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TOLERANCE OF TOMATOES TO METHYL BROMIDE FUMIGATION

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INTRODUCTION

In 1940 a treatment designed to destroy the Mediterranean fruit fly and the melon fly in a number of fruits and vegetables, including tomato, was approved for the shipment of these as fresh commodities to the Mainland. This treatment consisted of fumigation with methyl bromide at a dosage of 2 pounds per 1,000 cubic feet for $3\frac{1}{2}$ hours at a minimum temperature of 80° F. (1). After the discovery of the Oriental fruit fly in Hawaii several years ago, certification of this treatment was rescinded for exported commodities. Search for a satisfactory treatment that would destroy this new fruit fly in addition to the other fruit flies without damaging the tomato was instituted. This involved the use of many different treatments. One treatment that appears promising was developed from these studies. It is the purpose of this paper to present data on the tolerance of different varieties of tomatoes to this treatment which as yet has not been approved for tomatoes to be exported.

GENERAL PROCEDURE

The tomatoes were obtained from various sources and treated in the laboratory of the Investigations of Fruit Flies in Hawaii, Entomology Research Division, Agricultural Research Service, United States Department of Agriculture. After treatment they were stored under simulated shipping conditions and examined in the laboratory of the Department of Plant Physiology.

* Formerly known as *Progress Notes*.

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RELATION OF SURFACE INJURY TO STORAGE DECAY

In initial experiments, known and unknown varieties of tomatoes were obtained from the local market and treated with methyl bromide at various dosages and exposures. Results of these tests indicated extreme variations in tolerance to the fumigant as determined by storage decay incidence.¹ It seemed that these variations were caused by the differences in the degree of surface injury on the fruits.

In the next series of experiments, an attempt was made to correlate the degree of surface injury in fresh fruits to the degree of storage decay after fumigation. Known varieties from the collection of the Vegetable Crops Department were used. The lots consisted of freshly harvested mature-green to $\frac{1}{2}$ -ripe fruits when fumigated. A record of the number of fruits with growth cracks (cracked and ringed fruits) was kept for each variety. By "cracked" fruit is meant a fruit with radial splits on the stem end portion of the fruit. By "ringed" fruit is meant a fruit with concentric rings on the epidermal surface on the stem end portion of the fruit.

Tomatoes were fumigated with methyl bromide at a dosage of 2 pounds per 1,000 cubic feet for 3 and $3\frac{1}{2}$ hours at 70° F. The fumigated fruits were then stored at either 50° F. for 6 days or at 50° F. for 3 days, then at 45° F. for 3 additional days to simulate shipping conditions. After cold storage, the fruits were removed to room temperature and examined at intervals for a period of 7 days. In table 1 are recorded the results of a representative experiment, and the results of another are recorded in table 2.

According to tables 1 and 2, considerable differences in the percentage of cracked or ringed fruits among the three lots of the same varieties existed. However, regardless of exposure time all methyl bromide-treated fruits which were either cracked or ringed developed storage decay. Additional decay was caused by stem ends that failed to heal normally. The decay lesions appeared on the injured areas only. Un-injured fruits were not affected by the treatment. The number of fruits with "unhealed stem end" could not be determined until after the storage period. Therefore, final decay percentage in the treated lots minus the percentage of cracked or ringed fruits gives the percentage of fruits with unhealed stem ends. In all cases, surface injuries did not cause unfumigated fruits to decay.

Valid comparisons in tolerance between the 3- and $3\frac{1}{2}$ -hour exposures to methyl bromide for any variety could not be made because of the variable number of surface-injured fruits in the different lots (tables 1 and 2). For the same reason, comparisons between varieties could not be made.

¹Organisms causing the decay appear to be *Alternaria* sp. and *Penicillium* sp.

TABLE 1. Relation of surface injury to storage decay of tomatoes fumigated with methyl bromide (2 pounds per 1,000 cubic feet at 70° F.)

Variety	Methyl bromide exposure (hrs.)	Cracked or ringed fruits (%)	Decay (%) at room temperature after cold storage*			Decay area
			0 days	3 days	7 days	
Anahu	0	20	0	0	0	None
	3	30	0	90	90	Ringed or unhealed stem end
	3½	40	0	40	40	Cracked or ringed
Rutgers	0	50	0	0	0	None
	3	70	30	80	80	Cracked, ringed, or unhealed stem end
	3½	80	20	80	80	Cracked or ringed
6444	0	100	0	0	0	None
	3	90	40	90	90	Cracked or ringed
	3½	80	0	100	100	Cracked, ringed, or unhealed stem end
6540	0	25	0	0	0	None
	3	25	0	83	83	Cracked, ringed, or unhealed stem end
	3½	42	8	92	100	Ringed or unhealed stem end
N-5	0	60	0	0	0	None
	3	60	40	80	100	Cracked, ringed, or unhealed stem end
	3½	70	30	60	70	Cracked or ringed
N-11	0	80	0	0	0	None
	3	80	20	80	90	Cracked, ringed, or unhealed stem end
	3½	40	40	70	70	Cracked, ringed, or unhealed stem end
N-31	0	70	0	0	0	None
	3	40	30	80	80	Cracked or unhealed stem end
	3½	50	10	90	90	Cracked, ringed, or unhealed stem end
Step 278	0	70	0	0	0	None
	3	80	20	80	80	Cracked or ringed.
	3½	60	10	90	90	Cracked or unhealed stem end
Step 280	0	60	0	0	0	None
	3	70	50	60	70	Cracked or ringed
	3½	30	20	30	30	Cracked or ringed
Step 305	0	50	0	0	0	None
	3	60	0	60	60	Cracked or ringed
	3½	50	0	70	70	Cracked, ringed, or unhealed stem end

*At 50° F. for 6 days.

TABLE 2. Relationships between number of surface-injured fruits and storage decay incidence in tomatoes treated with methyl bromide (2 pounds per 1,000 cubic feet at 70° F.)

Variety	Methyl bromide exposure (hrs.)	Cracked or ringed fruits (%)	Decay (%) at room temperature after cold storage*		Decay area
			1 day	7 days	
Anahu	0	0	0	0	None
	3	0	30	70	Unhealed stem end
	3½	20	60	100	Cracked, ringed, or unhealed stem end
Rutgers	0	10	0	0	None
	3	10	50	50	Cracked or unhealed stem end
	3½	0	50	90	Unhealed stem end
6444	0	30	0	0	None
	3	30	40	90	Cracked, ringed, or unhealed stem end
	3½	20	20	90	Cracked, ringed, or unhealed stem end
6540	0	0	0	0	None
	3	8	42	50	Ringed or unhealed stem end
	3½	0	67	83	Unhealed stem end
N-5	0	10	0	0	None
	3	0	20	40	Unhealed stem end
	3½	30	30	50	Cracked or unhealed stem end
N-11	0	30	0	0	None
	3	30	40	70	Cracked, ringed, or unhealed stem end
	3½	10	50	60	Unhealed stem end
N-31	0	20	0	0	None
	3	50	40	100	Cracked, ringed, or unhealed stem end
	3½	10	30	40	Cracked, ringed, or unhealed stem end
Step 278	0	80	0	0	None
	3	50	40	50	Cracked
	3½	20	70	80	Cracked or unhealed stem end
Step 305	0	40	0	0	None
	3	10	10	10	Ringed
	3½	20	30	60	Ringed or unhealed stem end

*At 50° F. for 3 days, then at 45° F. for 3 additional days.

TABLE 2. *Continued*

Variety	Methyl bromide exposure (hrs.)	Cracked or ringed fruits (%)	Decay (%) at room temperature after cold storage*		Decay area
			1 day	7 days	
Step 281	0	33	0	0	None
	3	22	44	67	Cracked or unhealed stem end
	3½	11	44	56	Cracked or unhealed stem end
Step 311	0	33	0	0	None
	3	22	44	44	Cracked, ringed, or unhealed stem end
	3½	0	44	56	Unhealed stem end

*At 50° F. for 3 days, then at 45° F. for 3 additional days.

FUMIGATION OF SOUND FRUITS

In the next series of experiments, only selected sound mature-green and ¼-ripe fruits were employed. Fruits were harvested from the fields of the Vegetable Crops Department. Care was exercised in the picking process in order to avoid injury to the stem end. Fruits were treated with methyl bromide at a dosage of 2 pounds per 1,000 cubic feet for 3½ hours at 70° F. After fumigation they were stored at 55° F. for 7 days, followed by storage at room temperature for 7 days. Because of the similarity in the results obtained in the experiments, the data were combined for presentation in table 3.

The results recorded in table 3 show that sound fruits did not decay as a result of the fumigation. However, in most varieties the coloring was retarded by the treatment. Jones made similar observations (1). Some developed blotchy coloring. Varieties Kauai, Lanai, and Big Boy were probably not affected by the treatment (table 3).

TABLE 3. Tolerance of selected sound mature green and $\frac{1}{4}$ -ripe tomatoes to methyl bromide fumigation (2 pounds, $3\frac{1}{2}$ hours, 70° F.)

Variety	No. of fruits treated	Decay percentage		Remarks (treated as compared with control fruits)
		Treated	Control	
Manalucie	43	0	0	Retarded coloring
Maui	38	0	0	Retarded and blotchy coloring
Kauai	20	0	0	Normal
Rutgers	50	0	0	Retarded coloring
Oahu	20	0	0	Retarded coloring
Niihau	22	0	0	Retarded and blotchy coloring
Hawaii	26	0	0	Retarded coloring
Lanai	11	0	0	Normal
Big Boy	16	0	0	Normal
Anahu	43	0	0	Retarded coloring
6449	44	0	0	Retarded coloring

DISCUSSION AND RECOMMENDATIONS

It should be reiterated that the methyl bromide fumigation treatments employed in these studies are not as yet certified treatments for the control of Oriental fruit fly and therefore cannot be recommended at this time. Should any of these treatments be approved for the export trade, the following discussion and recommendations will be appropriate.

The experimental results presented here indicate the importance of selecting only sound fruits for fumigation. Cracked and ringed fruits do not tolerate the treatment. Stem ends that fail to heal normally are also focal points of decay after fumigation. Apparently sound tomatoes can tolerate $3\frac{1}{2}$ -hour exposure to methyl bromide at a dosage of 2 pounds at 70° F.

Growth cracks are known to be caused by various cultural factors. However, only varieties with low tendency to crack and ring should be planted for the export trade. Limited data presented here do not indicate the varietal differences in this respect.

The ease with which the stem end heals after the fruit is harvested may be a varietal characteristic; however, care should be exercised in order to prevent undue peeling of epidermis in the stem end zone in the picking process. Undue damage in this area may cause failure of the stem end to heal properly. Perhaps leaving a portion of the fruit stem attached to the fruit may alleviate the damage.

Since surface-injured tomatoes do not tolerate the treatment and since these fruits will be eliminated in the grading process anyhow, only sound fruits should be fumigated.

Since in most varieties there is retardation in color development due to the treatment, mature-green fruits should not be used. Perhaps only pink-colored fruits should be used.

Limited tests reported herein do not definitely indicate varieties which are completely tolerant to the treatment. However, it seems that varieties Kauai, Lanai, and Big Boy are more tolerant than the others.

A shipping temperature to 55° F. is considered to be desirable for tomatoes (2).

LITERATURE CITED

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