

Development of mechanized application methods for applying “Pheromone Rope” early season in cotton

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The necessity to explore all possible means of timely applications of ShinEtsu’s controlled release pheromone (PBW-rope) to non-Bt cotton in a statewide eradication program led program managers to discuss the feasibility of mechanizing this part of the program protocol.

The application of “PBW-rope” has always been labor-intensive operations requiring a labor crew to physically hand tie the rope to plants. In an eradication program, it is necessary to apply the rope before the plants pin square (at approximately the 7-leaf stage). This will assure that Pink bollworm males are unable to successfully find females within the field, mate, and subsequently the females laying eggs on hostable developing cotton squares.

The anticipation of large acreage of non-Bt cotton, and a relatively narrow window of application where the plants are large enough to tie ropes on yet prior to pin square, presented a significant challenge to find and employ enough field labor to accomplish the task. The rope is applied at 200 per acre on a grid of 217.8 square feet. This equates to an application technique of ropes being tied every 4th row and linearly every 16 to 17 feet.

The pheromone is a controlled release from the reservoir within the rope, and becomes an airborne scent carried by air currents. There are 200 release points per acre which inundates the field with pheromone. Adjustments may be made in either the width (number of rows) or the length (linear placement down the row) and still achieve the desired number of ropes per acre.

In order to mechanize the application, it would be necessary to find some other form of delivery to the field other than tying the rope to the plants. Small bamboo splints were a common product found in nursery and floral supply stores which, when the rope was attached, could then be applied in the seed line by hand or possibly mechanized. This method of application would also widen the window of application by allowing rope to be applied earlier before the plant was large enough to hand tie.

Rope, when properly applied, had never presented a problem from cultivation or other field operations of being inadvertently removed from the plant, and there was no evidence that the picking operations could result in contamination at the gin. In July of 2002, a field trial of ropes, hand wrapped on nursery sticks, was applied to a field in the seed line, followed by cultivation and subsequent field operations. In December of 2002, a field trial was conducted on a variety of methods of applying rope (i.e. had tied loose, twisted, on sticks, etc.) just ahead of picking operations. It was determined that pheromone rope wrapped on sticks and applied in the seed line presented no threat to contamination at the gin, and that normal field operations such as close cultivation would not remove or effect the placement of the sticks.

The next challenge was to find a method to efficiently wrap the pheromone rope on sticks and develop a mechanical device to apply the sticks in the field. USDA-APHIS assisted in developing a prototype wrapping machine, and a pneumatic driver that could be mounted on a tractor to place the stick in the field. However, testing of the wrapping machine eventually proved to discover that the rope was wrapped too tight, resulting in the breakage of the rope matrix and the rapid loss of pheromone as well as excessive cost to commercially develop enough machines to effectively provide an estimated three million wrapped sticks. The application machine also seemed cost prohibitive to develop and commercially be available and reliable in field conditions. The conclusion drawn was that we would need equipment that was already available on the market which could be modified for our purposes.

As a result, in February of 2004, the Council authorized the purchase of a single Transplanter and tool bar designed for transplanting seedling melon plants over the top of plastic mulch. This equipment allowed for the unit to travel down the row without making a furrow while effecting the placement of the transplant using a “cup” or “shoe” that rotates on a ground driven wheel punching a placement hole through the plastic mulch and seed bed, then opening and depositing the transplant. Press wheels then firm up the soil around the transplant.

Modifications of the equipment for our purposes included:

1. Removal of existing ground drive mechanisms that were designed to space melon plants only inches apart (ropes would be placed in linear feet down a row).
2. A hydraulic driven “orbit” motor installed to provide rotation of the Transplanter wheel, coupled to an electric actuated “clutch-brake” (designed for assembly-line industrial applications).
3. The 12-volt signal required to activate the rotation of the Transplanter was supplied via a sensor counting teeth on a sprocket mounted on a gauge wheel. This is relayed to an adjustable counter box that can be set to send the electrical signal on a pre-set count.

The modified single unit Transplanter was successfully demonstrated in May of 2004, capable of placing a single pheromone wrapped stick in the cottonseed line at a pre-determined distance down the row.

July of 2005, the Council was ready to demonstrate two transplanters mounted on a single tool bar allowing for the application of two rows in a single pass, six rows apart. Additional design was needed to strengthen the toolbars and larger press wheels were added for better flotation in soft ground.

The Pink Bollworm Eradication Program began in Arizona in 2006. Completion of three twin Transplanter units moved from fabrication straight to the field just in time to begin the application of rope. A contract with the Arizona Department of Corrections provided labor to wrap the pheromone rope on bamboo splints (sticks) that were purchased from Viet Nam. A total of 3,000 acres were mechanically applied on approximately 12,000 acres of non-Bt cotton planted in the 2006 program area.

The equipment was repaired and serviced in the winter months and returned to service in year two of the program treating another 3,000 acres of the non-Bt planted cotton. Replacement of the aluminum “shoes” or “cups” was required in the fall of 2007 because of wear.

Each unit requires a tractor driver and two “feeders” that are seated over the transplanters which “feed” a pheromone wrapped stick into the cup after each rotation. The tractor travels at 2 ½ mph. Linear placement occurs every eleven feet of row every three seconds. Depending on field size and distance of travel to additional fields, the three units can easily complete 160 – 200 acres a day.

These modified transplanters have provided an economical and accurate alternative or supplement to field labor forces.