Postharvest banana fruit rot control with systemic fungicides in Jamaica*1/

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COMPENDIO

Los baños de tiabendazol (200μg/ml) y de benomil (300μg/ml) fueron analizados para determinar la tasa de pérdida de ingrediente activo al tratar grandes cantidades de bananas. La delineación en la concentración fue más rápida en una suspensión de 22,8 litros que en una de 45,6 litros. Cuando las manos de banano fueron sumergidas en benomil (300μg/ml), el control perdió después de que 2200 kg de frutos fueron tratados en la misma concentración.

Introduction

ONE of the major disease problems of bananas shipped as stems from Jamaica and elsewhere has been wound anthracnose caused by *Colletotrichum musae* (Berk and Curt.) Arx (4), but with the packing of hands, crown rot caused by a fungal complex has assumed greater importance (2,3).

Control of superficial but not deep-seated infections was accomplished by using the nonsystemic fungicides such as mancozeb and sodium salicylanilide (5). The systemic fungicides benomyl and thiabendazole at 200-300 μg/ml were found to control banana fruit rot in Jamaica equally well when small quantities of fruits were treated but better control was obtained with benomyl than thiabendazole when concentrations were increased to 400 μg/ml (6,7).

This study reports on the effect of dilution of benomyl and thiabendazole suspensions with continuos dipping of banana hands; and compares the dip and spray methods for control of banana fruit rots.

Materials and methods

Continuous Dipping Studies Freshly harvested banana (*Musa acuminata* Colla cv 'Lacatan') bunches were dehanded and washed in flowing water to remove plant latex from the freshly cut crowns. Wet hands were then dipped in wooden tubs either containing 22 8 or 45 6 liters of a 200 μg/ml water suspension of thiabendazole (2-(4-thiazolyl)benzimidazole, Mertect 340, 40% WP, Merck and Co.). The mixtures were continuously agitated during treatment and duplicate samples (approximately 200 ml) of the suspension from each tub were taken after 0, 10, 20, 40, 60, 80 or 100 cartons (6-8 hands per carton) of banana hands had been dipped.

A second study involved dipping wet hands in a tub containing 45 6 liters of a 300 μg/ml suspension of benomyl (methyl 1-(butylcarbamoyl)-2-benzimizolecarbamate Benlate 50% wP, E. I. duPont de Nemours and Co). The mixture was continuously agitated during treatment. Seven duplicate samples of the tub suspension were collected after 0, 20, 50, 80, 120, 160 and 200 cartons of banana hands had been dipped. Both sets of fungicide samples were frozen, packed in dry ice and those containing thiabendazole were shipped to Merck and Co., and those containing benomyl to E. I. duPont de Nemours and Co., for residue analysis.

Fungicide Dip Studies Forty banana hands were dipped in either 100, 150 or 200 μg/ml thiabendazole or 2 000 μg/ml mancozeb (zinc ion plus manganese ethylene bisdithiocarbamate, Dithane M-45, 80% WP Rohm and Haas Co.).

There were five replicates of each treatment in randomized complete block design. The standard mancozeb treatment served as the control. In the continuous dipping studies six (replicates) cartons were taken at the time the benomyl suspension was sampled. The fruits were stored for 12 days at 13°C

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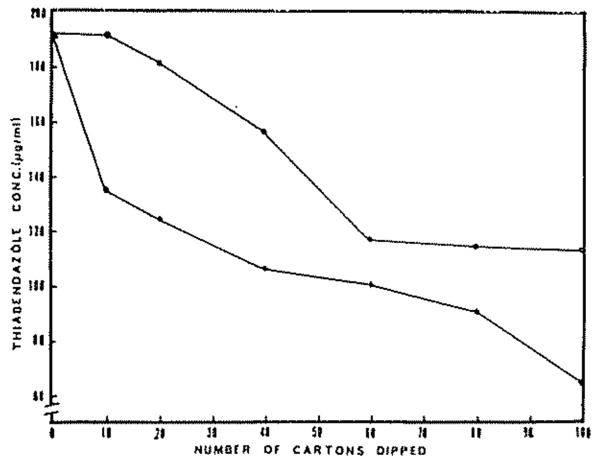

Fig. 1.—*Reduction of concentration with number of cartons of banana hands dipped in fungicide suspensions containing initially 200 µg/ml thiabendazole in 22.8 (——) and 45.6 (+——+) liters of water.*

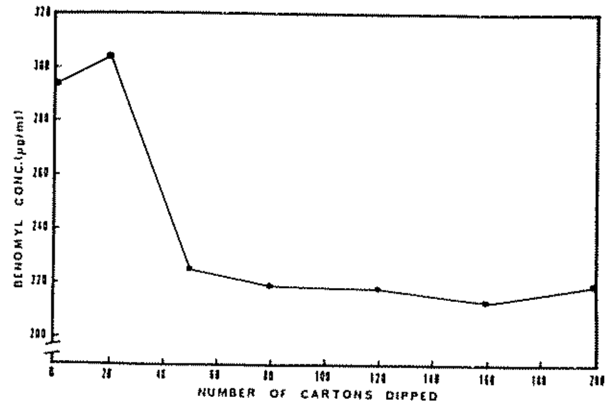

Fig. 2.—*Reduction in concentration with number of cartons of banana hands dipped in a fungicide suspension containing initially 300 µg/ml benomyl in 45.6 liters of water.*

and ripened with ethylene at 18-20°C. At colour 2 and 5 (8), each hand was scored for disease based on a scale of 0 to 3, where for crown rot and mold; 0 = no rot or mold 1 = up to one-quarter rotted or moldy; 2 = up to one-half rotted or moldy and 3 = more than one-half rotted or moldy and for anthracnose and neck rot; 0 = no lesions; and 1, 2 and 3 = 1,2 or more than 2 lesions per hand respectively.

A disease index (D.I.) was calculated for each treatment using the formula:

$$D.I. = \frac{\Sigma (n \times r) \times 100}{3 \times N},$$

where n = number of hands in each degree of decay, r = decay rating, and N = total number of hands scored.

Comparison of Spray and Dip Treatments. 'Lacatan' banana hands were washed and either were dipped for 10 seconds in a 200 µg/ml thiabendazole in 45.6 liters of water or laid with their crowns up and

Table 1.—Mean disease indices* for Lacatan bananas after treatment with mancozeb and various concentrations of thiabendazole

Treatment	Conc. µg/ml	Stage of ripening	Mean disease indices		
			Crown rot	Crown mold	Wound anthracnoce
Thiabendazole	100	Color 2	11.2 b**	40.1 a	2.5 a
,,	150	,,	9.3 b	30.4 b	4.6 a
,,	200	,,	7.6 b	23.1 c	3.2 a
Mancozeb	2000	,,	15.5 a	38.6 a	6.5 a
Thiabendazole	100	Color 5	32.6 a	56.0 a	6.0 a
,,	150	,,	26.3 b	43.7 b	7.8 a
,,	200	,,	21.2 c	29.0 c	8.2 a
Mancozeb	2000	,,	27.6 b	37.0 b	8.7 a

* Mean of five replicates assessed after cool storage at 13°C (color 2) and after ripening (color 5)

** Means followed by common letters in a column are not significantly different at P = 0.05 by Duncan's Multiple Range Test.

Table 2.—Mean disease indices* for Lacatan banana fruit samples taken during continous dipping in a benomyl suspension with an initial concentration of 300 μg/ml.

Number of sample cartons**	Mean disease indices			
	Crown rot	Crown mold	Neck rot	Wound anthracnose
1-6	38.0 b***	43.9 b	8.1 bc	15.7 bc
18-23	16.9 e	38.3 b	7.0 c	11.0 c
48-53	18.9 cd	38.9 b	14.4 bc	16.1 bc
78-83	27.2 bcd	42.8 b	7.8 bc	18.8 bc
118-123	24.8 bcd	30.4 b	14.1 bc	33.4 abc
158-163	32.0 bc	36.8 b	20.8 ab	26.6 abc
198-203	52.2 a	71.8 a	30.2 a	40.4 a

* Means of six replicate cartons of fruits assessed at color 5.
** Banana hands were dipped and packed into cartons numbered consecutively.
*** Means followed by common letters in a column are not significantly different at P = 0.05 by Duncan's Multiple Range Test.

sprayed at 350 g/sq. cm pressure to depoint of rumm off with 200 or 300 μg/ml thiabendazole with a hand sprayer. Hands, dipped in water, served as controls. Drained, still wet fuits were packed into 13.5 kg cartons, stored ripened and assessed for disease development as previously described. Each treatment of 40-50 hands was replicated five times in a randomized complete block design.

Table 3.—Mean dicsease indices* for Lacatan bananas after spray and dip treatment with thiabendazole at 200 μg/ml.

Method of fungicide application	Stage of ripening	Mean disease indices			
		Crown rot	Crown mold	Neck rot	Wound anthracnose
Spray	Color 2	16.0 b**	45.3 a	3.3 a	21.1 a
Dip	"	13.4 b	29.9 b	5.1 a	21.6 a
Water (control)	"	22.0 a	50.7 a	1.8 a	23.5 a
Spray	Color 5	44.2 b	69.4 a	8.4 a	23.9 a
Dip	"	30.2 c	51.0 b	5.4 a	20.9 a
Water (control)	"	55.3 a	77.3 a	5.8 a	22.1 a

* Means of five replicates assessed after cool storage at 13°C (color 2) and after ripening (color 5).
** Means followed by common letters in a column are not significantly different at P = 0.05 by Duncan's Multiple Range Test.

Results and discussion

The continuous dipping of banana hands in the treatment suspensions resulted in a lowering of fungicide concentration (Figs. 1 and 2). There was a nonlinear relationship between fungicide concentration and the number of hands dipped. Cuillé and Bur-Ravault (2) estimated that 20 liters of fungicide sus-

Table 4.—Mean disease indices* for Lacatan bananas after spray (300 μg/ml) and dip (200 μg/ml) treatment with thiabendazole.

Method of fungicide application	Conc μg/ml	Stage of ripening	Mean disease indices			
			Crown rot	Crown mold	Neck rot	Wound anthracnose
Spray	300	Color 2	3.9 b**	12.9 b	1.4 a	3.7 a
Dip	200	"	4.3 b	13.6 b	1.1 a	4.0 a
Water (control)	—	"	13.7 a	29.5 a	0.9 a	4.3 a
Spray	300	Color 5	19.5 b	33.1 b	3.0 a	7.6 b
Dip	200	"	20.8 b	32.5 b	2.2 a	6.6 b
Water (control)	—	"	41.3 a	56.0 a	4.3 a	12.0 a

* Mean of five replicates assessed after cool storage at 13°C (color 2) and after ripening (color 5).
** Means followed by common letters in a column are not significantly different at P = 0.05 by Duncan's Multiple Range Test.

pension was displaced per 1000 kg of fruit dipped. The reduction in fungicide concentration was due to the diluting effect of added water from wet fruit and increments of fungicide removed on the surface of dipped fruit. The decline of thiabendazole was more rapid in the smaller volume than in the larger volume suspension (Fig. 1).

Significantly better control of crown rot and mold was obtained using 200 μg/ml thiabendazole than 100 or 150 μg/ml thiabendazole or 2000 μg/ml mancozeb (Table 1). To maintain approximately 150-200 μg/ml thiabendazole, it would be necessary to replenish the fungicide dip with additional fungicide after 10 and 50 cartons of hands, respectively, had been dipped in 22.8 and 45.6 liters of the fungicide treatment.

After 160-200 cartons (2180-2730 kg) of fruit were dipped in benomyl the control of fruit rot decreased (Table 2). Therefore, increasing the initial concentration of the benomyl or thiabendazole suspensions or the volume would result in a longer period of fungicide efficacy.

There was no advantage to spraying fruit rather than dipping at the same fungicide concentration (Table 3). Control of crown rot and mold was not significantly different when a spray at 300 μg/ml or dip at 200 μg/ml were used (Table 4).

Summary

Thiabendazole (200 μg/ml) and benomyl (300 μg/ml) dips were analysed to determine the rate of loss of active ingredient as quantities of banana fruit are treated. The decline in concentration was more rapid in a 22.8 litter than a 45.6 liter suspension. When banana hands were dipped in benomyl (300 μg/ml) control was lost after 2200 kg of fruits were treated. There was no advantage in spraying rather than dipping at the same concentration.

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