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Control of Melon Fly in Pumpkins with Ethylene Dibromide Fumigation

Kensei NOHARA, Fumihiko ICHINOHE, Kunio SUNAGAWA
Sanae NAKASONE and Toshihiko HASHIMOTO

Naha Plant Protection Station

INTRODUCTION

Because the melon fly, *Dacus cucurbitae* COQUILLETT, and the oriental fruit fly, *D. dorsalis* HENDEL, occur in Okinawa and Amami Islands, the movement of some fresh fruits and vegetables to mainland Japan is prohibited or restricted by the plant quarantine law as a measure for preventing their introduction into uninfested areas.

Melon fly infestation in firm and unbrusied matured pumpkin is extremely rare. Therefore, of fresh fruits and vegetables that are restricted movement, pumpkins are currently allowed shipment after visual inspection. However, with the volume increase in pumpkin shipments of late requiring considerable time and labor in inspecting, an alternative quarantine treatment procedure is now necessary.

This investigation was carried out to determine the tolerance level of pumpkins to ethylene dibromide (EDB) fumigation and, also, the dosages needed to control infestation.

The quarantine dosage schedule of EDB 8 g/m^3 for 2 hr at 21.1°C for Zucchini squash shipped out of Hawaii is already established in the USA (ANON., 1962).

MATERIALS AND METHODS

General

Tests were conducted using 3 metal fumigation chambers of 0.256 m^3 capacity each. These were equipped with electric heater for volatilization of fumigant, circulation fan (1,800 l/min.) and thermostat.

Using a burette graduated to 0.01 m*l*, the amount of dosage of EDB was measured into a 50 m*l* beaker, then heated and applied. The circulation fan was constantly in use throughout the exposure period and gas concentration was checked 15 minutes prior to end of exposure using a Kitagawa gas detector with prescribed dilution (KAWAMOTO *et al.*, 1973).

Efficiency of Fumigation

Pumpkins used in tests for fumigation efficiency were purchased locally. These comprised 884 fruits (707 kg, "Uchiki-akaguri" variety) from Miyako Island and 387 fruits (366 kg, "Chikanari-ebisu" variety) from Okinawa Island, both, of *Cucurbita maxima* DUCH..

To facilitate oviposition, five needle holes of about 2.2 mm in diameter were opened in each fruit. Infestation occurred in 32×41×35 cm cages housing adult melon flies for 0.5–2 hr in a controlled room at 27–28°C, 70–80% RH.

The infested pumpkins were then contained in tight wooden boxes, 31×31×30 cm in size, screened with organdie under an optimum rearing condition with controlled temperature and humidity lasting 4 days and 6 to 7 days for 2nd and 3rd instar respectively, to allow larval development. In the initial trials, for lots in which eggs were treated, the pumpkins were fumigated a day after infestation. For the second series of tests, 250 eggs per fruit were inserted in artificial needle openings of about 2.2 mm in diameter with a small soft brush a day before fumigation.

The infested fruit with developed larvae in respective stages was removed from holding boxes and segregated into four lots, three lots for fumigation with one lot as nonfumigated control.

These were then packed in a ventilated cardboard box of 27×50×21 cm in size weighing 10 kg each to simulate shipment weight. About 16 hr prior to fumigation, the boxes were preconditioned to fumigation temperature. Dosages of 6, 8, 10 g/m^3 at 17°C for the first series of tests and 14, 16, 18 g/m^3 at 15°C for the second series of tests were applied for 2 hours. The load was 33% of chamber space and 129 kg/m^3 in weight.

All fumigated fruits were thence placed on sand in holding boxes under an optimum rearing condition before checking the result. Except for the initial trial group, the larvae of both 2nd and 3rd instar were examined on the third day after fumigation and the eggs on the fifth to seventh day. Examination was done by slicing the fruit and extracting the larvae. Larvae still alive were carefully reared on slices of pumpkin and observed until their adult stage for three weeks. The fumigated fruit of the initial trial group was held up to adult stage of the fly to determine survivals. The population in fumigated fruit was estimated by the number of flies emerging from the nonfumigated control.

Tolerance to Fumigant

Tests related to fruit tolerance as well as taste and flavor using good quality commercial pumpkins were conducted. The "Uchiki-akaguri" variety from Miyako Island and "Ogasawara variety" (of *Cucurbita moschata* DUCH.) from Yoron Island were selected totalling 576 fruits. The "Chikanari-ebisu" variety, although only in a preliminary trial was tested. The period between harvest and fumigation was 7 to 10 days.

These were fumigated in their bare state, without wrappings or boxes, and also in the manner as described earlier. Dosages of 8, 16, 24 g/m^3 for 2 hr at 30°C were applied to a volume load of 38% or 147 kg/m^3 in weight.

Treated fruits packed in cardbord boxes were stored in room temperature set at 20–25°C; subsequently, observations for fumigation effects were carried out and recorded every other day for 15 days.

Taste tests to detect differences including the untreated control lot were made on the 7th and 17th days after fumigation.

The panel of 18 persons, given a representative piece of steamed pumpkin from every lot including control, sampled for quality, taste and flavor. Comparing with a fruit used as standard, these were evaulated as good, fair or bad. By analysis of variance, the

data were analyzed statistically.

RESULTS

As shown in Table 1, the first series of trials involving 80,858 eggs and larvae and using dosages of 6, 8, 10 g/m³ for 2 hr at 17°C with the exception of 10 g/m³ for egg stage failed to achieve 100% mortality.

The second series of tests, however, involving the fumigation of 44,167 eggs and larvae for "Uchiki-akaguri," and 22,039 eggs and larvae for "Chikanari-ebisu" and using dosages of 14, 16, 18 g/m³ for 2 hr at 15°C achieved 100% mortality. Conjunctively, 16,448 eggs and larvae in "Uchiki-akaguri" and 6,691 eggs and larvae in "Chikanari-ebisu" in the control lot survived. (Tables 2 and 3.)

There were no fumigation injuries for the three varieties of pumpkins tested. Also there appeared no signfiicant differences in quality, taste and flavor.

Bromide residue analysis was conducted 3 days after fumigation by Mr. Yukihiro Kamimura of the Kagoshima Agricultural Experiment Station. Total bromine residues amounted to 4.02±0.03, 14.81±0.13 and 18.07±0.06 ppm for both the nonfumigated control and for those receiving dosages of 14 and 16 g/m³ 2 hr, respectively. These are below the tolerance level of 20 ppm for fresh fruits established by FAO (KAMIMURA, unpublished data, 1975).

Therefore, based on results of tests as conducted, we evaluate EDB fumigation using a dosage of 14 g/m³ for 2 hr at 15–30°C in a chamber load of not more than 33% volume or 129 kg/m³ is an effective treatment method or completely destroying melon fly eggs and

TABLE 1. Efficiency of fumigation with EDB against melon fly eggs and larvae in "Uchiki-akaguri" pumpkin. Three tests were performed in 33% volume load or 129 kg/m³ in weight

Dosage	Stage	Estimated population	Survivors	Mortality %
10 g/m³ 2 hr 17°C	Egg	7,640	0	100
	2nd Instar	7,255	217	97.01
	3rd Instar	11,226	86	99.23
	Total	26,121	303	98.84
8 g/m³ 2 hr 17°C	Egg	7,639	1	99.99
	2nd Instar	7,246	375	94.82
	3rd Instar	16,654	147	99.12
	Total	31,539	523	98.34
6 g/m³ 2 hr 17°C	Egg	7,621	19	99.75
	2nd Instar	6,819	802	88.24
	3rd Instar	8,758	1,104	87.39
	Total	23,198	1,925	91.70
Control 17°C	Egg		12,429	
	2nd Instar		13,716	
	3rd Instar		15,938	
	Total		42,083	

TABLE 2. Efficiency of fumigation with EDB against melon fly eggs and larvae in "Uchiki-akaguri" pumpkin. Three tests were performed in 33% volume load or 129 kg/m³ in weight

Dosage	Stage	No. of eggs and larvae	No. of survivors	Mortality %
18 g/m³ 2 hr 15°C	Egg	6,000	0	100
	2nd Instar	3,806	0	100
	3rd Instar	5,719	0	100
	Total	15,525	0	100
16 g/m³ 2 hr 15°C	Egg	6,000	0	100
	2nd Instar	2,124	0	100
	3rd Instar	6,682	0	100
	Total	14,806	0	100
14 g/m³ 2 hr 15°C	Egg	6,000	0	100
	2nd Instar	2,843	0	100
	3rd Instar	4,993	0	100
	Total	13,836	0	100
Control 15°C	Egg	2,041	2,018	1.13
	2nd Instar	7,055	6,995	0.85
	3rd Instar	7,543	7,435	1.43
	Total	16,639	16,448	1.15

TABLE 3. Efficiency of fumigation with EDB against melon fly eggs and larvae in "Chikanari-ebisu" pumpkin. Three tests were performed in 33% volume load or 129 kg/m³ in weight

Dosage	Stage	No. of eggs and larvae	No. of Survivors	Mortality %
18 g/m³ 2 hr 15°C	Egg	6,000	0	100
	2nd Instar	2,189	0	100
	3rd Instar	606	0	100
	Total	8,795	0	100
16 g/m³ 2 hr 15°C	Egg	6,000	0	100
	2nd Instar	534	0	100
	3rd Instar	292	0	100
	Total	6,826	0	100
14 g/m³ 2 hr 15°C	Egg	6,000	0	100
	2nd Instar	269	0	100
	3rd Instar	149	0	100
	Total	6,418	0	100
Control 15°C	Egg	3,590	3,579	0.31
	2nd Instar	2,607	2,607	0
	3rd Instar	505	505	0
	Total	6,702	6,691	0.16

larvae in pumpkins of the variety as described with no deleterious effect on quality, taste and flavor.

SUMMARY

The effectiveness of EDB fumigation on pumpkin against the melon fly, *Dacus cucurbitae* COQUILLETT and fruit tolerance to fumigant were investigated. The fumigation using a dosage of 14 g/m³ for 2 hr at 15–30°C and involving 20,254 eggs and larvae of melon fly in "Uchiki-akaguri" and "Chikanari-ebisu" varieties resulted in 100% mortality with no injury to fruit.

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摘　　要

カボチャに寄生したウリミバエの EDB くん蒸による殺虫

野原　堅世・一戸　文彦・砂川　邦男
仲宗根早苗・橋本　敏彦
那覇植物防疫事務所

カボチャの EDB くん蒸による薬害及びウリミバエの殺虫効果について試験した。カボチャは沖縄本島産の近成えびす，宮古島産の打木赤栗（両品種とも，*Cucurbita maxima* DUCH.）及び与論島産の小笠原（*C. moschata* DUCH.）を供試した。

薬害試験は，8, 16, 24 g/m³，2時間，30°C で実施したが，薬害の発生及び品質，味等における影響はなかった。殺虫試験は，第1部が 8, 10, 12 g/m³，2時間，17°C で，第2部が 14, 16, 18 g/m³，2時間，15°C と対照区でそれぞれ実施した。結果は，12 g/m³ 以下の薬量では完全な殺虫結果を得ることはできなかった。しかし，14 g/m³ 以上の薬量ではすべて 100% の殺虫効果が得られた。

残留臭素量については，14 g/m³，2時間くん蒸3日後のカボチャを使用して分析した結果，全臭素量が 14.81±0.13 ppm であったとの報告があり，これは FAO が定めている青果物における許容量，20 ppm 以下である。

従って，打木赤栗，近成えびす，小笠原の3品種のカボチャについて，ウリミバエを対象としたくん蒸は，14 g/m³，2時間，15-30°C，収容比 33%（容積），0.129 t/m³（重量）で実用化が可能であると考える。

正　誤　表（本誌 No. 13 p. 70 右上 2～4 行）

正	誤
本試験の結果でも2令幼虫以下のステージについては，曾煥秋らの結果と一致する。	が，本試験の結果では2令幼虫を除いてはこの結果とは一致しない。