followed by different letters are significantly different at the 5% level.

Table 5. Decay of apples exposed to inocula, treated with fungicides and then held at room temperature for 14 days.

Inoculum	Fungicide	Conc (ppm)	Decay[z] (%)
	'Cortland' - May 1969		
500 *Penicillium* spores/ml	---	0	95 a
	TBZ	500	36 b
	TBZ	1000	11 c
	TBZ	2000	5 c
500 *Botrytis* spores/ml	---	0	95 a
	TBZ	500	23 b
	TBZ	1000	12 b
	TBZ	2000	10 b
500 *Alternaria* spores/ml	---	0	19 a
	TBZ	500	20 a
	TBZ	1000	11 a
	TBZ	2000	6 b
	'Melba' - August 1969		
10,000 *Alternaria* spores/ml	---	0	44 a
	TBZ	1000	33 a
	TBZ	2000	30 a
	TBZ	10,000	40 a
	Cl_2	400	7 b
	Cl_2	600	6 b

[z]Percentages in each group followed by different letters are significantly different at the 5% level.

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Replant Problem in Quartz Sand[1]

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Abstract. **Thoroughly washed quartz sand previously used in culture experiments inhibited seed germination and growth of apple seedlings and grafts. The addition of potassium did not overcome this problem. Black currant germination was unaffected and growth was stimulated by washed used sand.**

Used sand may accumulate in a research station, if large scale sand culture experiments are carried out over a no. of years. Can it be used again?

"Used" quartz sand of 0.7 – 1.2 mm particle size in which apple trees had been grown for 3 years (1) and "new" sand of equal grain size were compared in a series of experiments. One hundred seeds of 'Transparent Blanche' ('Weißer Klar') apples were planted into the used sand that had been thoroughly washed with warm water as well as new sand to compare the % germination in the 2 substrates. After formation of the 5-6th leaf the seedlings grown in the new sand were transplanted into 7 l

[1]Received for publication May 7, 1970.

[2]The cooperation of Dr. A. Karnatz in providing the data on the germination of apple and black currant seeds is gratefully acknowledged.