CURRENT INITIATIVES IN THE MASS PRODUCTION AND FIELD RELEASE OF THE MEXICAN FRUIT FLY, *Anastrepha ludens*, IN THE LOWER RIO GRANDE VALLEY OF TEXAS

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Abstract

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In order to reduce program operating expenses in the South Texas Mexican Fruit Fly Sterile Release Program, four cost reduction initiatives are in progress at the U.S. Department of Agriculture's Mexican Fruit Fly Rearing Facility. These initiatives include implementation of a less expensive larval diet formulation, automation of the larval diet dispensing process, processing and reutilization of spent larval diet medium, and a more efficient system for emerging and feeding sterile flies prior to field release.

1. INTRODUCTION

The Mexican Fruit Fly, *Anastrepha ludens*, Loew, a destructive pest of citrus was first reported infesting fruit in South Texas in 1927. Since the Mexican fruit fly was not established in other citrus producing areas of the U.S., all fruit originating in South Texas for shipment to these areas required treatment with the fumigant ethylene dibromide (EDB). In 1984 , the U.S. Environmental Protection Agency, banned the use of EDB on citrus destined for consumption in the U.S. From 1984 to the present time, the sterile release program has been the principal means of fruit certification in the Rio Grande Valley of Texas. Funding for the program is provided by The Citrus Industry, The Texas Department of Agriculture and The U.S. Department of Agriculture. In order to maintain program viability within the constraints of limited funding it has been necessary to reduce program expense wherever possible. Four such cost reduction initiatives are discussed here.

2. DESCRIPTION OF INITIATIVES

2.1. Development of less expensive larval diet formulations

The larval rearing medium for the Mexican fruit fly was adapted from the fresh carrot medium developed in Hawaii by substituted powdered dehydrated carrot for fresh carrot but results were inconsistent when used in mass production. Rhode and Spishakoff [4], found that the addition of dried torula yeast, a non-fermenting, dietary supplement, produced more consistent results and improved yield and larval weight. The torula yeast-fortified, dehydrated carrot diet medium was the standard used for mass production of the Mexican fruit fly from 1965 until recently.

The quality and cost of both dehydrated carrot powder and torula yeast have proven to be highly variable and problems with quality have produced disastrous production results on numerous occasions. Additionally, carrot powder is perishable and storage at room temperature is limited to approximately three months. For these reason, a search for alternative ingredients was undertaken.

2.1.1. Replacement of dehydrated carrot powder

The quality of dehydrated carrot powder was highly inconsistent and production results were variable. For this reason, a replacement for carrot powder was the first priority. A wide variety of dried, powdered materials were tested but wheat germ was found to produce superior results (Table 1). While raw wheat germ produced slightly better results, stabilized wheat germ, or wheat germ that has been heat treated to reduce enzymatic activity, is the ingredient of choice due to its extended shelf life.

2.1.2. Replacement of torula yeast

Torula yeast was chosen for replacement primarily due to its high cost. Earlier tests had shown that torula yeast could be reduced by 50% (6.4% to 3.2%) and replaced with raw wheat germ and a vitamin supplement and meet all of the quality control parameters. The complete removal of yeast from the larval diet and replacement with raw wheat germ increased the larval development period by two days and decreased yield by approximately 20 percent. The quality control parameters were normal. Jang [5] demonstrated the importance of niacin, calcium pastothenote and riboflavin in the nutrition of medfly. Larval yield and ratio of development were normal when these B vitamins and Roche vitamins mixture were added to the diet. Production and quality control parameters comparisons of the standard torula yeast and yeast free diet are found on Table 2. The comparison of the carrot powder, wheat germ and no yeast larval diet medium, expressed as percentage by weight, is found in Table 3.

2.2. Automation of larval diet dispensing process

The larval diet medium used at the USDA facility in Texas consists of dry, finely ground nutritive ingredients, preservatives, acid and water (Table 3). The consistency of the finished product is semisolid and conveyance of the material from the mixer to the tray loading area has typically been performed through the use of a screw type auger. While the auger is an adequate means of conveyance it is not useful for accurate dispensation of product. Further, when dispensing a semisolid material such as the larval diet medium, it is necessary to manually spread the material and smooth the surface prior to the seeding of eggs. This process was very labor intensive and was identified as an area where cost savings could be obtained through automation.

Engineers at the USDA, APHIS, PPQ Aircraft and Equipment Operations Center, Edinburg, TX began investigating commercially available pumps that were capable of conveying the diet medium with enough force to extrude the material into a smooth surfaced sheet while being dispensed into the diet tray. Several designs showed promise but the most compact, least expensive design was the sinusoidal rotor pump, model MR-135-RF manufactured by the Sine Pump Company, Orange Mass. 01364. A pneumatic motor, axial piston design, model number 73337AA7, Cooper Industries, Gardner-Denver Division, Lexington, S.C. 29072, was chosen as the pump drive motor due to the repeated cycling

Table 1: CARROT POWDER REPLACEMENT

Ingredient	Pupal Wt Mg	Pupal/ Kg of diet	% Eclosion	% Fliers
Carrot Powder	7.4 ± 1.5	5,458 ± 532	96.7 ± 4.4	94.7 ± 4.0
Stabilized W.G.	20.2 ± 1.6	4,993 ± 846	96.7 ± 1.5	93.7 ± 3.1
Corn Germ Cake	18.9 ± 1.4	4,393 ± 1039	95.0 ± 2.4	91.2 ± 2.7

Means ± SD

Table 2: TORULA YEAST REPLACEMENT

Diet	Pupal Weight (mg)	Pupae Per kg Diet	Percent Emergence	Percent Fliers
Torula Yeast	20.7 ± 0.75	5,522 ± 451	98.4 ± 0.75	95.5 ± 2.5
Yeast Free	18.8 ± 1.31	5,805 ± 698	98.4 ± 1.1	94.9 ± 5.4

Means ± SD

Table 3: MEXICAN FRUIT FLY LARVAL DIETS. MISSION MEXICAN FRUIT FLY FACILITY; MISSION, TEXAS

Ingredients	Carrot Powder	Wheat Germ	No Yeast
Water	66.8	59.6	60.00
HCL	0.66	0.95	0.95
Sodium Benzonate	0.08	0.1	0.1
Methyl Paraben	0.21	0.23	0.23
Corn Cob Fractions	11.93	15.8	15.8
Sugar	7.42	8.40	8.4
Carrot Powder	7.42	--	--
Torula Yeast	5.44	6.3	--
Wheat Germ	--	8.4	14.86
Guar Gum	--	0.1	0.1
Vitamin Mix*	--	0.1	0.1
B Vitamin Supplement**	--	--	0.0025

*Vitamin Premix, Roche Vitamins and Fine chemicals, Hoffman-LaRoche, Inc., Nutley, New Jersey 07110.
**D-Calcium Pantothenic acid, Riboflavin, and Niacin @10:5:10 mg/Kg of diet.

required for dispensing into individual trays. When in operation, the pump is controlled by a programmable digital revolution counter which controls a pneumatic solenoid valve on the air motor. Magnetic sensors on the pump shaft send pulses to the revolution counter and when the programmed set point is reached power to the solenoid valve is interrupted.

The labor required to dispense diet and infest trays was reduced by more than 50 percent by implementing the diet pump.

2.3. Processing and reutilization of spent larval diet medium

The majority of mature Mexican fruit fly larvae will pupate in the spent larval diet medium if not removed. The standard procedure used for Mexican fruit fly larval collection has been to dilute the spent diet medium containing larvae (and some pupae) with water, agitate the slurry with compressed air and collect the larvae by passing the slurry through a screen sieve. This system results in the loss of the spent diet medium and the creation of much waste water. Additionally, the larvae collected from the water must be placed in a pupation substrate, such as vermiculite or sawdust, to reduce mortality during pupation.

Tests are in progress to replace the water sieve larval collection process with a dry method utilizing a rotary screen sieve. The spent diet medium is dried thoroughly during the last 24 hours of larval development by using dehumidifiers and wall mounted fans. The dried, granular spent medium is then poured into the hopper of the rotary screen apparatus. The screen cylinder, 61 cm in diameter x 175 cm in length, rotates at 4.6 revolutions per minute. The cylinder has two screened sections, the first, measuring 91.5 cm in length consists of screen with hole opening size of 2.4 mm. The second screen is 30.5 cm in length with an opening size of 6 mm x 18 mm. The dried diet medium passes through the first screen into a collection cart situated beneath the screened cylinder. The larvae continue down the inclined screen cylinder to the second screen where they exit and are collected in plastic pails. The surface of the diet medium often forms a crust that is difficult to break up and exit with the granular material. The large pieces (> 6 mm in diameter) exit the end of the cylinder and are collected in plastic pails. This material is combined with the granular material and processed for use as animal feed, soil conditioner or other purposes.

Efforts are currently underway to process the spent diet medium by pelletizing. The pelletizing machine requires that the diet moisture content range between 8-15 percent.

The pelletizer will destroy residual Mex fly larvae and produce a product which can be stored in reduced space for extended periods. The new larval collection and diet disposal system will hopefully be operational in the near future.

2.4. Emergence and feeding of sterile flies prior to field release

Sterile fruit flies are typically released by air as either active or chilled adults. Sterile flies used in the South Texas SIT program are emerged from pupae in screen panelled, plastic boxes measuring approximately 50 cm x 60 cm x 30 cm. Each box holds 6 paper bags containing 4,000 pupae each. The bags are loosely closed with staples to permit exit of the emerging flies from the bag into the box. Food in the form of 1% agar, 24% corn syrup and 75% water is placed on a screen panel centered on the lid of the box. Flies obtain water and nutrients from the food.

These emergence containers are commonly called PARC boxes (Plastic Adult Rearing Container) and are an improvement over earlier containers made of cardboard. They are durable and can be cleaned with water after each use. However, there exists inefficiencies with this system such as poor space utilization, high expendable supply cost and excessive insect escape.

A new system is presently being investigated which, if successful will either eliminate or reduce the extent of the aforementioned problems associated with the PARC box. The basic unit consists of an aluminum window screen frame measuring 76 cm x 76 cm constructed of 2.5 cm x 2.5 cm aluminum square tubing. Each frame is fitted with polyethylene screen material with a opening size of approximately 1.2 mm. A diagonal brace, located on each inside orner of the frame, forms the pupae loading area of the system. The diagonal brace is constructed of perforated aluminum with perforation hole size of 2.4 mm. A cloth panel, 15 cm x 15 cm, is sewn into the center of the screen panel and serves as a feeding site.

In operation, approximately 3,250 irradiated dyed pupae are poured into each of the four pupae compartments. The individual trays are stacked one on top of the other to a height of 185 cm, which is a total of 73 trays. The top tray forms the lid and is not loaded with pupae. The adult flies emerge from the pupae for a period of 5 days. The emerging adults escape the pupae compartment by crawling over the top of the perforated aluminum partition, or passing through the perforations. Once the flies are free of the pupal compartment and within the confines of the stacked trays, they obtain water and nutrition from the cloth pad located on the center of each tray. A mixture of 5% sucrose, 0.02% sodium hypochlorite and water is fed the flies by using a drip emitter tube located at the top of the tray stack. The liquid is dispensed at a constant rate of approximately 400 mls per hour throughout the 5 day eclosion period. Some further refinement of the feeding system is required at this time. This work is in progress.

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