GIBBERELLIC ACID REDUCES SUSCEPTIBILITY OF CITRUS FRUIT TO TEPHRITID FRUIT FLIES

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The naturally-occurring plant growth regulator, gibberellic acid (GA), has been used for many years to delay the onset of peel senescence of citrus fruit and to inhibit spontaneous fruit drop. We have found that its use also is beneficial in extending the natural resistance of citrus fruit to tephritid fruit flies, including the Caribbean fruit fly (*Anastrepha suspensa*).

Currently, approximately 92% of Florida grapefruit are shipped to Japan using the Caribbean Fruit Fly Protocol fly-free certification approach, rather than by use of postharvest treatments (cold treatment or methyl bromide fumigation). Because of increased fruit susceptibility to the Caribbean fruit fly late in the season, the Standard Season (December 20 - April 15) certification requirements are more rigorous than the Early Season (pre December 20) requirements.

Many growers cannot meet the requirements of the Standard Season Protocol, which includes a 1/2 mile host plant-free buffer zone, whereas the Early Season Protocol requires only a 300 foot buffer zone. GA treatment is currently being evaluated as a means to help growers achieve fruit fly-free certification of mid-season Florida grapefruit. The intent is to use a prescribed GA treatment to extend the early-season properties of the fruit that afford resistance, and thereby allow an extension of the early-season Caribbean Fruit Fly Protocol certification provisions, allowing continued use of a 300 foot host plant free buffer zone through February 28th. This could permit many growers to achieve certification beyond the normal end of their harvest season as an alternative to removing host plants up to 1/2 mile from their groves.

Heat and Other Considerations for Postharvest Commodity Disinfestation

William E. Currie

HEAT

People have been using heat since the discovery of fire in prerecorded history. Through the centuries heat has been applied in various forms to preserve food and other goods, and the means and techniques have become more sophisticated as we have learned more. The scientific literature has many studies documenting the application of heat to control insect pests in various situations, since about 1883. Some of the early work cited that raising the ambient heat could be used to kill insect pests in mills, libraries or other structures. In the 1920's research turned more toward determining the high and low temperature death point for insects under highly controlled conditions. It was found that most insects have a relatively narrow ambient temperature tolerance, which varied by species. It was also noted that a gradual change in temperature, either up or down, allowed the insects to adapt somewhat and therefor survive at higher or lower than normal temperatures. Most of these studies were not conducted in large quantities of infested commodities until recently.

Dr. Ebeling and the late Dr. Forbes started putting heat to practical use in controlling insects in structures in the late 1980's. Using polyethylene or other heat impervious tarps to contain the heat, and using propane fired forced air burners to duct the heat into the structure, they found that drywood termites, cockroaches and some other structure infesting insects could be controlled. Unfortunately, it is not yet practical to use heat for controlling subterranean or Formosan termites using this method. The disadvantage is that, similar to fumigation, reinfestation can occur when the temperature drops below the kill point. For some insect pests, such as cockroaches, the application of a non-volatile residual pesticide, such as boric acid, just before the heat is applied does provide residual control, and also has a synergistic effect upon the insects, achieving a faster kill. This is the patented Thermal Pest-Eradication method.

The International Pest Management Institute (IPMI) has collaborated with TOPP Construction Services in research to develop a practical method to use heat for killing insect and other pests inhabiting or contaminating commodities. Because this effort is funded from our own pockets, and expendable time is low, progress has been slow. From the literature we know the temperature kill range is 40°C (104°F) up to 77°C (170.6°F), with exposure times from 12 minutes for the higher temperatures to 50 hours at lower temperatures. Variations are also noted for different species and life stages of insect pests.

From this basic information we decided to build a machine that would have the capability to conduct the lengthy trial and error research to determine the optimal temperature and dwell time necessary to kill insect and other pests infesting commodities. The criteria we had to consider are many, and we continue to find new ones as the project develops.

The first criteria is to be able to bring the temperature to the desired level rapidly to avoid the pest becoming conditioned, thus raising the kill point. The method chosen is a direct propane-gas fired forced hot air pressurized heater which provides 400,000 BTU's per hour and 4600 cubic feet per minute air stream.

The second criteria is to eliminate the influence of outside temperature fluctuations. We found that the housing of the machine can be a heat sink reducing internal temperatures, or outside weather conditions may cause internal temperature variations. An insulated refrigerator shipping container, either 20 or 40 feet long is structurally sound, can be mounted on a truck, or shipped by rail or boat to its destination, and with its 4 inches of insulation negates the influence of temperature variations from outside conditions.

The third criteria is to provide for adequate air flow to eliminate hot spots or cool spots within the SAFE-HEAT container. By the appropriate placement and sizing of vents to the outside of the SAFE-HEAT container, air flow eliminates the presence of hot spots or cool zones inside.

The fourth criteria is to be able to accurately monitor the temperature at several points concurrently or any given point separately and be able to graph the data. Several micro temperature probes are mounted within the SAFE-HEAT container at critical points, and other probes can be inserted into vessels or commodities to record temperature data. The data is downloaded into a computer and programmed to make a graph.

The fifth criteria is to prevent the escape of mobile insects that may attempt to avoid the temperature increase. The interior of the SAFE-HEAT container is sealed with fiberglass, and vents or other openings through the shell and insulation are lined with stainless steel and molded fiberglass. The double door in the end of the SAFE-HEAT container has a tightly fitting double rubber seal. Additionally the opening is lined with a specially designed heat tape that is thermostatically controlled to provide a 170°F barrier to prevent escape of crawling insects. Flying insects don't live long enough to escape.

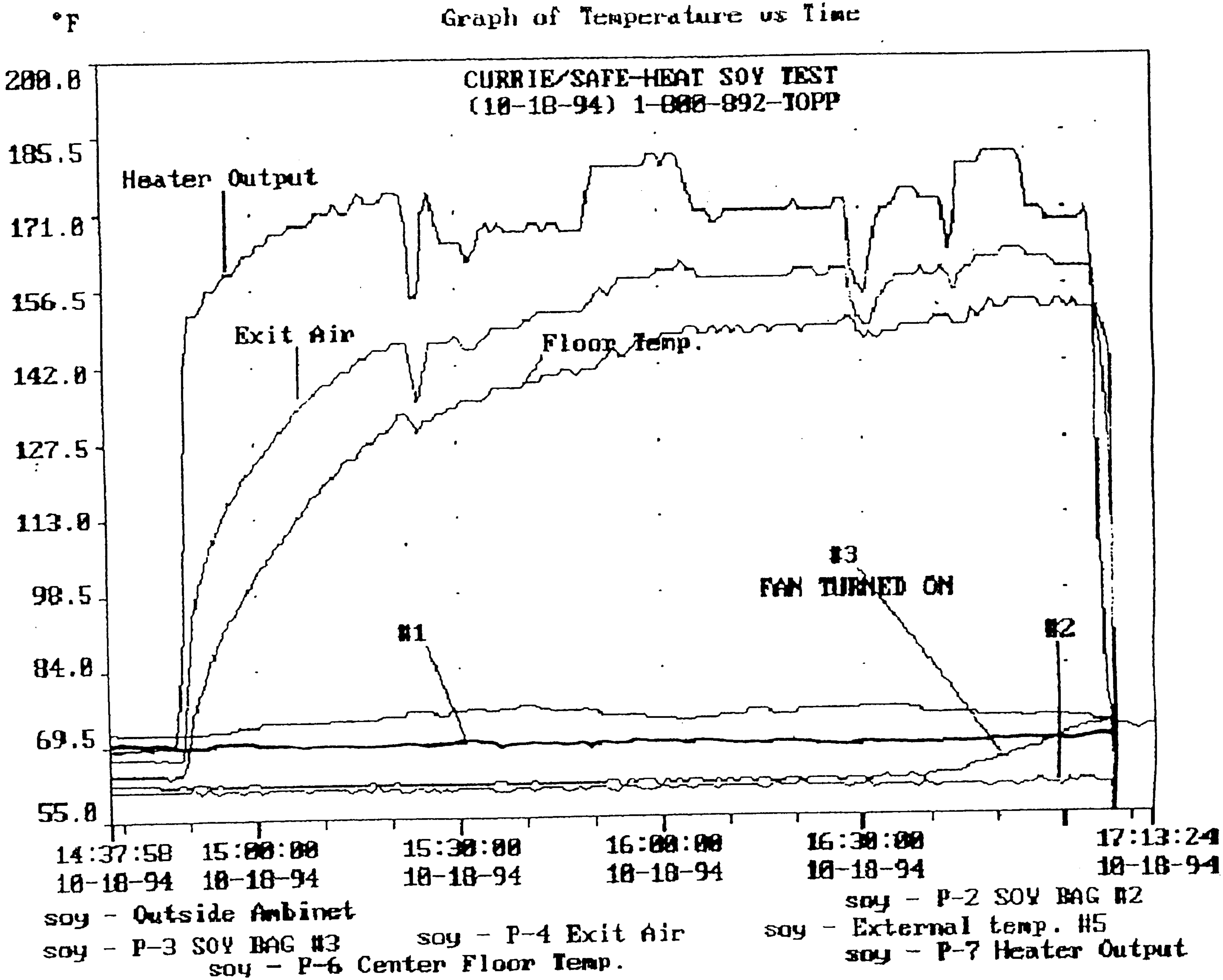
The sixth criteria is to be able to increase the air pressure within the SAFE-HEAT container to provide better penetration of materials. A manometer is installed to indicate air pressure in inches of water column, and the aperture of the main exit air vent can be adjusted to increase pressure. With the doors closed and the exit air aperture fully open, the manometer reads 0.17 inches H_2O. With the aperture 50% closed (limited) the manometer reads 0.25 inches H_2O.

Several tests have been conducted on German cockroaches (*Blatella germanica*), in contained aquaria and glass bell jars, as well as set free on the SAFE-HEAT container floor. Those that cannot escape the 140°F heat into a crack or crevice within 10 minutes become moribund, and die in about 15 minutes elapsed time. Mice that cannot escape this heat, die within about 30 minutes. These tests were conducted without the presence of commodities to escape into, only providing water, a small amount of food, and wood or cardboard as refuge within the glass containers.

We decided to cut to the chase and see what happens if heat is applied to a raw commodity heavily infested with insects. Three 100 pound bags of raw soy-beans infested with dermestid beetles and sawtooth grain beetles were placed inside the SAFE-HEAT container. Temperature sensing probes were placed in the center of the three bags. Heater output air temperature increased rapidly and reached 156.5°F within 7 minutes. The heater was adjusted to provide about 170°F for the remainder of the test. Exit air temperature reached the desired 140°F in about 22 minutes after start up. Exit air temperature is critical as it reflects ambient air temperature inside the SAFE-HEAT container. The aluminum floor can act as a heat sink, which is reflected in the slower rise to killing temperature recorded.

The thing that most amazed and frustrated us is that the temperature in the center of the bagged commodity did not change more than a 2°F fluctuation. It had not occurred to us that the bagging material may have been impervious to heat, thus protecting the insects inside. After an hour and a half, we placed the Soy Bag #3 in a bin that is fitted with a forced air fan to blow the heat directly onto the bag. Only then was there a discernable rise in temperature.

We have a lot more work to be done, before this method will be ready to be used for disinfesting agricultural commodities. However, There is a lot of promise in the approach we have taken and our goal is to be able to provide a SAFE-HEAT container machine for disinfesting commodities in the near future.



°F
Graph of Temperature vs Time
CURRIE/SAFE-HEAT SOY TEST
(10-18-94) 1-800-892-TOPP
200.0
185.5
171.0
156.5
142.0
127.5
113.0
98.5
84.0
69.5
55.0
Heater Output
Exit Air
Floor Temp.
#1
#3
FAN TURNED ON
#2
14:37:58 10-18-94
15:00:00 10-18-94
15:30:00 10-18-94
16:00:00 10-18-94
16:30:00 10-18-94
17:13:24 10-18-94
soy - Outside Ambinet
soy - P-3 SOY BAG #3
soy - P-6 Center Floor Temp.
soy - P-4 Exit Air
soy - P-2 SOY BAG #2
soy - External temp. #5
soy - P-7 Heater Output

70-4