EFFECT OF PLANT TEMPERATURES ON DEVELOPMENT OF MOLD ON COLD-STORED STRAWBERRY PLANTS[1]

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Abstract

Strawberry plant temperatures and occurrence of mold were observed in strawberry storages over a 5-year period. Losses due to mold were mainly caused by a Typhula sp., with occasional outbreaks of Cylindrocarpon radicicola, Fusarium sp. and Sporotrichum sp. Less mold developed on fall-dug strawberry plants when they were cooled to -1.1C within 15 days of digging and maintained at this temperature for the entire storage period. Adequate air movement around storage crates was essential for rapid cooling.

Introduction

Losses of cold-stored strawberry plants due to mold have been reported in Nova Scotia (1), and it has subsequently been shown that a psychrophilic Typhula sp. was the pathogen most frequently involved (2).

This paper reports on observations in commercial storages over a 5-year period of strawberry plant temperatures and losses due to mold.

Materials and methods

From 1963 to 1968, strawberry plant temperatures in four commercial storages in Nova Scotia were recorded at intervals of 1 to 4 weeks during each yearly storage period from November to May. Plants were normally tied in bundles of 25, with 500–750 plants in each polyethylene-lined crate (4). Temperatures were determined with a Tele-thermometer (Model 42 SC, Yellow-Spring Instrument Co. Inc., Yellow Springs, Ohio) by inserting the temperature probe into the center of a crate of strawberry plants. Temperatures in 4 to 6 crates selected at random in each storage were recorded on each sampling date. Dates of digging and placing in storage were also recorded. Observations were made on the occurrence of mold at each sampling date, and estimates of losses during storage were obtained from the growers.

Results and discussion

Losses due to mold were mainly caused by a Typhula sp., with occasional outbreaks of Cylindrocarpon radicicola Wollenweber, Fusarium sp., and Sporotrichum sp. C. radicola and Fusarium sp. appeared responsible for the high losses in storage "J" in 1964-65, when 119 days were required to reduce plant temperatures to -1.1C (Table 1).

Sporotrichum sp. developed on plants in storage "W" in 1965-66. Here some freshly dug plants were stored temporarily in polythylene-lined crates with the liner left open to speed cooling, and the plant temperatures were reduced to -1.1C in 4 days. However, the plants in the top layer of the polyethylene-lined crates became desiccated and overgrown with Sporotrichum. This organism has frequently been found on plants which had been exposed to freezing temperatures.

A serious outbreak of Typhula in the 1966-67 storage season appeared to be associated with the rapid filling of storages and the stacking of crates too close to qne another, thus prolonging the time required for the plants to reach the optimum storage temperature of -1.1C (4). The largest losses occurred in storages "A" and "C", which were filled with plants faster than in previous years and in which adequate spacing for air movement around each crate was not provided. All losses in storage "W" occurred on plants stored in solid-side crates that were stacked directly on top of one another; under these conditions, cooling for 75 days was required for all plants to reach -1.1C. In contrast, the bulk of the plants in storage "W" were stored in partly filled, slatted crates that permitted adequate air movement; in these crates mold did not develop during the 16 days required to lower the temperature to -1.1C.

In 1967-68 losses were lowest when the average plant temperature for the entire storage season was less than -1.0C and when all plants were cooled to -1.1C in 15 days or less (Table 1). Cooling was most rapid in all storages when stacks were spaced 2 to 4 inches apart and air spaces of 1 inch or more were left between crates in each stack.

Development of mold on plants was usually associated with conditions that extended the cooling-down period over 15–20 days, although, in some instances, little or no mold developed on plants that required 69 days to cool to -1.1C. Mold development was not associated with date of digging. Plants dug in mid-November, when plants are normally hardened off, stored as well as those dug in early

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Table 1. Losses of strawberry plants from mold during various cooling periods and 6 months'cold storage

Year*	Storage	Average plant temperatures (C)	Days required to reduce plant temperature to -1.1C: First plants	Days required to reduce plant temperature to -1.1C: All plants	Number of plants stored	Losses due to mold (%)
1963-64	C	-0.71	22	47	97,000	<0.1
	W	-1.04	25	53	692,000	1.5
	J	-0.99	22	88	43,000	5.0
1964-65	C	-0.88	23	60	85,000	0.1
	W	-1.09	10	37	700,000	0.6
	J	-0.75	53	119	43,000	25.0
1965-66	C	-1.00	51	69	200,000	0.1
	W	-1.10	4*	45	1,000,000	3.3
1966-67	C	-0.90	16	53	269,000	26.4
	W	-1.02	16	75	850,000	5.8
	A	-0.90	16	75	155,000	11.0
1967-68	C	-1.03	15	15	60,000	0.1
	W	-1.08	11	14	100,000	1.1
	A	-1.06	14	14	22,000	0.0

* November to May

* Plants were stored loosely in polyethylene-lined crates and removed from storage, cleaned, and restored at a later date.

December. Typhula and Sporotrichum sometimes occurred on plants at -1.1C. C. radicicola and Fusarium sp. were usually found on plants with storage temperatures 0.5 to 1C above the recommended plant temperature of -1.1C.

Traces of Typhula sp. were first observed on root rot lesions 3 months after plants were placed in storage. Evidence of Typhula growing all over the surface of the plants appeared in 4 to 5 months, and the greatest mold growth occurred after 5 months. Sclerotia were often found on Typhula-infected plants after 6 months in storage. Since Typhula sometimes occurred on plants at -1.1C and appeared on bundles in various positions within the crate, all plants had probably not been infected or in contact with Typhula inoculum. Infection time is not known. However, Remsburg (3) reported that Typhula sporulated in the fall and winter months during rain and snow flurries with temperatures near OC. Similar weather conditions suitable for sporulation of Typhula often occur in Nova Scotia during November, when plants are being dug for winter storage. In commercial fields, basidiospores have not been found, although Typhula mycelium has been found in April in scattered patches on strawberry plants under mulch. However in field plots containing Typhula-inoculated plants, basidiospores have been found on mycelial mats on the soil in mid-November (unpublished results).

To avoid excessive development of mold in storage, the temperature of fall dug strawberry plants must be reduced to -1.1C within 15 days after digging and plant temperature maintained at this temperature for the entire storage period. Crates should be stacked to allow adequate air movement.

Literature cited

1. Lockhart, C. L., and A.A. MacNab. 1966. Cold storage mold losses andlosses in strawberry fields in Nova Scotia - 1965. Can. Plant Dis. Surv. 46:88-89.

2. Lockhart, C. L. 1967. Effect of temperature and various CO_2 and O_2 concentrations on growth of Typhula sp., a parasitic fungus of strawberry plants. Can. J. Plant Sci. 47: 450-452.

3. Remsberg, R.E. 1940. Studies in the genus Typhula. Mycologia 32:52-96.

4. Worthington, J.T., and D.T. Scott. 1957. Strawberry plant storage using polyethylene liners, Amer. Nurseryman 105:56-57.