IMPROVING COLD TREATMENTS FOR THE CARIBBEAN FRUIT FLY IN CARAMBOLAS.

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Cold treatments enable shipment of a number of commodities such as citrus and carambolas which are quarantined because of the potential for spreading fruit flies. The carambola in Florida is a potential poor host for the Caribbean fruit fly, *Anastrepha suspensa* Loew (Swanson & Baranowski 1972). A cold quarantine treatment was developed (Gould and Sharp 1990, Gould 1996) which takes 12 days at 1.1°C to produce probit 9 mortality (99.9968% mortality). This requires considerable advance time for marketing and shipping fruits, and the cost of keeping the fruits refrigerated at the proper temperature for 12 days is high. In this study we examined the effect of rapidly cooling carambolas with water at 1.0°C on the mortality of Caribbean fruit fly larvae infesting the carambolas to determine if the quarantine treatment time can be shortened.

MATERIALS AND METHODS: Carambolas were exposed to Caribbean fruit flies for two days, then randomly placed into two treatment groups and a control. The control was held without any cold treatment and the larvae emerging were used to estimate the treatment population. One treatment consisted of carambolas in commercial cardboard boxes placed into a walk-in cooler at 1.1 ± 0.75°C. In the second treatment, fruits were placed in nylon bags and immersed in 0.3 ± 0.1°C ice water until the fruit core reached the water temperature (37-42 min.), then placed in commercial boxes in a walk-in cooler (1.1 ± 0.75°C). At one day intervals 10 carambolas were removed from each treatment up to 12 days. This two treatments were replicated five times at one week intervals.

RESULTS AND DISCUSSION: The air cooled carambolas in this experiment required at least 24 hours (at 24 h 2.15 ± .26°C) to cool down to the treatment temperature. Water cooled fruits cooled down in 40 to 45 m (0.97 ± 0.35°C to 0.93 ± 0.27°C). Gould and Sharp (1990) found similar results from ice water and air cooling.

The mortality of insects from the two treatments was dramatically different. After one day, larvae in water cooled fruits had greater than 65% mortality, while larvae in air cooled fruits had about 20% mortality (Fig. 1A). Larvae in water cooled fruits had 98% mortality at four days, and no larvae (from approximately 1900 treated) were recovered more than 9 days after treatment. Twenty six larvae were recovered from air cooled fruits (from approximately 1900 treated) after 8 days of treatment, and one larva was recovered after 11 days of treatment. These differences are lessened when the data are shifted one day to account for the time it takes air cooled fruits to cool down to treatment temperature (Fig. 1B).

The probit transformation gave the best 'fit' for the data of equations tested. Predictions for 75, 90, 99 and 99.9968% mortality are given in Table 1. Both the predictions for probit 9 for larvae in air cooled and the shifted air cooled carambolas are close to that found by Gould and Sharp (1990). The prediction for mortality of larvae in water cooled carambolas differs greatly from those for either of the air cooled data sets and the 95% fiducial limits do not overlap indicating the differences are significant. Larvae in cold water treated fruit reach probit 9 mortality in just over half the time required by larvae in air cooled fruits.

It may be possible to incorporate this into the current cold treatment of 12 days at 1.1°C for Florida carambolas and reduce it substantially. Reductions in the treatment time may make the treatment less costly and also less damaging to the fruits.

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TABLE 1. MORTALITY ESTIMATES FROM COLD TREATMENTS.

Treatment	Mortality	Estimate (Days)	95% Fiducial Limits	
			Lower	Upper
Water Cooled	75%	1.65	1.11	2.06
	90%	2.80	2.38	3.39
	99%	4.78	4.02	6.21
	99.9968%	7.94	6.44	10.95
Air Cooled	75%	4.48	4.17	4.80
	90%	6.08	5.69	6.56
	99%	8.84	8.18	9.71
	99.9968%	13.27	12.09	14.82
Air Cooled	75%	3.35	3.13	3.56
Shifted 1 day	90%	5.14	4.88	5.43
	99%	8.21	7.73	8.80
	99.9968%	13.14	12.22	14.28

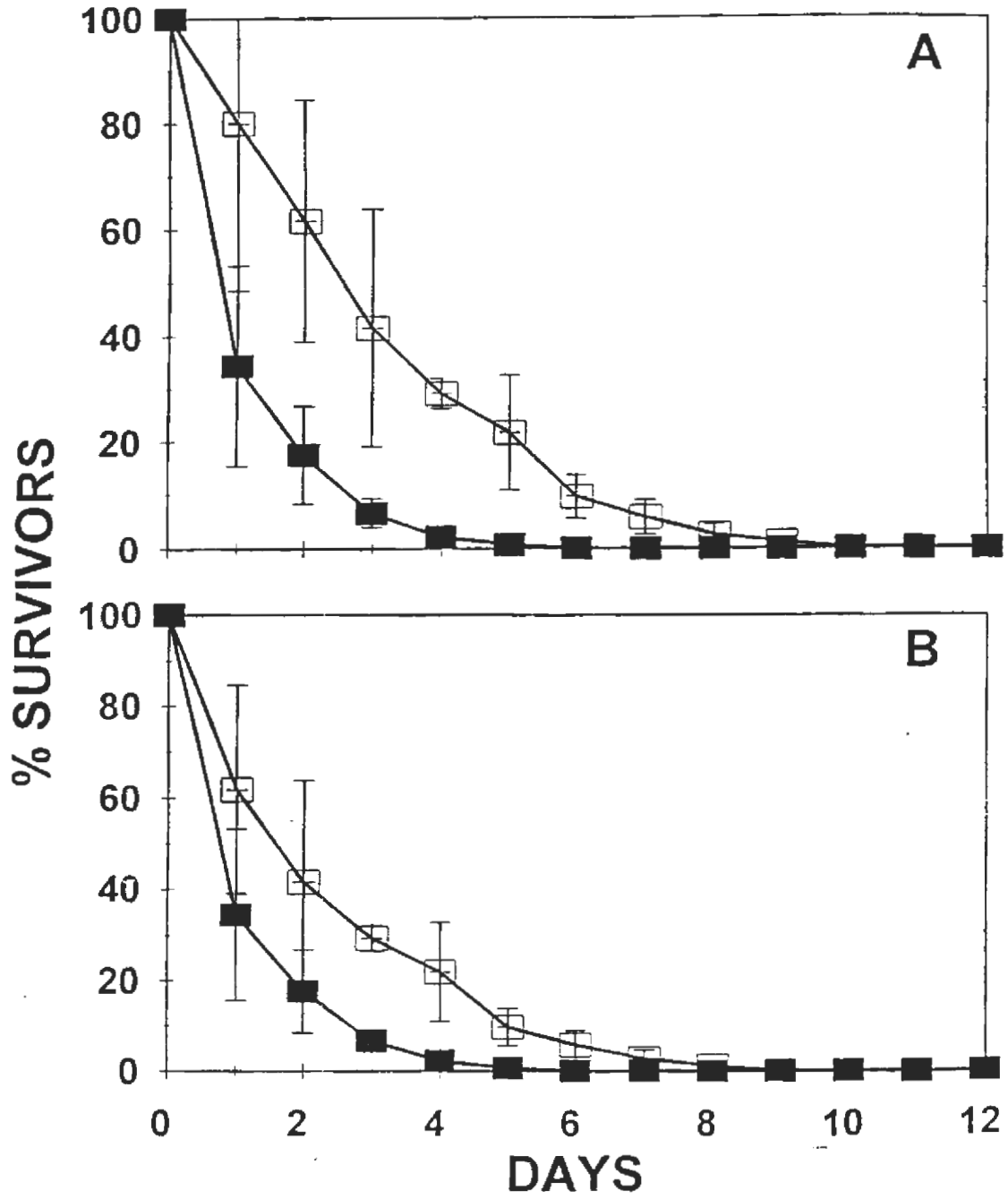

Fig. 1. Survivorship of (A) Caribbean fruit fly larvae in carambolas treated with cold water (solid square) and cold air (open square). Survivorship of (B) Caribbean fruit fly larvae in carambolas treated with cold water (solid square) and cold air (open square) adjusted to account for delayed cooling time.