Proceedings from the

Third

ORGANIC CRANBERRY GROWING CONFERENCE

May 2001

CRANBERRY EXPERIMENT STATION
UMASS. EXTENSION

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UMass Cranberry Experiment Station

May 14, 2001

Organic Cranberry Growing: A 10-year Perspective

Kristine Keese, Cranberry Hill Farm

Notes

My husband and I have been organic cranberry growers for the past twelve years. We had never grown any other way, so we had no preconceived ideas or "chemical dependencies". The bogs are adjacent to our house and we wanted to avoid chemical inputs in that environment. We had been told that cranberries can not be grown organically, but we saw bogs abandoned since the early 1940's that still bore some fruit. So we knew that the plant could survive with no inputs. The challenge was to manage the bog in such a way that we could get a consistent yield, and at the same time, keep the vines healthy and productive.

What we learned

At the time we started, there were no resources for learning about organic management of bogs. Much of the existing organic literature was not usable for cranberries. Theories of organic growing emphasized building up organic matter in the soil and avoiding a monoculture. Most organic inputs were not suitable for cranberries. We learned mostly by going back to old growing methods, relying on sand and water. We also studied the work of Dr. Franklin on pests and predators, and made our own observations on the bog.

First, we found that our yields, though consistent, continued to be reduced. Currently, a reasonable expectation for organic yield is 50-60% of the average yield for a given conventionally grown cultivar. Secondly, we found that insect and disease pressures were not as great a problem as predicted. Also, dire warnings of deteriorating plant quality and yields over time did not come true. The vines remained healthy and resistant to disease. Labor inputs for controlling weeds and the reduced yields are still the major problems for commercial organic production.

Cranberry growing has a strong heritage of accepted practices and continued innovations. There are also generally accepted prescriptions for timed chemical inputs, many based on research supported by the companies that produce these inputs. Some growers follow these prescriptions very closely; others are more likely to observe their bogs, know them well and continue with innovations. It is this need to know the bog well and to understand its needs that makes growing cranberries an exciting enterprise. When growers ask us what materials to apply, (i.e., when and how) for organic management, we are forced to say that we can not provide blanket prescriptions because so much depends on understanding the individual bogs.

Recently, there has been more interest in growing cranberries organically due to a continually expanding market for organic produce and a more stable price, as compared to the downturn of the conventional market. We believe that this is a continuing trend, but better prices for organic crop are not assured. Thus if one was to transition to organic growing based solely on expectations of higher profit, this would be a prescription for failure. Organic growers must first and foremost care about the plant, its health, and the health of its environment. Innovation in the service of that goal is an important aspect of organic growing, as is a strong desire for the organic practices to succeed. This is the basic motivation.

At this stage, the challenge of growing organically is an important experiment. We often hear a concern that growers who want the label of *organic* will "cheat" in their practices. It seems to us that in this new technology of organic, growers, who opt to "cheat" by using non-organic practices, are essentially cheating themselves of their newly learned skills and possibilities.

Our Production Practices

When we first began to work our bog over ten years ago, there were very few inputs allowed for organic agriculture that were suitable for cranberries.

With the assistance of the UMass Cranberry Experiment Station, we found a single fish fertilizer, Bordeaux mixture for fungus and Bt spray (*Bacillus thuringiensis*) for limited pest control, as well as some mined mineral products and food grade additives (e.g., molasses) that we could use on our farm. With the establishment of the Organic Materials Review Institute (OMRI; see Resources page), and the increased organic acreage of various crops, many companies began producing such inputs. The list of available materials, including fertilizers, soil additives and fungicides, has grown tremendously. It is possible to pick and choose various formulations, though many have not been actually tested on cranberries. Herbicides are not allowed under organic programs.

For insect control, we use industrial-sized insect electrocuters, as most cranberry pests are night flying moths, and late water. Regular sanding and late water give us good control for diseases and helps to control many pests. Some formulations of copper-based fungicides are also allowed. We think that since our vines are not pushed to high yields with chemical fertilizers, they are more resistant to diseases. We have had no dodder on our bog. The year it appeared, it was on the edges of our dike.

Our biggest problem is the variety of weeds. Our biggest labor effort is hand weeding. Sanding and proper management of drainage help manage weeds. We need to learn more about soil composition and plant nutrition. We hope that eventually we may be able to condition the soil to discourage certain weeds, but right now we do not understand enough about why they grow where we find them.

Many growers assume that under organic management, yields are reduced due to insect damage. This is not the case. We speculate that the weaker buds do not develop into fruit since they do not have the extra stimulation provided by chemical fertilizers. This could possibly be remedied with greater understanding of plant nutrition and by experimenting with newly available fertilizer products and plant stimulants.

We have consistently used late water and saw no reduction in yield. We have actually seen increases in our yield with a yearly spring flood. We think that the weaker buds, lost on an organic bog, may be adversely affected by a spring flood regardless of the fertilizers used, hence reports of a reduced yield on conventional bogs following late water.

Transitioning a chemically managed bog to organic takes longer than one season. The whole bog system must adjust to a different management regime. The required time for organic certification is three years with no forbidden (chemical) inputs. The yield is likely to fluctuate during the transition period.

For pest control, we depend a lot on predators. We try to use pest control methods that have no negative effect on the population of predators. We attempt to create habitats for predators off the bog that provide for their needs, such as areas of shade and nectar sources. This keeps them nearby. Here is an interesting note on weeds. Looking at the history of bog use by Native Americans, we found that nine out ten of the weed species that grow on bogs were once used and harvested for their medicinal properties. Perhaps such a use could be considered again.

What About the Future?

The market for organic cranberries is still growing, but so are numbers of competing growers. Canada has over 100 acres of organic bog under cultivation. There are several small bogs in Oregon and Washington. Wisconsin, which outproduces Massachusetts in conventional bogs, has over 41,000 acres under organic cultivation in various other crops. So, it is no stranger to organic production and cranberries can not be far behind.

Currently, most organic cranberry fruit goes to the fresh market and there is not enough crop for the interested processors. Juice makers are looking forward to more product. The price differential between fresh fruit and processing fruit appears to be greater for organic fruit than for conventional cranberries. It is not at all certain that the high price commanded by organic fruit will remain stable if the production increases substantially. Therefore, it is important to emphasize that a commitment to organic should come from a belief in this way of growing , not solely from a desire for profits. We look forward to more growers experimenting with organic methods and sharing their ideas and innovations.

The Use of Trichograms to Control the Cranberry Fruitworm

by Dominique Pelletier, François Fournier, and Guy Boivin

Introduction

The Cranberry Fruitworm is a pest of major concern to North American cranberry growers. Because the use of insecticides to control this pest involves health and environmental concerns, including threat to pollinators and natural enemies, alternative control method would be useful to growers.

In recent years, biological control has gained increasing interest among the agricultural community. The aim of biological control is to reduce pest populations by the use of natural enemies. Selection of natural enemies that are indigenous to a culture and well adapted to climatic conditions and to the pest is usually the key to a successful biological control program. Besides microorganisms (bacteria, virus, fungus) and predators, parasitoids are used commercially to control a wide variety of pests in many cultures worldwide. Parasitoids are insects that parasitize their hosts and kill them as they develop. They include *trichograms* that are minute egg parasitoids attacking eggs of lepidopteran pests such as the Cranberry Fruitworm. Upon emergence, a female trichogram searches the environment for host eggs that she destroys by laying her egg in it (Figure 1). The trichogram larva develops inside the host egg and eats the content. A few days later a new trichogram emerges.

The use of a trichogram strain native to cranberry bogs should be considered as a relevant alternative to practices that involve insecticides. Blackheaded Fireworm (*Rhopobota nævana*) which is the main cranberry lepidopteran pest in British Columbia, was found to be parasitized to levels up to 99% in an abandoned cranberry field. Further laboratory tests designated *Trichogramma sibericum* to be responsible for the same phenomena. Field trials demonstrated successful control of the pest with the selected species, which is now used commercially. Such success in the West Coast made us curious to find out if indigenous trichogram species would control the Cranberry Fruitworm in the East as well. We thus collected indigenous trichogram strains in wild and commercial cranberry bogs located across northeastern North America. Species collected were tested in the laboratory and selected according to their efficacy to parasitize Cranberry Fruitworm eggs as well as Sparganothis Fruitworm eggs, a cranberry secondary pest (table 1). Ease of rearing was also evaluated for each strain, since selected strains would be eventually mass-produced.

Figure 1. Trichogram female at work. *(Photo credit: Mathiew St. Louis.)*

Table 1. Ranking of collected strains according to their acceptance of Cranberry Fruitworm (CF) and Sparganothis Fruitworm (SF) eggs, and their ease of rearing. Legend: ★ poor, ★★ good, ★★★ very good. Shadowed strains were selected for field trials.

Strains	CF acceptance	SF acceptance	Rearing	Overall rank
INS-5	★	★	—	★
INS-6	★	★	—	★
INS-7	★★	★★★	★★★	★★★
INS-8	★	★★★	★	★
INS-9	★★	★★	★★	★★
INS-11	★★	★★	★	★★
INS-12	★★★	★	★★★	★★★

Among the seven strains tested, INS-7, INS-9 and INS-12 were considered the best ones. Strains INS-7 and INS-9 were tested in the field in 2000. Both strains demonstrated good Cranberry Fruitworm control but INS-9 showed lower parasitism of Sparganothis Fruitworm eggs in the field than INS-7. Strain INS-12 was found during summer 2000 and showed parasitism above expectations in lab trials, which lead us to substitute it for strain INS-9 in 2001 field trials.

Field trials

Since trichograms only parasitize eggs, they must be released in the field at the onset of the Cranberry Fruitworm egg-laying activity. Because the egg-laying period begins a few days after the first adult flights, pheromone traps have been used to catch males and to predict the beginning of the egg-laying period. Cranberry Fruitworm females are known to lay their eggs in the fruit calyx, but they can also lay eggs on flower buds if no fruits are available. As shown in figure 1, the first adults were trapped around the 20th and the 18th of June in 2000 and 2001 respectively. Due to cold weather in June 2000, the maximum trap catches were reached 40 days later. Normal weather conditions in 2001 allowed adults to emerge at an earlier date. The peak was thus observed 15 days following the first adult captures.

Experiments were carried out in four and three cranberry fields, in 2000 and 2001 respectively, all located in Central Québec. Cranberry beds were divided into four 0,1 ha (0,25 acre each) independent plots: a control, an insecticidal soap treated plot, and two plots treated with a different trichogram strain. In order to proceed safely, introductions were done prior to the first trap catches during the first year trial (figure 2).

In 2000, one million females/ha (ca. 400 000/acre) were introduced each five days, since trichograms are known to survive an average of 4-7 days in the field. Trichogram releases in 2001 were more accurately synchronized with the beginning of the first trap catches and the number reduced to 500 000 females/ha (ca. 200 000/acre). Each introduction included two cohorts emerging at an interval of three days. This permitted us to reduce the frequency of introductions to once a week. The device used to release trichograms were "tricho-cards" that are already used in sweet corn. Tricho-cards are made out of cardboard material rolled and stapled in a way that allow trichograms to get outside but also prevent predators feeding on the eggs. Tricho-cards were introduced manually and evenly across treated plots.

Cumulative damage was assessed once a week from fruit formation to the end of August, by sampling 100 upright bearing fruits in each plot. Most damage was found in the control plots, which had 4% and 6% damage in 2000 and 2001 respectively at the end of the evaluation period (table 2).

In 2000, the trichograms significantly reduced damage, nearly by half. Insecticidal soap treatment reduced damage as well but

(Please turn page.)

Figure 2. Trap catches of Cranberry Fruitworm males. Arrows indicate trichogram applications.

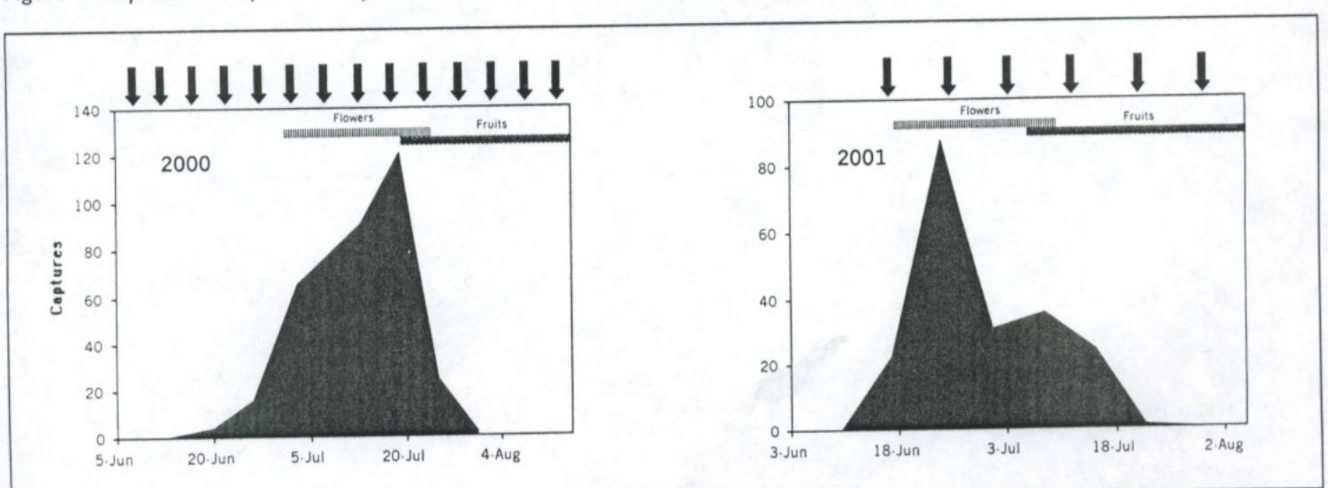


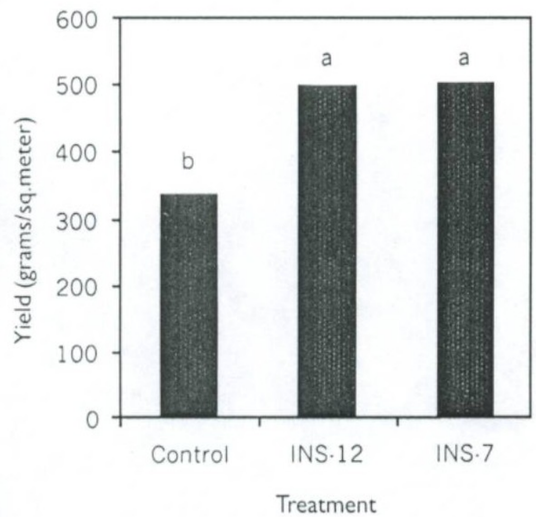
Table 2. Cumulative damage in all treatments for both years. Means of all experimental sites. Means in the same week row with different letters are significantly different (ANOVA followed by LSD test, P<0,05).

	2000				2001		
Week	Control (%)	Soap (%)	INS-7 (%)	INS-9 (%)	Control (%)	INS-7 (%)	INS-12 (%)
1	0,7a	0,1b	0,0b	0,2b	0,0a	0,0a	0,0a
2	2,5a	0,5b	0,1b	0,4b	0,5a	0,1a	0,0a
3	3,3a	1,7ab	1,7ab	1,1b	0,9a	0,5a	0,6a
4	4,1a	2,2ab	1,8b	2,1b	3,2a	1,8a	1,5a
5	—	—	—	—	5,6a	3,2a	3,1a

could not be statistically discriminated between trichograms and control. In 2001, insecticidal soap treatment was not applied. Although differences were not significant, we found that trichograms reduced damage by half during the last sampling week, as in 2000, with half the trichograms used.

In 2001, the yield was estimated before harvest (figure 3). Results indicated a significantly higher yield in plots that were treated with trichograms, suggesting that fewer pests caused damage in those plots, resulting in an increased fruit production.

Figure 3. Yield at harvest. Means with different letters are significantly different (ANOVA followed by SLD test, P<0,0001).



Conclusion

Infestation levels were variable among experimental sites in both seasons. Such variability may attenuate the differences between treatments. Despite this, trichograms were shown to parasitize Cranberry Fruitworm eggs and appear to reduce by half their damage. Trichograms are "stimulated by success": the more they encounter hosts the longer they stay in the field foraging for more. Québec's typical low infestation levels may therefore have reduced the trichogram efficacy. High infestations such as those found in Massachusetts may provide more hosts to trichograms and thus result in a better control of the pest.

Another advantage related to trichograms is that a relatively small time window is required to apply trichograms so they can be used in conjunction with other control agents or insecticides directed against pests occurring sooner or later than the Cranberry Fruitworm. Consequently, organic as well as traditional growers may use trichograms against the Cranberry Fruitworm as long as no insecticide, fungicide or herbicide remain in the field.

We are currently evaluating another device that should be more suitable to cranberries than tricho-cards. It is a capsule that is biodegradable and does not float during harvest. Until we find out, trichograms will be released by plane next summer.

Acknowledgements

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CHAPTER EIGHT

TRICHOGRAMMA WASPS

This family of wasps includes several varieties, each having its own specific prey. Your customer must be able to tell you what crop he's raising and then (if you have a large enough operation) you can fit the correct variety to his problems. This procedure will give your customer the protection he needs and he will return to you again and again.

However when you're starting out small you won't have room to rear more than one variety of the species. That variety should be chosen to fit the crops of most of the growers in your area.

For Trichogramma wasps it takes an egg around 8 days to become an adult. The optimal temperature for egg development is 85 degres Fahrenheit; the relative humidity should be 85%. Trichogramma wasps lay their eggs inside the egg of the desired host. The wasp egg becomes a larva and feeds on the host egg which has been paralyzed to prevent further development. The wasp larva turns into an adult and emerges to repeat the cycle again.

Angoumois grain moth eggs are used commercially to raise Trichogramma wasps. The eggs can be frozen for long-term storage or they can be kept at around 50 degrees Fahrenheit for anywhere from 1-5 days. Take them out as needed.

Some growers use water-proofed sheets upon which the eggs are sprinkled in a single crowded layer which will resemble sandpaper when finished. The paper strips are moistened with water and then the eggs are applied. A natural glue makes the eggs adhere to the paper sheets. After the strips have been parasitized (the wasps have laid their eggs inside the moth eggs), they are cut into one-inch squares which contain approximately 5,000 parasitized eggs. The technique will come readily to you after you have done a few preparations.

Again, as with the adult moths, you can count eggs into a container. Repeat until you know how many containers full of eggs will give you **around** 5,000 eggs. Naturally since the eggs are so small you'll only be getting an estimate. In this case a few hundred eggs **more** won't hurt. Bear in mind that 70,000 moths can lay 35,000,000 eggs in just a handful of days.

THAT SEEMS LIKE A LOT OF MOTHS!

Not really. Recall how small they are. One moth can lay 400 to 600 eggs in 3 days. Start out with 2,000 eggs and they will give you adults which will produce about one million eggs which in turn will give you all the moths you'll ever need. You can start off with a bang with the Trichogramma oviposition unit shown on pages 84,85,86.

The reason for making squares of 5,000 parasitized waps each is to give your customers the opportunity to hold these squares in cold storage so they can be released at regular intervals later on in the field. The customer should be told to place the cards or squares where moths can and have been seen. The squares should not be placed in direct sunlight or on the ground where ants can find them.

Another approach is to use glass; the same procedure is used. Moisten the glass sheets on one side and then sprinkle on the eggs. In this case, after the moth eggs have been parasitized, you will have to brush off the eggs and start again. The eggs are then sold in bulk by the ounce as they are with the Gothard firm listed above.

In all cases it is recommended that paper sheets, cards or eggs by the ounce be sold to the customer rather than selling the adult wasps. The adults tend to wander away from where the customer needs them to lay their eggs.

BUT HOW DO YOU KNOW WHEN THE MOTH EGGS HAVE BEEN PARASITIZED BY THE ADULT MOTHS? THE MOTH EGGS TURN BLACK AS THE WASP LARVAE BEGIN TO DEVELOP INSIDE.

Assuming your eyes are that good, if you find a small hole in a blackened moth egg, the wasp has already emerged and flown away. It takes about 8 to 10 days for the adult wasp to emerge after having been laid as an egg inside the moth egg.

Since you're using a host other than the desired hosts generally found in the field, you must rear your Trichogramma by the highest standards possible. You must have the correct species and the parasitized eggs must be placed and released when the desired host eggs are present. The customer can check later to see if any holes have appeared in the parasitized eggs.

HERE IS A LIST OF VARIOUS TRICHOGRAMMA AND WHAT THEY PROTECT:

Trichogramma pretiosum: best for vegetable control, particularly tomato and/or tobacco hornworm, cabbage looper, European corn borer, diamondback moth, corn earworm, imported cabbage worm.

Other Trichogramma which affect vegetable pests are: **Trichogramma minutum** and **Trichogramma evanescens.** Trichogramma minutum are also good for orchard crops. **Trichogramma platneri** is another good orchard species. Most of these wasp species will go after the eggs of all kinds of moths and butterflies whose larvae if permitted to live will dine on vegetable and orchard growth. There are more varieties of this wasp family but I have listed the important ones.

So pick out the species which will best serve your customers' needs and spend your time on raising it. You can always branch out later on.

It's OK if you want to sell your parasitized eggs by the ounce (as many firms do). But I think using the square and the card methods are the way to go. The following description of this setup can also be used in a modified way for paper strips. Some growers continue to use glass plates and trays, but glass has a tendency to break. I prefer plastic trays.

When I talk of a square with 5,000 parasitized moth eggs, I'm not talking about a lot of space. Only one inch square, to be exact. That's why they're called squares. In addition, the adult wasp itself is only 1/50 of an inch long - about the size of the period at the end of this sentence. Its egg and consequent larva do not need a host egg of any great size. In fact, in the field you can sometimes find as many as 40-50 wasps emerging from one tomato hornworm egg! The wasp itself is yellow, sometimes with a mixture of black. It has antennae which are short and red eyes.

Small they may be, but Trichogramma wasps are used very extensively throughout the world. In Russia and China as well as here and in Europe. They are especially effective in a greenhouse. These wasps are one of mankind's most important weapons against crop pests. **We could not do without them!** BUT they are not immune to pesticides. The customer must be aware that like all insects the field must be relatively clear of any insecticide if he wants top performance from the Trichogramma (or any other beneficial insect).

HOW MUCH ARE TRICHOGRAMMA EGGS WORTH TO YOU?

The egg-laying unit proposed on pages 84-86 has space for 24 trays. Twelve for parasitizing and twelve for holding. Each tray will hold a "card" 5" x 10". This card is composed of 50 "square" inches. The eggs are sold by the square or the card. Since each square will hold around 5,000 parasitized eggs, a card will hold around 250,000 such eggs. The card is normally made out of a thin laminated cardboard which is flexible enough to be cut into 1 inch squares.

If you sold all 12 trays or cards at once (which would give the lowest possible selling price), each card would sell at around thirty dollars. Take 12 times 30 and you get $360! Each day you start a new crop. Multiply that by 365 and see what you get! **FROM JUST ONE UNIT!** All you need to do is get the customers. I'll show you how to do that in a little bit. You'd have to spend a lot of money in advertising and setup apparatus to make even a dent in this kind of income!

BUILDING THE OVIPOSITION UNIT:

Here is where we produce our product. A unit must be constructed which will give a steady product flow. In this case, the product is moth eggs which have been "seeded" with wasp eggs. The following describes a unit which can be used continuously and give good production results. It is very simple to build from easy to get inexpensive materials.

During the rearing process, the temperature should be held at around 85 degrees Fahrenheit. The relative humidity should be around 85%. If necesssary the moth eggs can be kept at 40-50 degrees Fahrenheit for up to several days to slow down their internal growth. You want them ready and viable when the adult wasps are ready to lay their eggs.

You'll soon get the hang of when to place the parasitized moth eggs inside the dark end of the egg-laying unit. They must be placed there just a day or two before they emerge from their host and begin to look for hosts eggs. At the same time, you have to get your fresh moth eggs ready for the arrival of the adult waps.

NOW TAKE A LOOK AT PAGE 84 AT THEN END OF THIS MANUAL:

The first thing you see at the top of the page is the heading: Trichogramma Oviposition Unit. Below that is a list of materials which you will need to build the unit.

Just below that is the overall view which gives you the main measurements. Under that is a drawing of the masonite shelving used in the unit. As you will see the unit has been designed for easy assembly and for easy cleaning between crops. (When you do clean, avoid using liquid cleaners - because the wood will swell and contract. Use chemical gas sterilizers and use them out-of-doors.)

On the next page you will find more detail in the "Overview", the "Grouting" detail and the "Plastic Trays". Why are there so many separate drawings? Because in the past it has been found that the more detail you get, the easier it will be for you to complete the project.

Look now at the Overview. Particularly the strap hinges. There are two strap hinges for each end door and for each side plastic "window". By strap hinges I mean those composed either of metal or leather. The end doors will have to be lifted up now and then, first when inserting the egg-laden trays and second when removing them from the other end after the wasps have done their duty.

The unit must be built so that there is ample air but at the same time secure enough to keep the wasps inside. The plastic "windows" also have strap hinges. But these windows are only opened when the unit is being cleaned. Both end doors and the side windows also have turn-type "L" latches to keep them closed at the bottom.

THE GROUTING IS IMPORTANT:

You could use small tacks or brads in place of grouting, but they won't hold up like the grouting does. Besides, this one unit can produce at least $360 per day! So why take short cuts? Build yourself a good piece of equipment which can be kept secure and sanitary. The grouting is contained in the posts on the left side of the drawing. This is done because you need an anchor there for the masonite trays which will hold, up the plastic egg trays. If you don't have grouting tools, it's simple enough to go to the lumberyard and have someone do it for you.

On the grouting view, you are looking at the inside of the wall on the far side.

SO WHAT'S THE PROCEDURE NOW THE UNIT IS BUILT AND READY?

First the masonite boards are slid into place in the grouting grroves and pulled back into the grouting grooves on the left hand posts. After that, every day you'll follow this pattern:

Sprinkle the moth eggs thickly onto the card which has been adhered to the plastic tray. After the card is on the tray sprinkle on water or mist it onto the card and then sprinkle on your moth eggs.

If you're going to use the entire unit this will mean that you'll have to prepare 12 trays. Of course, you don't have to start out that strong. You can fix just the number of trays you need, both for wasp and moth eggs. (You'll only place the wasp eggs in once because they will survive to lay eggs for up to 7 days I recommend you take take out the wasps on the fifth day and "re-plant" with new wasp eggs which are ready to emerege.)

Meantime you have placed your wasp eggs inside the other end. As was stated above, they should be ready to emerge within a day or two so they can attack the moth eggs. At the same time, place some wheast on a piece of paper at the bumper end of the tray. Also place a cotton of cotton swab moist with water in the same location. In other words, you're using the same feeding principle you used with the lacewing.

No, you don't place the wasp eggs on trays and insert them from the right end. ALL TRAYS ARE INSTERTED FROM THE LEFT END. When you first startup, this mean you have to insert the wasp egg trays first and push them down into the darker end. That's why you have the plastic bumper or noseguard on the right or forward end of each tray. It just makes things work easier.

After the wasps have emerged and begun to parasitize the first crop of moth eggs, you can use them over several times before letting them go, as suggested, on the fifth day.

HAVE ALL MOTH EGGS TRAYS READY BEFORE YOU OPEN THAT LEFT HAND DOOR:

DO NOT HAVE ANY LIGHTS ON AT THIS TIME. At least no bright ones. As fast as possible, push the prepared moth egg trays inside. If previous parasitized eggs are in place push them gently into the dark end. Then shut the end door and tie it closed with the L-type hinge.

Turn on the two 40 watt lights which have been placed about ten inches out from the plastic windows. If you find this distance is too hot on the plastic, place the lamps further out. The light from these lamps will illuminate the interior where the moth eggs are. Within an hour the wasps at the dark end will be attracted to the light and move into the moth egg section to lay their own eggs inside the moth eggs.

At this same time, if the plates in the dark end have already been parasitized, open the door on the right (dark end) and take out those trays. Leave everything else alone until the next day when you will insert another batch of trays. Make certain that each new tray has a predatory tray at its other end.

After taking out the parasitized egg trays, you can begin to fill customer orders. Most customers like the card or square method. A few may still want loose eggs (which you must remember to ask for when you order your first batch to start up your operation). To get a loose crop of eggs just sprinkle on the moth eggs as before. When you pull them out at the other end, brush them of the tray and into the shipping or counting conatiners. Use a small brush whose bristles aren't stiff.

If you want to hold some of these eggs or you don't have an immediate customer for them, you can place them in a refrigerator which is set around 60 to 63 degrees Fahrenheit. This should be done after the parasitized eggs are a few days old. This process will slow down the wasp larval growth and you will be able to hold them for another 8 days before selling.

This is a stop-gap measure only. Best to sell right away. DON'T FORGET TO HOLD BACK 15-20% of your eggs to use for future adult wasp production. They can be kept at normal temperatures for about 6 days at which time they're ready to go into the rearing unit for the next 1 to 3 days. Just keep in mind these wasps only take ten days from being deposited as an egg inside the moth eggs to emerging as an adult.

Common Name: Trichogramma Wasp
Scientific Name: *Trichogramma* sp.
(Hymenoptera: Tricogrammatidae)
Stage:
Photo Credit: Extension Entomology