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Short Communications

Phytotoxic Responses of Japanese Pears Fumigated with Methyl Bromide

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Abstract: Japanese pears, Nijisseiki without packing materials were fumigated with methyl bromide (MB) at nominal dosages of 0, 15, 25 or 40 g/m³ at 16℃ for 2 hr, load factor 85% (v/v) or 0.26 kg/l in 30 liter fiber-glass chambers and, then, stored for 3 or 7 days at 2°C (Storage A), for 3 or 7 days at 16°C (Storage B) and for 10 days at 2°C followed by for 4 days at 16°C (Storage C), respectively, to confirm phytotoxic responses of fresh pears to MB fumigation. There were no skin MB injury to pears from any of the three dosages at Storage A, B and C. No phytotoxicity was also observed on fruit pulp when treated with 15 g/m³ of MB and held at Storage A, B and C, and with both 25 and 40 g/m³ of MB at Storage A. These data indicated clearly that phytotoxity of pears fumigated with MB could be drastically reduced by storing at low temperature after treatment.

Key words: fumigation, methyl bromide, phytotoxicity, Japanese pear (Nijisseiki Nashi)

Introduction

In September 1989, Japanese pears, Nijisseiki were exported to Australia for the first time. But some injurious mites unknown in Australia were found by import quarantine inspection at Melbourne. Consequently, the consignments were fumigated with methyl bromide (MB) at a nominal dosage of 25 g/m³ at 16°C for 2 hr under the tarpaulin tent.

MB fumigation is widely proposed as a practical disinfestation method for insect and mite pests to overcome quarantine barriers.

Past research on phytotoxic responses of Nijisseiki pears in Japan provided that fresh pears were highly susceptible to MB fumigation under the conditions of high dosages (30-56 g/m³), high exposure temperatures (18-26°C) followed by storage at ambient temperatures (18-26°C) after fumigation. These days, however, the conditions of commercial handling of fresh fruit are different from those of past days, viz. pears are usually stored or transported at low temperatures like 1-2°C as fast as possible after harvest or quarantine treatments.

This research was carried out to reconfirm phytotoxic responses of Nijisseiki pears to MB fumigation under the present conditions of commercial handling. And it was also to estimate whether pears fumigated in Australia have induced phytotoxicity of MB or not.

Materials and Methods

Test fruit

Nijisseiki pears (280 grams per fruit) were obtained from commercial packinghouse in Tottori Prefecture. These fruit were harvested, selected and packed on September 3, and,

then, stored at 1°C for 56 days. After arrival at the Research Division, Yokohama Plant Protection Station, fruit were held at 16°C for 16 hours until used for fumigation.

Fumigation

All fumigations were carried out in 30 liter fiber-glass chambers (external dimensions : 52.0 cm long, 43.5 cm wide, and 57.5 cm high) equipped with an air circulation fan, three ports (for gas application, gas sampling and a temperature probe) and an exhausting system. The chambers were placed in a constant temperature room which maintained chambers and fruit at 16±0.5°C.

Twenty-eight of fruit without packing materials were placed in each chamber and fumigated for 2 hr at 16°C with nominal dosages of 15, 25 or 40 g/m^3 of MB. A load of 28 fruit in 30 liter chambers was equivalent to an approximate 85% load (v/v) in the tarpaulin tent which was used for the MB fumigation in Australia. This calculation was based on the number of fruit per carton (36 fruit) and the volume of the export carton (0.033 m^3 : external dimensions of 48 cm long, 35 cm wide and 19.5 cm high).

MB was injected as a gas into chambers using a gas-tight syringe. Two-hour fumigation was timed from injection. Gas circulation fan was operated continuously during fumigation. The concentrations of MB in the chambers were monitored 30 and 120 minutes after injection of the gas using a Gas Chromatograph with FID (8 AF : Simazu). Air and fruit temperatures in chambers were monitored continuously during fumigation using a multi-channel temperature recorder (Hybrid Recorder AH : Chino). After fumigations all cambers were aerated for one hour at 16°C by the exhausting system.

Storage

Twenty-eight of fumigated fruit and unfumigated control fruit, were divided into three lots and packed in the commercial shipping boxes, viz. fruit were held for 3 or 7 days at 2°C (Storage A), for 3 or 7 days at 16°C (Storage B) and for 10 days at 2°C followed by for 4 days at 16°C (Storage C), respectively. The lot of Storage C was simulated as commercial handling to Australian markets.

Quality evaluation

Past research on phytotoxic responses of Nijisseikj pears in Japan showed that typical symptoms of the injury usually appeared as irregular brownish scalded or blotchy areas of skin and/or as brownish blotchy spots areas of fruit pulp. Therefore, quality of pears was mainly evaluated by the rating on aggregate percentage of the symptoms on skin or fruit pulp areas visibly affected, and the rating of symptomes were classified on the basis of the percent area involved.

Results and discussion

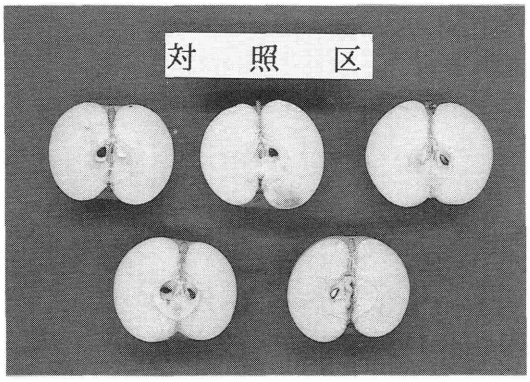
Gas concentration and temperature readings

Gas concentration and temperature monitored during fumigation are shown in Table 1.

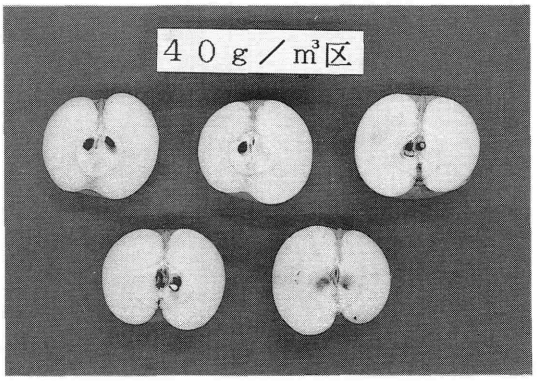
The average gas concentration readings after two hour fumigation period were 15.4 mg/l (nominal dosage of 15 g/m³), 25.9 mg/l (25 g/m³) and 40.4 mg/l (40 g/m³), respectively. Air and fruit temperatures during fumigation were 16.6-16.8°C and 16°C, respectively.

Table 1. Fumigation schedules and methyl bromide concentration and temperature recorded in 30 liter fumigation chambers.

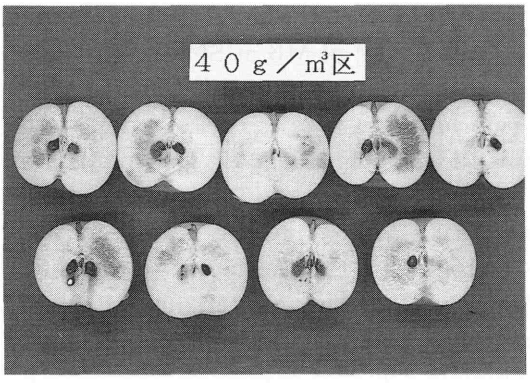
Fumigation conditions				Gas concentration (mg/l)		Temperature (°C)	
Dosage (g/m³)	Exposure time(hr)	Temp. (°C)	N. of fruit tested	30 min.	120 min.	Chamber	Fruit
15	2	16	28	18.9	15.4	16.7	16.0
25	2	16	28	32.1	25.9	16.6	16.0
40	2	16	28	48.5	40.4	16.8	16.0
Control	—	16	28	—	—	16.8	16.0



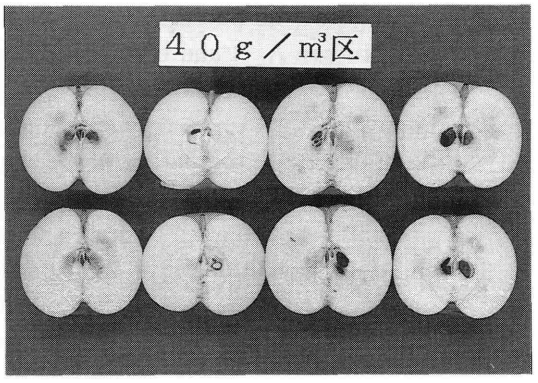
Control (for 7 days at 16°C)



MB 40 g/m³ (for 7 days at 2°C)



MB 40 g/m³ (for 7 days at 16°C)



MB 40 g/m³ (for 10 days at 2°C followed by for days at 16°C)

Symptoms on fruit pulp appeared by MB fumigation

Table 2. Quality of Nijisseiki pears fumigated with methyl bromide at 16°C for 2 hr and, then, stored for 3-7 days at 2°C, for 3-7 days at 16°C and for 10 days at 2°C followed by for 4 days at 16°C, respectively.

Dosage (g/m^3)	2°C				16°C				2°C 10 days followed by 16°C 4 days	
	3 days		7 days		3 days		7 days			
	Skin	Fruit pulp	Skin	Fruit pulp	Skin	Fruit pulp	Skin	Fruit pulp	Skin	Fruit pulp
15	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/4	0/4
25	0/5	0/5	0/5	0/5	0/5	5/5 (100)	0/5	4/9 (56)	0/4	1/4 (25)
40	0/5	0/5	0/5	0/5	0/5	3/5 (140)	0/5	8/9 (167)	0/4	3/4 (100)
Control	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/4	0/4

Note:

a. N. of fruit injuried/N. of fruit tested

b. ( ) Injury was rated on aggregate percentage of fruit pulp areas visibly affected.

Rating	Percentage of areas affected
(0):	No injury
(1):	1- 20%
(2):	21- 40
(3):	41- 60
(4):	61- 80
(5):	81-100

$$\frac{(1)\times 1+(2)\times 2+(3)\times 3+(4)\times 4+(5)\times 5}{\text{N. of fruit tested}}\times 100$$

Quality evaluation

a. Skin injury

There were no skin MB injury to pears from any of the three dosages at Storage A (at 2°C for 7 days), B (at 16°C for 7 days) and C (at 2°C for 10 days, and followed by at 16°C for 4 days) (Table 2).

b. Fruit pulp injury

There were no phytotoxic responses in pears when treated with 15 g/m^3 of MB and held at Storage A, B and C, and with both 25 and 40 g/m^3 of MB at Storage A. Pears fumigated at both 25 and 40 g/m^3 of MB and held at Storage B and C showed typical symptoms of brownish blotchy spots on fruit pulp with light to severe discoloration. The rating of aggregate percentage of the symptoms on fruit pulp areas at 25 g/m^3 of MB was less than that of 40 g/m^3 of MB.

The rating of injuries on fruit pulp showed that phytotoxic responses of pears were severe at the conditions of a higher dosage, and a higher temperature of storage after treatment. These data also indicated clearly that phytotoxicity of pears fumigated with MB could be drastically reduced by storing at low temperature after treatment (Table 2).

In Australia, Nijisseiki pears were fumigated for 2 hr with 25 g/m^3 of MB under the tarpaulin tent. In this case, it was estimated that if the fumigation was carried out with 85% load (v/v), at least nearly 40% of the nominal dosage (25 g/m^3) would be lost during fumigation due to sorption by packing materials and fruit or gas leakage from the tent.

In the experiments carried out by the authors in Japan, only fruit or fruit without packing materials were fumigated with 15, 25 or 40 g/m^3 of MB for 2 hr in gas-tight chambers, and the residual gas concentrations after two hour fumigation were 15.4, 25.9 or 40.4 mg/l, respectively. Judging from the residual gas concentrations, nominal dosages of 15, 25 or 40 g/m^3 of MB would be equivalent to dosages of 25, 41.7 or 66.7 g/m^3 of MB, respectively, of Australian case if MB gas loss of nearly 40% was considered.

From these, it was estimated that no phytotoxicity would be observed on both skin and fruit pulp of Nijisseiki pears fumigated in Australia in September 1989.

These experiments were carried out in small scales in the laboratory. Further experiments in larger scales are necessary, as fumigation elements in small scale experiments are differrent from those of large scale experiments.

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摘　　要

日本産二十世紀梨の臭化メチルくん蒸薬害試験

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1989年9月，オーストラリアへ輸出された二十世紀梨にダニ類が発見され，現地においてMB天幕くん蒸（MB 25 g/m³, 16℃, 2 hr）が行われた。本くん蒸により果実に障害が発生したかどうか確認するための試験を行った。

果実28果を裸のまま30 l くん蒸ビンに入れ，MB 15, 25又は40 g/m³を用いて16℃下で2時間くん蒸した。くん蒸後果実を輸出用カートンに入れ，2℃下で3～7日（保管区A），16℃下で3～7日（保管区B）又は2℃下で10日次いで16℃下で4日（保管区C）保管した後障害の発生の有無を調査した。

果皮上における褐色斑の発生は，全ての薬量区及び保管区において認められなかった。果肉における褐変症状は，15 g区では保管区A, B及びCにおいて，また，25 g区では保管区Aにおいていずれも認められなかった。

25及び40 g区の保管区A及びCにおいて典型的な症状である褐色の染み状の斑点が認められたが，その程度は投薬量が多いほど，保管温度が高いほど顕著であった。

これらの結果は，くん蒸後果実を低温に保管すればMBくん蒸による果実の障害は抑制可能であることを示している。

オーストラリアで天幕くん蒸された果実の障害の有無については，この時の貨物収容率を85%と仮定すれば，MBガスは収着や漏洩により少なくとも投薬量の40%がくん蒸中に消失していると考えられるので，この消失分を考慮すれば，本試験における投薬量15, 25又は40 g/m³は，それぞれ25, 41.7又は66.7 g/m³に相当する。オーストラリアでは果実はくん蒸後直ちに2℃下に保管されているため，果実に障害は発生していないと考えられる。