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Project No. 86-87 - Tree Crop Research, Fumigation and Concealed Damage Studies

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Objectives: Objectives of the project are to determine the developmental stage of the navel orangeworm (NOW) most resistant to phosphine (PH_3). Tests are to include eggs, larvae and pupae. Secondly, to determine estimated lethal concentration (LC_{50} and LC_{95} or $_{99}$) using the most resistant stage only at temperatures of 10, 21 and 32°C with exposure periods of 72, 48, and 24 hours. Third to determine estimated lethal time (LT_{50} and LT_{95} or $_{99}$) at the above temperatures. This part of the study will only be necessary if the above stated temperatures are not adequate for effecting required mortality.

The concentration response curves estimated by probit regression can then be used to determine the concentration and time (CT product) required for obtaining an efficacious treatment. For commercial fumigation, start and ending concentration of the exposure period can be estimated from the CT products obtained from probit analysis for LC_{99}.

Interpretive Summary: When navel orangeworm (NOW) eggs, larvae and pupae were fumigated with phosphine at various dosages and with various temperatures, the egg stage was the most difficult to kill. As a consequence, only the egg stage is being used in the fumigation tests. Work completed at 90°F shows that a start reading of 600 ppm and an ending reading of at least 400 ppm during a 24 hour period of the total exposure time is required to obtain 100% mortality of all stages of NOW. If phosphine, irregardless of the formulation, is monitored during the fumigation exposure period these concentrations can be used as guidelines for NOW mortality in commercial fumigation of almonds.

Experimental Procedure:

Navel orangeworm used in this study will be from our laboratory reared strain. For fumigation tests, naked insects (no load) will be placed in plastic screened cages with small amount of media (depending on stage used). Dosage levels at each temperature will be replicated as needed to provide a minimum of 200 insects treated at each dose or time of exposure.

The chamber to be used are 29 L gas tight fiberglass or equivalent, housed in a temperature controlled room. Temperature will be controlled at ± 1.0°C. RH will be maintained at 50% or above. The chamber gas/air will be circulated for the duration of the exposure period.

PH_3 used in the tests will be taken from a pre-analyzed gas mixture (PH_3/N_2)

contained in a cylinder from Matheson Gas Co. During fumigation, PH_3 concentration will be determined at intervals of ca. 4, 8, 12, 24, 48, 72 h, etc. Determination will be made by flame photometric as chromatography.

At the end of exposure, the chambers will be forced air aerated to levels of 1.0 ppm or less before opening. Following aeration, insects will be placed in a holding room at 26.7°C and 60% RH until mortality is determined. Mortality will be determined by the ability (or lack of) to develop to the adult stage, egg mortality will be on a hatch/no hatch basis.

Probit regression will be used to estimate the concentration response curves and the Simultaneous Test Procedure to test for differences between slopes. Probit percent mortality vs log concentration (CT product-g.h/m^3) will be graphically plotted.

Results: In our range finding tests, we found that 0-24 hour old eggs of NOW were the most resistant stage to PH_3. (As this part of the study was reported 12/85, the data will not be presented in this report). As a consequence of these results, all present and future studies will be conducted with the egg stage only.

The mortality studies on eggs at 32°C for 24 hours have been completed. Figure one, shows the CT product (ppm.h/m^3) derived from probit regression for egg mortality and ranges from 5 to 99%. CT products for 100% mortality can be extrapolated from this regression line.

Presented in Table 1 are the CT products for an LC_{50} and an LC_{99} for NOW eggs. Also shown, are the estimated (from the CT products obtained from probit analysis for LC_{99}) start and end concentrations required to obtain 100% mortality during a 24 hour period of the total exposure. Therefore, in a commercial application, irregardless of the source of PH_3, if temperatures are 32°C (90°F) or above, and PH_3 concentration are monitored during the exposure period a start reading of 600 ppm and an end reading of at least 400 ppm can serve as a guideline for the concentration profile and NOW mortality results should be predictable.

Discussion: It is hoped that in presenting the required concentration as "start and end" readings that this will prove to be the most practical way of utilizing the data commercially. It will be interesting to see how this information matches up in various commercial applications. One concern is that if enclosures are not reasonably tight, concentrations may never reach 600 ppm. If we find this to be the case, then the best solution (other than making the enclosure tight) would be the use of CT products, which has been considered in the past, but never accepted commercially to any great extent.

Our plans are to complete the study on the two remaining temperatures (10° and 21°C) by early summer.

Table 1.

Concentration times time products (C x T) of phosphine (PH_3) required for a LC 50 and LC 99 on navel orangeworm 0-24 hour old eggs treated at 32.2°C for 24 hours and estimated concentrations (ppm) to obtain 100 % mortality in a commercial situation.

Lethal concentration % mortality	C x T Product ($ppm \cdot h/m^3$)	For Commercial Fumigation Required approximate start and end concentration (ppm) during a 24 h period of the total exposure period at 32.2°C to obtain 100% mortality.	
		Start[a]	End
LC 50 (95% FL)	3,447.2 (3202.8-3710.3)		
LC 99 (95% FL)	10,909.4 (8960.2-13,282.6)	600	409

[a] Start and end concentrations for 100% mortality were estimated from the C x T products obtained from probit analysis for LC 99.

Concentration-response of 0-24 h old navel orangeworm eggs to phosphine fumigation at 32.2 °C for 24 hours.

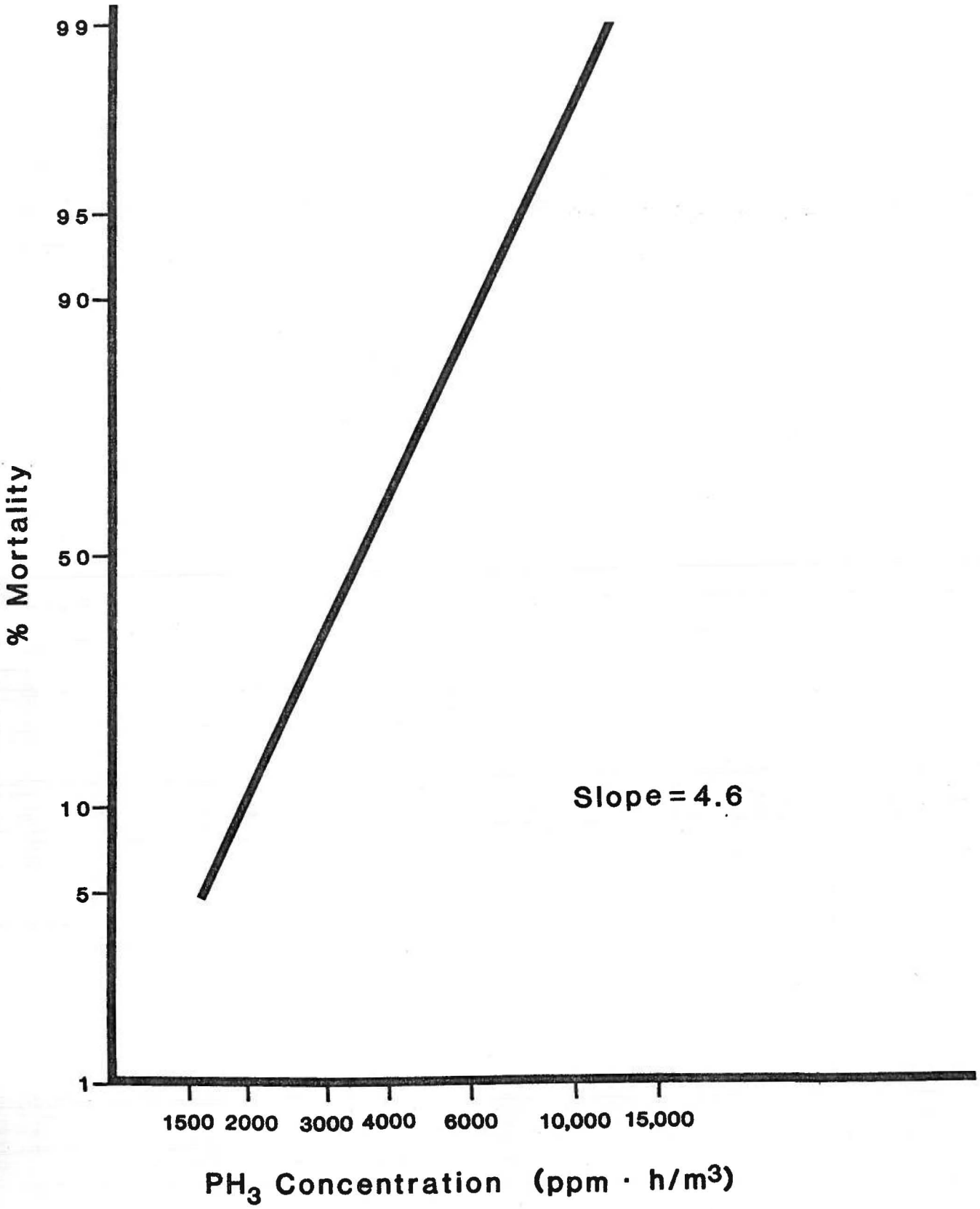

Figure 1