INTEGRATED TEMPERATURE AND CHEMICAL CONTROL METHODS AGAINST THE CIGARETTE BEETLE*

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ABSTRACT: Temperature and chemical methods for insect control are integrated into a program. However, temperature frequently enters the program as an unavoidable factor during storage and processing of agricultural commodities. Frequently, natural atmospheric conditions are not severe enough to kill the cigarette beetle, *Lasioderma serricorne* (F.) in tobacco stored in louvered or closed warehouses. Winter chilling usually kills insects located near the surface of packaged tobacco but is less efficient at inner depths. Results from an experiment conducted in a modified warehouse indicate the cigarette beetle can be effectively controlled by a forced ventilation system using fans. Air is drawn into the storage during the winter season whenever the tobacco temperature is 3.3° C. above the temperature of outside air, and the relative humidity of the air does not exceed 90%. The forced air ventilation system should be used only in properly constructed storages, and the operation of fans should be automatically controlled.

Larvae of the cigarette beetle can be triggered to crawl from tobacco hogsheads by exposing the hogsheads to a long period of cooling followed by a rapid warming period of short duration.

Suction light insect traps are operated continuously from early April to mid November in tobacco storages in the U.S. The traps are used to detect surviving insect populations, and these data are used to forecast the need of fumigation or aerosol treatments. Tobacco infested with the cigarette beetle may be protected by fumigation with phosphine followed by daily treatments of dichlorvos. Chemical treatment of storages for control of insects ends in the fall as insect flight activity decreases and temperature control begins. A major tobacco storage corporation has used successfully this type of integrated temperature and chemical control program since 1968.

Most temperature and chemical insect control programs are integrated. Generally, emphasis in this combined method of insect control is placed on temperature of a range that is adverse

*The use of trade names is for identification purposes only and does not constitute an endorsement by the U. S. Department of Agriculture.

to insect development, and chemical pesticides are used only when control of destructive insects was not achieved by means of temperature. Entomologists, including those working with stored products, would like to believe that temperature as a planned method for insect control is more widely used than chemical pesticides because it does not contaminate the product with a residue. However, control of insects with either high or low temperature occurs, in most instances, only because it cannot be easily avoided. Heat is required for the processing of most raw commodities into a product suitable for consumption and a by-product of this process is insect control. Likewise, most raw agricultural products are stored in unheated structures and insects infesting the stored commodities are controlled during the cold winter months by accident and not by design.

The tobacco industry has constructed louvered storages that vent readily, and during the winter temperature of the stored tobacco becomes quite low, Figure 1. The industry did not construct this type of building for control of insects, but rather for the purpose of ageing tobacco stored in bales, cases, or hogsheads. Tobacco stored in louvered warehouses located as far north as Richmond, Virginia and Louisville, Kentucky becomes infested with the cigarette beetle, *Lasioderma serricorne* (F.). This occurs despite the fact that during the winter air temperatures are frequently less than 4.4° C. The most resistant stage of the cigarette beetle to low temperature is the fourth larval instar.

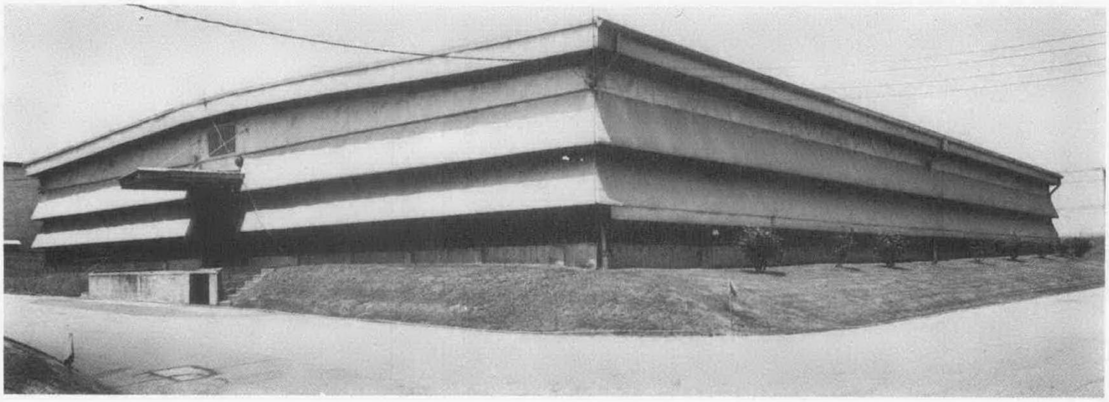

FIGURE 1. Louvered tobacco storage.

Childs et al. [1,2] reported that an exposure of 3 weeks was required to kill all unprotected larvae held at 4.4° C, but protected larvae found near the center of a hogshead of tobacco were killed only after the hogshead had been exposed to 4.4° C for a period of 8 weeks. The air temperature inside louvered tobacco storages located in the United States seldom is consistently below 4.4° C for a period of 8 weeks, therefore, some cigarette beetles survive in tobacco stored in this type of a structure.

Since low temperature during the winter does not kill all the cigarette beetles infesting tobacco stored in louvered warehouses, most tobacco companies in the United States have closed their storages so that they may protect the commodity more efficiently with aerosols and fumigants, Figure 2. Another advantage of the closed storage is that the migration of insects into the storage is reduced. Tobacco does not chill as well in closed storages, therefore, the environment has been improved for breeding of cigarette beetles. However, even in closed storages many cigarette beetles located in tobacco near the perimeter of the container are killed by winter temperatures.

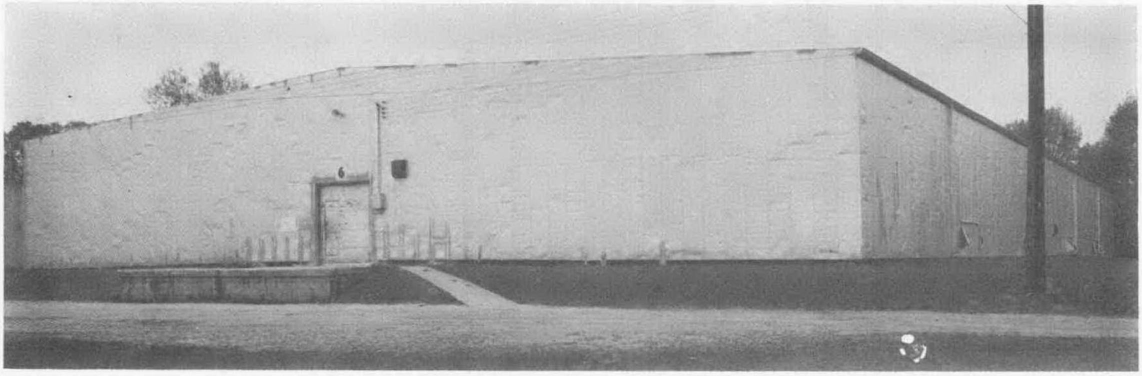

FIGURE 2. Closed sheet metal tobacco storage.

Fletcher et al. [3] conducted an experiment in a tobacco storage constructed of sheet metal side walls, composition roof, and wooden floors to evaluate controlled ventilation of the storage during the winter. They attempted to sustain temperatures of less than 4.4° C in hogsheads of tobacco over a period of more than 8 weeks. When temperature of air outside the tobacco storage was more than 3.3° C lower than tobacco temperature at 10 cm inside a hogshead, fans were activated to draw outside air into the storage. When the difference in temperature was less than 3.3° C, the ventilation system was inoperative. The ventilation system was controlled automatically and was never in operation when the relative humidity exceeded 90%. The experiment was conducted from November 1969 through April 1970.

The total number of days with mean temperatures of 4.4° C or less at the surface and at depths of 2 and 24 inches in three test hogsheads were 91, 92, and 93 respectively or approximately 13 weeks, Figure 3. In two of the hogsheads the relative humidity remained stable during the entire experiment and in the third increased by 7%.

Data given in Table I show no survival of the cigarette beetle in the test hogsheads exposed in the warehouse, but both control hogsheads contained living insects in the adult, pupal, and larval stages. The absence of any surviving cigarette beetles indicates the insect could be controlled in warehouses by using low temperatures, providing the winter season is sufficiently long and cold to provide the chilled air. A review of winter temperatures in the Durham, North Carolina area (location of the fan ventilated storage) indicated that temperatures were low enough

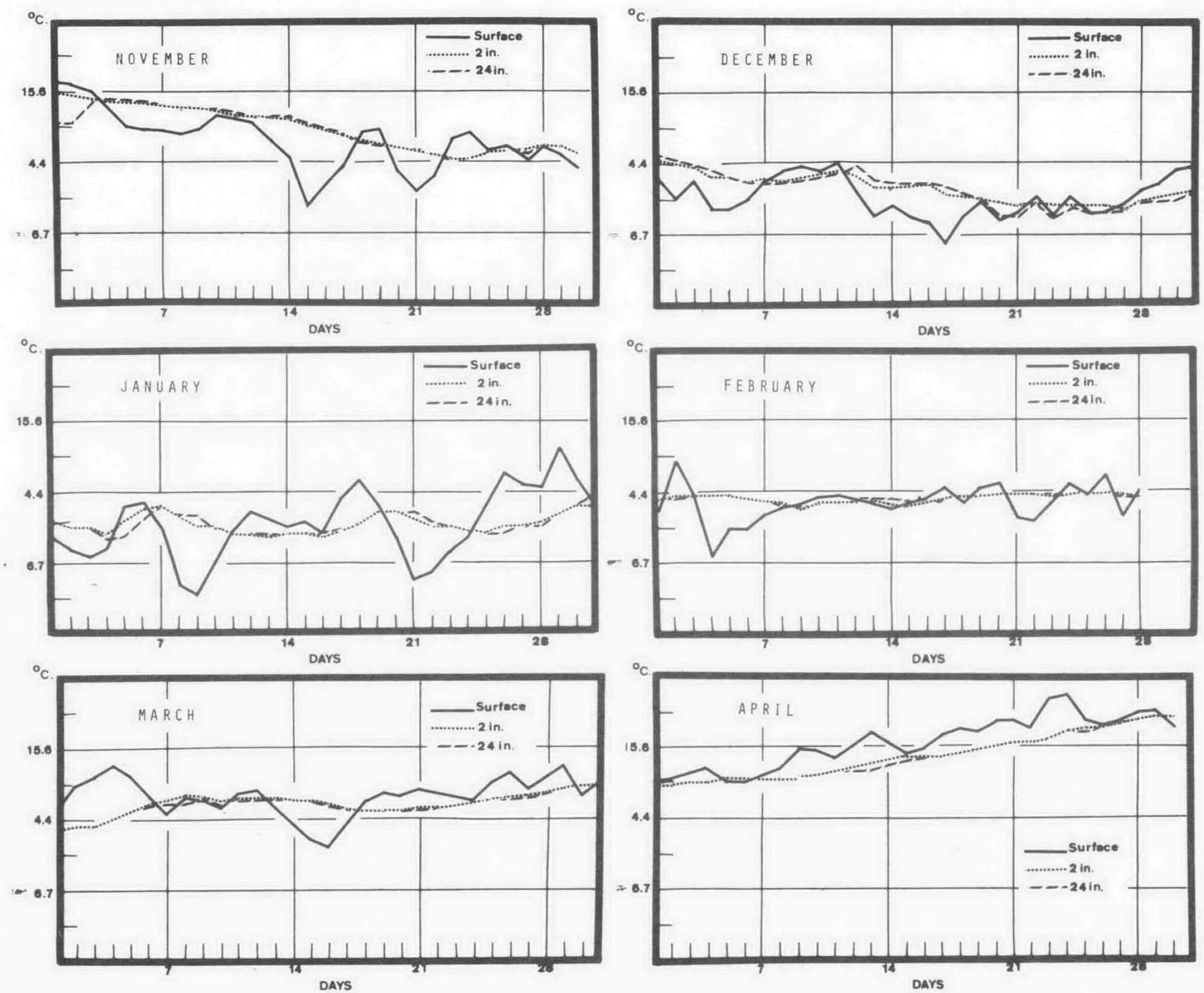

FIGURE 3. Mean daily temperatures recorded at the surface of a tobacco hogshead and at a depth of 2 and 24 inches in a fan ventilated storage.

during ten of the past twelve years to have been useful in controlling cigarette beetle infestations. Control probably was possible during the entire twelve-year period if warehouses designed to make maximum use of low temperatures had been available.

TABLE 1. Number of living and dead cigarette beetles removed from infested hogsheads of flue-cured tobacco stored under field (test) and laboratory (control) conditions (four 0.5 lb. samples per hogshead).

		Number of Insects					
		Adult		Pupae		Larvae[a]	
Hogshead	No.	Live	Dead	Live	Dead	Live	Dead
Test	1	0	347	0	4	0	870
	2	0	547	0	1	0	1547
	3	0	252	0	3	0	1962
Control	4	20	721	34	2	463	69
	5	26	627	4	1	165	5

[a] First and second instars not included as tobacco not examined microscopically.

A number of tobacco storages were constructed in the United States during 1973 and more are planned for 1974. These storages were constructed similarly to closed storages built 30 or more years ago. We would like to have storages constructed with sheet metal side walls, composition roof, concrete floors, side walls and roof insulated, and the exterior surfaces coated with reflective paint to reduce heat generated from solar radiation. Ventilation should be provided by fans operating from the roof to draw outside air into the storage. Air is to be vented from the storage through gravity close vents located along the side walls about 0.3 m above floor level. The fans should have the capacity to completely change the air in the storage at 4-minute intervals. Operation of the fans should be controlled automatically by sensors that detect outside air temperatures and relative humidity and temperatures within the hogshead. Forced ventilation with fans for insect control should be practiced only from late fall to the end of the winter season.

Larvae of the cigarette beetle are motivated by temperature and/or moisture to move from a nonpreferred to a preferred climate zone, Fletcher et al. [4]. The authors applied these findings to a field experiment that caused larvae of the cigarette beetle, 4th instar, to move from tobacco near the perimeter of hogsheads to the warehouse floor. The experiment was conducted in the fall when there was an opportunity through force ventilation to chill or warm the tobacco. Data given in Figure 4 show that the tobacco temperature over a period of 19 days was reduced to less than 12.8° C. At this time, the ventilation system was changed from a cooling to a warming cycle. The tobacco temperature increased rapidly and for 56 hours was above 15.6°C. During the warming period, relative humidity at the surface of the tobacco was lower than at a depth of 2 inches in the hogsheads. Larvae were seen leaving the hogsheads during the warming period. A second larval emigration occurred after the tobacco temperature was again lowered to less than 12.8°C and the increased rapidly to a gradient of more than 15.6° C. During the second warming period, temperature of the tobacco was above 15.6° C for 20 to 24 hours and again larvae were observed leaving the hogsheads. The total number of larvae that fell to the floor during the two emigrations exceeded 1,200 and all were the fourth instar. No larvae migrated from hogsheads stored in the laboratory as controls.

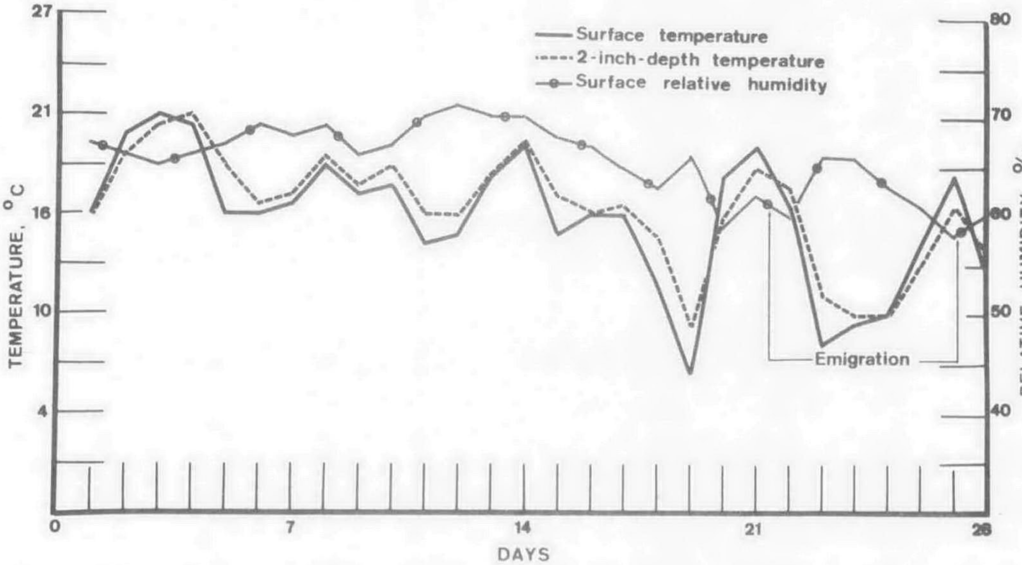

FIGURE 4. Average daily temperatures and humidities recorded before and after two larval cigarette beetle migrations.

We believe that a cooling period of sufficient length followed by a rapid warming cycle triggered larval movement. Under these conditions larvae migrated to the surface of the tobacco where it was warmer and drier and fell to the floor. The larvae eventually died from cold as no suitable overwintering habitat was available.

The integrated insect control program currently recommended for protection of tobacco stored in the United States commences in the spring by activation of a light trap, Figure 5. This is the standard trap used by the tobacco industry and is operated continuously in tobacco storages from early April to mid-November. Two traps are operated at each floor level provided the cubic meters of storage space do not exceed 17,000. The traps are hung near the ends of the storage, facing each other, above the top tier of bales, cases, or hogsheads. The traps are examined weekly for catches of the cigarette beetle.

Usually, tobacco storages are not treated with a chemical

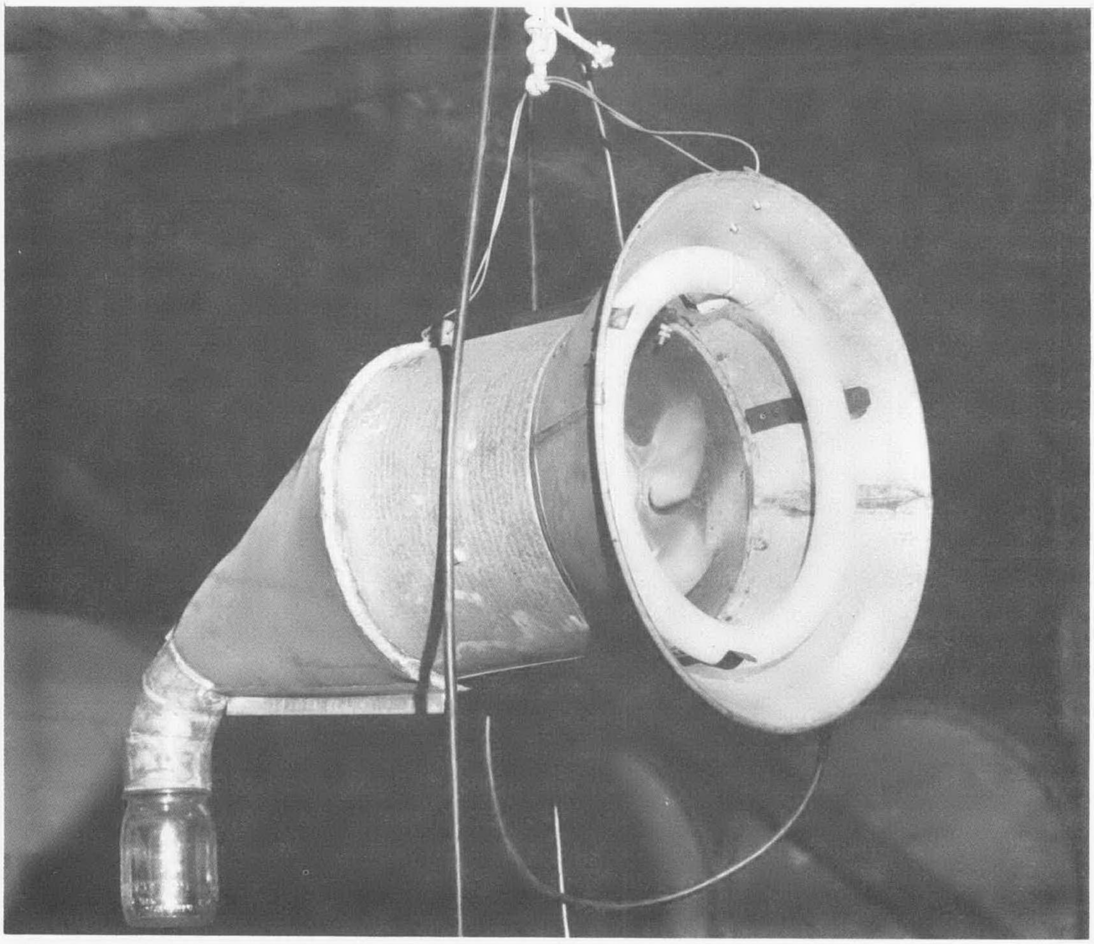

FIGURE 5. Standard suction/light trap used in the tobacco industry.

pesticide until the number of beetles caught weekly exceeds 500 per trap. At this time, the storages are sealed for fumigation with phosphine. The dosage of fumigant is 3 bags of Detia(R) Gas-EX-B or 20 tablets of Phostoxin(R) per 28.3 m^3. With tobacco temperatures above 20° C each storage is under fumigation for 4 days and then is aerated for 2 days. After the aeration period, dichlorvos is released daily in the storage to prevent reinfestation of tobacco by cigarette beetles entering the storage from an outside source. Normally, dichlorvos is released by an automatic dispensing system at approximately 5:00 p.m. and the dosage per application is 0.5 g per 28.3 m^3. Dichlorvos is released in the storages until flight activity of the cigarette beetle ceases due to cool fall temperatures.

A major tobacco storage corporation has followed this type of an insect control program since 1968 and has not lost a hogshead of flue-cured tobacco from crops placed in storage since that time. The cost of their insect control program, including repair of storages and expenses related to recording insect catches in traps located at 20 storage points (approximately 150 warehouses) was 65 cents per hogshead in 1973. The expense of this insect control program is nominal when compared to the average value of tobacco in a hogshead which is more than $1,000.00.

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