NOTE

Improvements in the Production System for Green Lacewings: A Hot Melt Glue System for Preparation of Larval Rearing Units[1, 2]

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Chrysoperla carnea (Stephens) and *Chrysoperla rufilabris* (Burmeister) are two green lacewing species of considerable importance in augmentative biological control. These species are produced commercially and marketed by numerous insectaries in the United States for use against a variety of pests (Bezark, L. G. 1989. Suppliers of Beneficial Organisms in North America. California Department of Food and Agriculture, Sacramento, CA). However, to maximize the potential of green lacewings in augmentative biological control, more efficient mass production systems need to be developed. The production procedures generally used in commercial insectaries and needed improvements, including the need for improvement in the larval rearing procedures, were recently reviewed (Nordlund, D. A. and R. K. Morrison. 1992. pp. 427-439. *In* T. E. Anderson and N. C. Leppla [eds.], Advances in Insect Rearing for Research & Pest Management. Westview Press, Boulder, CO).

Chrysoperla are highly predaceous and cannibalistic in the larval stage, making it difficult to maintain and feed the larvae in high-density cultures. Early efforts involved the use of layers of paper in a wood tray covered with muslin and ample provisioning, assuming that if a surplus of prey was provided in a large universe, cannibalism would be limited (Finney, G. L. 1948. J. Econ. Entomol. 41: 719-721; Finney, G. L. 1950. J. Econ. Entomol. 43: 97-100). Later Hexcel® (Hexcel Products, Inc. Dublin, CA), a honeycomb-like paper product, was used for larval insolation (Ridgway, R. L., R. K. Morrison, and M. Badgley. 1970. J. Econ. Entomol. 63: 834-836). The Hexcel system required that the larvae be anesthetized with carbon dioxide to prevent escape when the glass plate top was removed for re-provisioning. A system was then developed, using ornamental Masonite® and organdy for larval rearing, which eliminated the

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[2] Mention of a commercial or propriatory product does not constitute an endorsement by the USDA.

need for anesthetizing the larvae because the cells containing the larvae could be provisioned without opening the unit (Morrison, R. K., V. S. House, and R. L. Ridgway. 1975. J. Econ. Entomol. 68: 821-822). In the late 1970's the manufacture of the Masonite was discontinued. In its place, a system using Verticel® (1.27 cm [0.5 in] thick, 1/4-50-50-0%) (cell size - paper weight - paper weight - % of phenolic impregnation) (Hexacomb, University Park, IL) for larval rearing units was developed (Morrison, R. K. 1977a. Southwest Entomol. 2: 188-190; Morrison, R. K. 1977b. pp. 149-151. *In* Proceedings of the 1977 Beltwide Cotton Production Research Conference, National Cotton Council, Memphis, TN).

Verticel is an ideal material because it is lightweight, inexpensive, easy to dispose of, and is very space efficient (ca. 16 cells/2.54 cm^2[in^2]). A polyvinyl acetate glue and water mixture (1:1 v/v), was applied to the Verticel using a paint roller, to attach organdy to the Verticel (Morrison, R. K. 1977a. Southwest Entomol. 2: 188-190). Glue was applied once, allowed to dry, and a second coat of glue and the organdy was applied. For the small culture maintained in my laboratory, a paint brush has been used to apply one coat of undiluted polyvinyl acetate glue to attach the organdy. This basic system is the predominant one used in commercial rearing operations today. However, application of polyvinyl acetate glue to Verticel with either a paint brush or roller is time consuming (even if only one application is used) and messy. Immediately after the glue is applied, the organdy must be applied, the units must be separated, and the units must be weighted down while the glue dries.

This paper describes a manual system for using hot melt glue for preparation of larval rearing units. Applying a hot melt glue to the Verticel eliminates a number of the problems described above and this system is amendable to automation, with a variety of equipment that is readily available.

A number of hot melt glues with different softening points, working times (the time during which the glue remains sticky after it is removed from the heat), and heat resistances are available. Quik Pak (Dexter Hysol Aerospace & Industrial Products Div., Seabrook, NH), a glue developed for carton closing, was selected because it has a relatively low softening point of 104.4° C (220° F) and a work time of 10 sec. The glue was applied to both sides of the Verticel larval rearing unit with a Hysol Hot Wheelcoater 600WC (Dexter Hysol Aerospace & Industrial Products Div., Seabrook, NH). This applicator, which is one of the least expensive models available, has a 15.24 cm (6 in) wide coating wheel, and thus, the size of the rearing unit that could be conveniently prepared was limited. Coating the Verticel involved simply holding the piece of Verticel on the coating wheel (Fig. 1). First one side was coated and then the other. Once coated, pieces of Verticel can be stored for extended periods.

A variety of glue application equipment is available from commercial sources, ranging from the small unit used here (ca. $2,000) to very large scale equipment that coats both sides of the material at once (ca. $17,000) (manufactured by Black Bros. Co., Mendota, IL). However, from the insectary standpoint, the ideal situation would be to purchase precoated Verticel directly from the manufacturer. If demand is sufficient, this should be possible.

Application of organdy to the coated Verticel is a simple process. A piece of organdy is placed on the coated Verticel and heat and light pressure are applied

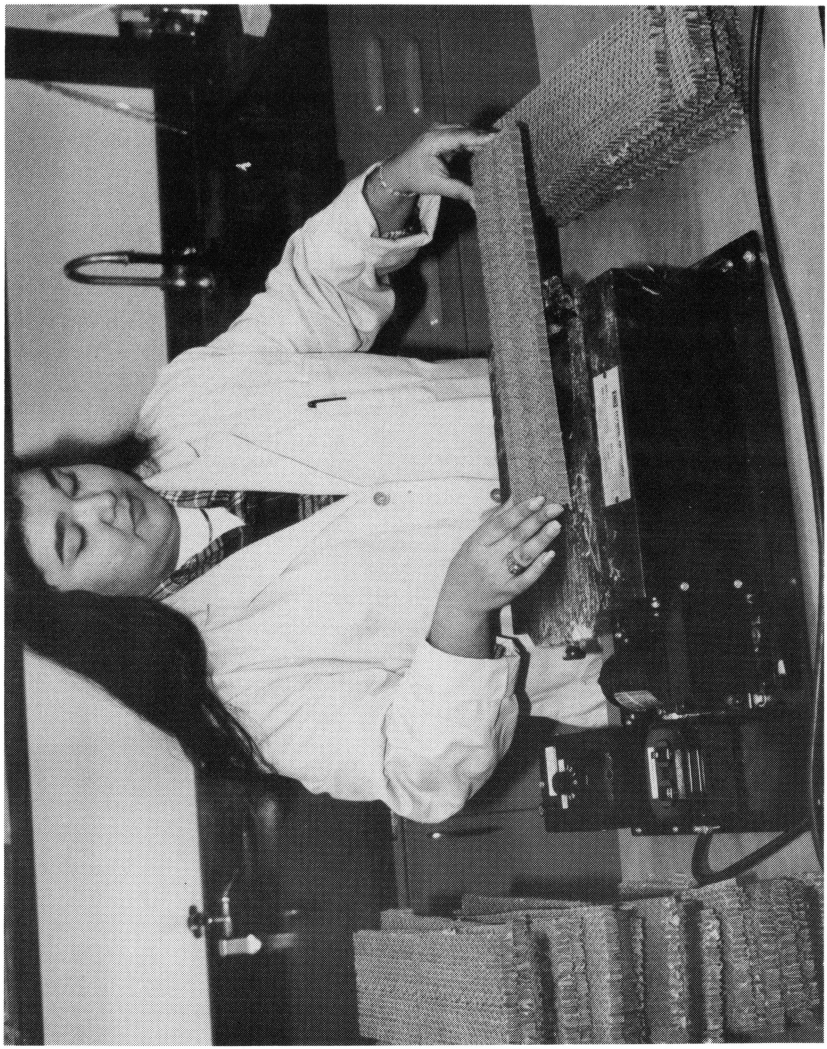

Fig. 1. Application of Quik Pak hot melt glue to Verticel, using a Hysol Hot Wheelcoater 600WC.

for a second or two. A household flat iron was used here. The units were prepared and stored with organdy applied to one side of the Verticel. This activity can be done when it is convenient and reduces time spent actually infesting the units and applying the final piece of organdy. A closeup view of uncoated and coated verticel and organdy attached to coated Verticel is shown in Fig. 2. Larval rearing units prepared in this manner hold up extremely well throughout the rearing process, even when liquid artificial diet is used. There is no delay necessitated by drying time, the process is very fast, and the units do not have to be separated during the preparation process.

A number of commercially available devices could easily be modified to mechanize the preparation of larval rearing units. For example, Oliver Products Company (Grand Rapids, MI) has a Model 54-095 Handlidder and a Model 54-057 Trayveyor that could easily be modified for mechanized larval rearing unit preparation.

An automated larval rearing system is an important step in the development of an efficient mass production system for *Chrysoperla* spp. (Nordlund, D. A. and R. K. Morrison, 1992. pp. 427-439. *In* T. E. Anderson, and N. C. Leppla, [Eds.] Advances in Insect Rearing for Research & Pest Management. Westview Press, Boulder, CO). Verticel is an ideal material for use in larval rearing because it is inexpensive, space efficient, and disposed of easily. However, the use of polyvinyl acetate glue slows the preparation process and limits our ability to automate it. The use of hot melt glue eliminates a number of the problems associated with the polyvinyl acetate glue, and facilitates the development of an automated process for assembling, infesting, and sealing the larval rearing unit for these important biological control agents. Verticel precoated with hot melt clue may eventually be commercially available. The use of hot melt glue, even when organdy is applied with a flat iron, is significantly faster than with polyvinyl acetate glue. With some minor modifications, much more efficient equipment, using hot melt glue, could be developed, resulting in significant improvements in efficiency and increased production capacity for green lacewings.

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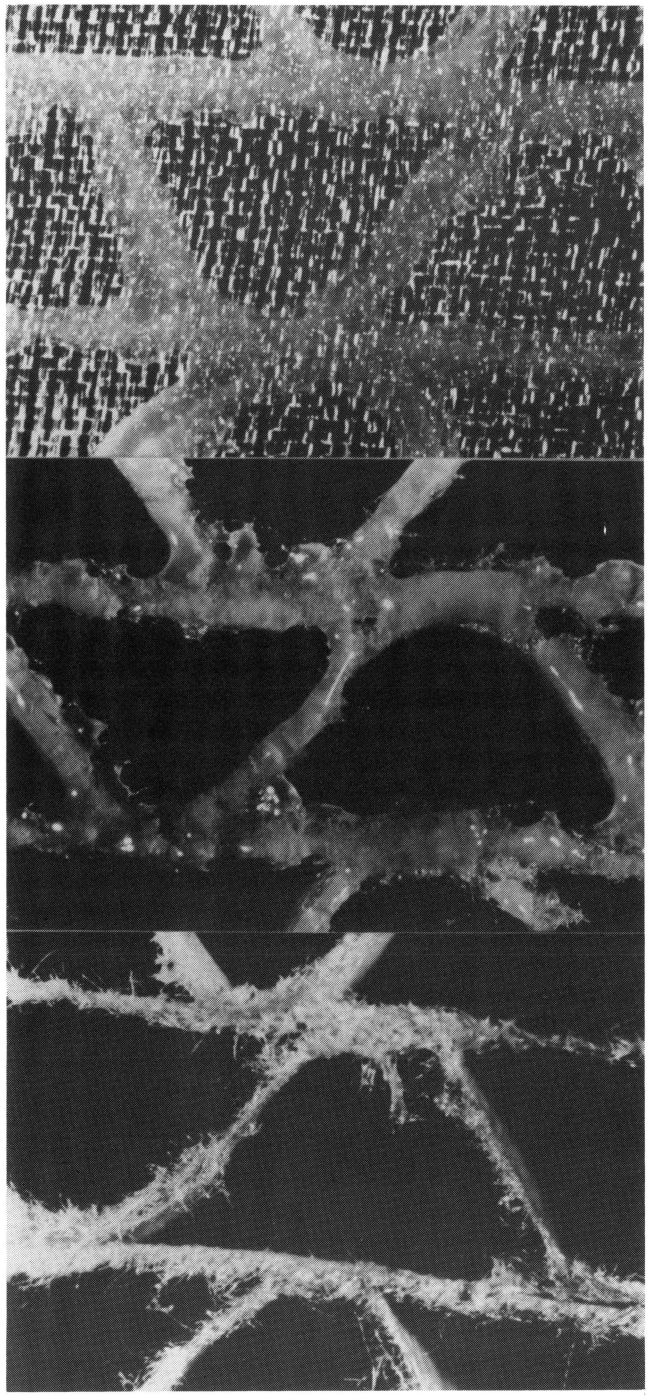

Fig. 2. Close up view of (from left to right) uncoated verticel, coated verticel, and coated verticel with organdy attached.