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A PORTABLE FIELD CAGE FOR MASS CULTURING APHID PARASITES

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DESCRIPTION OF CAGE

During studies conducted at Yakima, Wash., in 1964 to develop methods for mass culturing parasites of the pea aphid [Acyrthosiphon pisum (Harris)], we designed a sturdy, lightweight cage with a total volume of 1,000 cubic feet (fig. 1). The cage provides an environment suitable for growing plants upon which aphids and their natural enemies may reproduce during inclement weather; it also permits studies of the bionomics of the aphid predators and parasites.

The cage is 12 feet wide by 16 feet long by 7 feet high. It is assembled from panels framed with wood and covered with polyethylene film or Saran[2/] screening. This type of construction permits easy dismantling and stacking in compact units for transportation or storage. The special construction allows the cage to be used in either hot or cold weather. Because of its versatility, the cage can be adapted for many other uses.

The surface area of the cage is 441 square feet. Two layers of polyethylene film cover 325 square feet of this area. For this purpose we found it best to use an unfolded and unseamed ultraviolet-inhibited film such as GER-PAK "601," since ordinary polyethylene film may have to be replaced within 6 to 8 months. The treated film may last nearly 2 years. Films with folds or seams tend to break down rapidly at these points in windy areas and where daily temperatures fluctuate greatly. The remaining area is screened but can be covered with one or two layers of inexpensive 2-mil film during inclement weather.

Assuming a 50° variance from ambient, a heater rated at 25,000 B.t.u. per hour is required to heat the cage. When temperatures dropped to 17° below zero during the winter of 1964-65, the average cost for heating was less than 15 cents a day. The heater we used was a propane-fired, complete-combustion model requiring no outside venting other than for air supply and was fitted with a high-velocity fan. Installed inside the cage about 3 feet above the floor and a third the length of the cage from the end wall, it provided excellent circulation of the heated air. Plants along the border of the cage suffered little injury and the temperature of the soil was fairly even.

1/ In cooperation with the College of Agriculture Research Center, Washington State University.

2/ Mention of trade names in this report does not necessarily imply endorsement of these products by the U. S. Department of Agriculture.

Figure 1.--Portable field cage for mass culturing aphid parasites.

MATERIALS AND COSTS

(1) Roll (8 by 110 feet) of flat, sheet, 4-mil, ultraviolet-inhibited GER-PAK "601" from Gering Plastics Co., Dept. AVG-2, Kenilworth, N. J.; about $8.

(2) Roll (3 by 40 feet) of 32-mesh Saran "Lumite" screening from Chicopee Mfg. Co., Lumite Div., Cornelia, Ga.; about $22.

(3) "Heat Motor" automatic vent control from Heat Motors, Inc., 635 West Grandview, Sierra Madre, Calif.; about $50.

(4) Cedar flume lumber (1 by 6 inches): Two pieces 16 feet long, two pieces 12 feet long; about $3.50.

(5) Two sheets of 1/4-inch exterior-grade plywood cut into 8-foot strips 1-1/4 and 1-3/4 inches wide, respectively, for stripping the plastic; $8.

(6) Douglas Fir Select lumber (2 by 2, no knots): 25 pieces 16 feet long, 11 pieces 14 feet long; about $30. (See cutting list.)

(7) Hardware:

Hexagonal capscrews (3/8 inch): 20 capscrews 4 inches long, 30 capscrews 2 inches long.

Flathead bolts (10-32 by 2 inches): 2 dozen.

Zinc-plated, flathead, wood screws (3/4 inch by No. 7): 9 dozen.

Steel strapping (1/8 by 1-1/2 by 36 inches) cut into six 6-inch pieces.

Steel strapping (3/16 inch by 1 inch by 6 feet) to be cut into 1-inch pieces after drilling and tapping as nut plates for 3/8-inch capscrews: 50 pieces.

Aluminum angle (1-1/4 inches by 1-1/4 inches by 25 feet) for nine angle braces required for each cage. Scraps may be used to manufacture six tie plates (fig. 2, E) needed for each cage.

The total estimated cost for materials, exclusive of the vent control, is about $125 (in 1965), if materials are obtained from commercial sources.

CUTTING LIST

All measurements of angles are taken from a plane parallel to the length of the board. Amounts are for one cage. For the roof rafters, cut 18 pieces, 7 feet long, with pitch cuts of 55° and seat cuts of 35° and 55° from the 14-foot "2 by 2" material. Three of these should then be trimmed 13-1/2 inches from the pitch cut if the operator wishes to install the roof vent. The seat cut is 1-1/2 inches on the 35° angle and 3/4 inch on the 55° angle.

The following pieces should be cut from the 16-foot "2 by 2" lumber:

(1) For roof and sidewall panels: Eight pieces 16 feet long.

(2) For end-wall panels: Two pieces 12 feet long.

(3) For end-wall rafters: Four pieces 85-1/2 inches long with seat and pitch cuts.

(4) For door jambs: Two pieces 72 inches long cut 55° on one end.

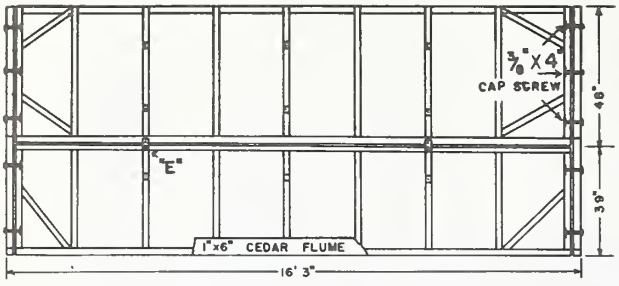
(5) For end-wall studs: Four pieces 68-1/2 inches long cut 55° on one end.

(6) For end-wall studs: Four pieces 54-1/2 inches long cut as item 5.

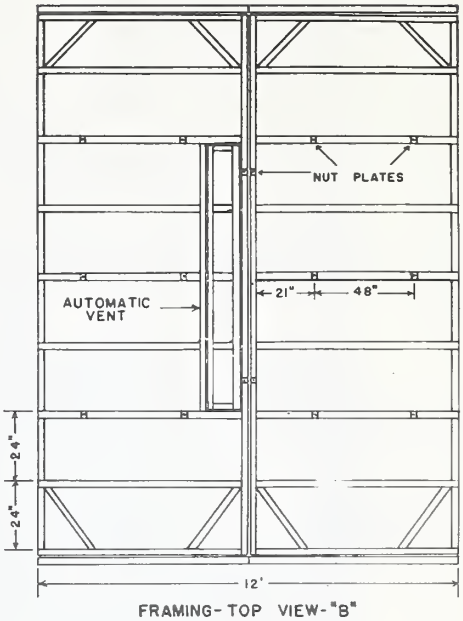
(7) For end-wall corner studs: Four pieces 40-1/2 inches long.

(8) For door sides and rear end-wall center: Three pieces 72 inches long.

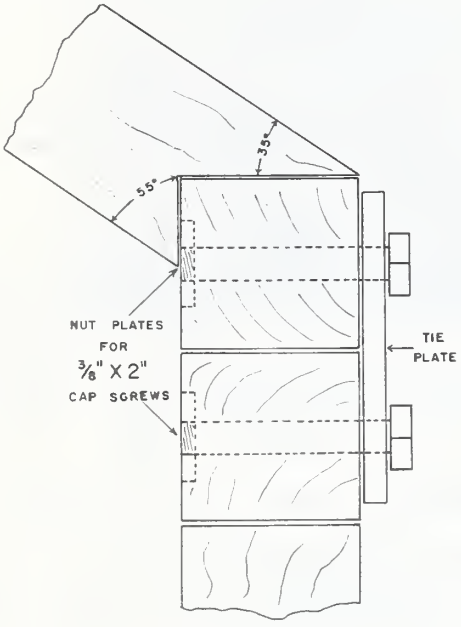
(9) For door pieces: Three pieces about 33 inches long. To insure a well-fitted door, it is best to cut these after the jambs are installed.



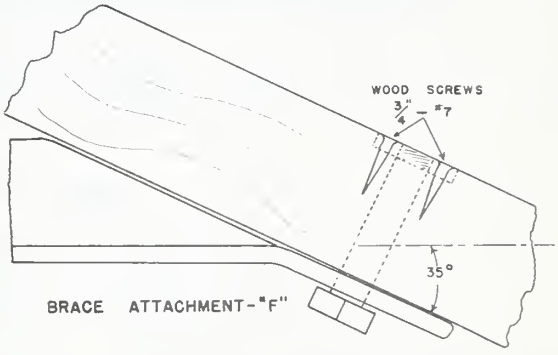
FRAMING-SIDE VIEW-"A"



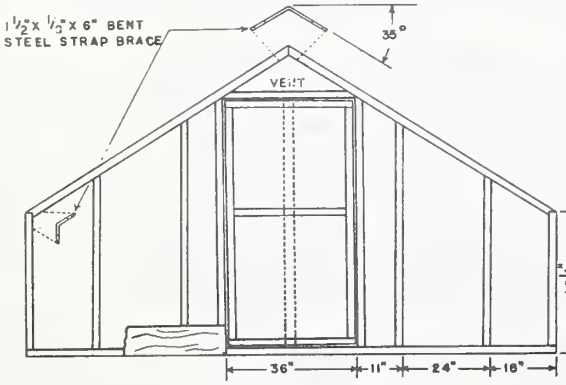
FRAMING-TOP VIEW-"B"



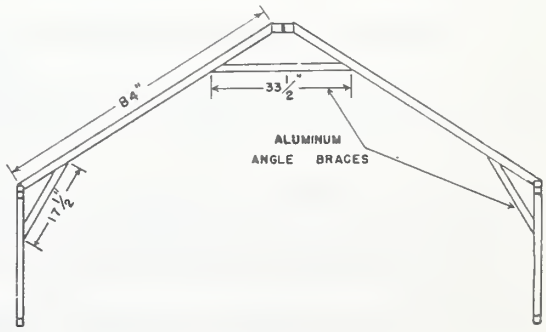
ROOF-SIDEWALL JOINTURE @ "E"



BRACE ATTACHMENT-"F"



END WALL FRAMING-"D"



CROSS SECTION-"C"

Figure 2.--Framing detail of portable cage.

(10) For door header-vent member and rear panel-vent member: Two pieces 36 inches long cut 35° on both ends.

(11) For sidewall studs: 18 pieces 36 inches long.

(12) For roof vent header: One piece 94-1/2 inches long.

(13) For roof vent: Two pieces 94-1/2 inches long.

(14) For roof vent: Five pieces 9 inches long.

Note: Dimensions of some pieces may vary slightly if "2 by 2" used is other than 1-1/2 by 1-1/2 inches.

CONSTRUCTION OF CAGE

One of the criteria affecting the design was that assembling and moving the cage require a maximum of three or four men. In addition, the design had to be such that five or more disassembled cages could be transported simultaneously on a 1-1/2-ton flat-bed truck. The cage as designed (see fig. 2) consists of six panels--two roof (fig. 2, B), two sidewall (fig. 2, A), and two end-wall (fig. 2, D)--held together with bolts (fig. 2, A), braces (fig. 2, C and F), and tie plates (fig. 2, E).

The technique of construction is as follows: All required pieces are sawed to dimension and the individual panels are then assembled with twelve-penny nails. If more than one cage is to be constructed, it is advantageous to assemble all panels of one kind at the same time. Construction is easiest if all members of a panel are laid out in position on a flat surface, such as a concrete floor, and then assembled. Corner braces for the sidewall and roof panels are cut to fit from scrap and installed as construction proceeds.

The two end-wall panels are identical in construction except that the center post is removed from one and the door framing installed (fig. 2, C and D). A screened opening is made at the peak of both end walls for ventilation. Because of the desirability of ventilating the cage in the winter when the automatic ventilator is not operating, we found it best to cover the screened openings and substitute a vent cut into the film placed over the lower part of the door (fig. 1). The end-wall steel strap braces are bolted into place with the 10-32 flathead bolts.

Except for the vent, the two roof panels are identical in construction (fig. 2, B). This ventilator may be installed on either side and hinged at the top or bottom, depending on its uses. We installed it with the hinges at the bottom to permit ready escape of the insects reared in the cage and also to increase movement of air out of the cage. The door of the vent acts as an air foil, which force-ventilates the cage.

The two sidewall panels are identical (fig. 2, A and E). Unlike the other panels, they are covered entirely with a screening material on the exterior. The mesh of the screen used depends on the size of the insects to be included or excluded. We employ 32-mesh Saran "Lumite" to limit the movement of the

predators and parasites of the aphids. In addition, pieces of 1- by 6-inch cedar flume are installed along the lower edges of the sidewall and end-wall panels to permit banking of soil against the cage without injury to the covering materials.

Either the panel members or the assembled panels, prior to covering, should be painted white to limit heating of the structural members and thus slow the weathering of the film at attachment points and where it crosses frame members. This also adds to the appearance of the cage. Also, prior to installation of the polyethylene film, each cage is bolted together as in figure 2, A, the aluminum angle braces (fig. 2, C) and aluminum tie plates (fig. 2, E) are installed, and the nut plates are countersunk (fig. 2, E) and screwed (fig. 2, F) into place. Although it might seem that all like panels should be interchangeable between cages, we found it advisable to label the panels and braces as to position and the cage to which they belong. The cages are then taken apart and the polyethylene film or screening is installed.

The roof and end walls are fitted with an inner and outer layer of film. This reduces heat loss and wind whip in the winter and may keep the cages 10° to 15° cooler in the summer. It also precludes having to dismantle the cages in the fall to add the extra interior layer.

In applying the film, we found it best to place the panels on 42-inch high carpenter's horses in a room having a temperature of at least 70°F. to permit stretching the film. Attach the material to one end of the panel with staples and a plywood strip (see below) and then stretch it over the other end, leaving enough along the sides to overlap. The film is then stretched sideways and tacked with staples. All the strips are then installed on the covered side. The panel is turned over and the process repeated. The edges are then lapped, tacked, and stripped to provide a relatively airtight unit. Excess film is trimmed off.

It is necessary to provide a protective covering of plywood strips for the film at joints and where it contacts the framing. These strips (1-1/4 and 1-3/4 inches) also aid greatly in holding the film to the structure where high winds or heavy snows are a problem. The exterior (wider) strips should extend at least one-fourth inch past the frame member on each side to provide shading. Where shading is not provided, the film may weather rather rapidly adjacent to the member and tear so that it will come out in complete sections as though cut with a knife. It is advisable to strip the inner surfaces of the panels with the narrower plywood.

Since no lumber of the proper dimensions was available for the strips, we tried exterior-grade masonite, metal, and plywood. The best material appears to be 1/4-inch exterior-grade plywood. The painted strips are screwed or nailed to the framing members every 4 to 6 inches and are sufficiently stiff to hold the film in place. The plywood is readily removed and is reusable if reasonable care is exercised.

Depending on the number of cages to be constructed at a time, the labor required for the complete construction and assembly of one cage ranged from 3 to 6 man-days.

ERECTION OF CAGE

After the panels are complete, a cage can be erected by a team of three men in 30 to 45 minutes. Although two men can erect and move an assembled cage, we recommend that three or four be employed. Wind conditions make the task particularly difficult. In a light wind, the roof panels alone are capable of carrying a man a short distance.

In erecting the cage, the end wall containing the door is placed first. The two sidewalls are then bolted loosely to it by using the 3/8- by 4-inch capscrews. After the remaining end wall is bolted, the roof panels are installed by using three capscrews in each end of the panels. Two men outside and one man inside the cage place the roof panel in position. While the man inside holds the panel in place, the men outside bolt it to the end walls. In order to prevent stressing the panels and to facilitate erection, it is best to wait until all panels are in place before tightening any of the bolts. Taking this precaution also helps to square the cage. The internal braces and the tie plates can then be installed. Their installation makes the cage into an integral unit,which will support a 200-pound man and at least 12 inches of wet snow. A person may walk along the ridge to make repairs or remove snow. A hair push broom should be used to remove heavy snow, since its weight tends to stretch the polyethylene film and may damage the roof. The snow also blocks out the light.

Our current practice is to erect the cage on the selected site or to move it there by using the wheel assembly and lifting jack shown in figure 3. The wheeled carriages are attached to the middle of the sides or ends of the cage by the channels and setscrews, and the cage is then pushed to the desired site. With these devices, one man can move a cage over irrigation corrugations or other rough ground.

The wheeled carriages are constructed from two size 4.30 by 8.00 pneumatic wheelbarrow tire and rim assemblies set on a common axle to which is attached a metal channel 2 inches deep, 3 inches wide, and 36 inches long. On one side at each end of the channel is a 3/8-inch setscrew, which is used to lock the channel to the cage while it is being moved. The cage fits into the channel. The lifting mechanism is a hydraulic bumper jack adapted to fit under the cage wall.

With a little care and thought, five or six disassembled cages can be stacked and transported simultaneously on a truck without having to use spacing blocks and timbers. Simply stack only the roof and sidewall panels for as many cages as are to be hauled and then place the end-wall panels on top of the load. It is best to arrange in order the disassembled cages and end-wall panels so that the cages can be erected as they are taken off the truck. A tarpaulin securely tied over the disassembled cages will prevent undue damage and unexpected loss of panels while en route.

To use the cage as a greenhouse or rearing unit in inclement weather, tack additional polyethylene film over one or more of the vents, the door, and the sidewalls, all of which are usually screened. Sealing the cage to the ground with banked soil aids in temperature control and prevents unnecessary "flights"

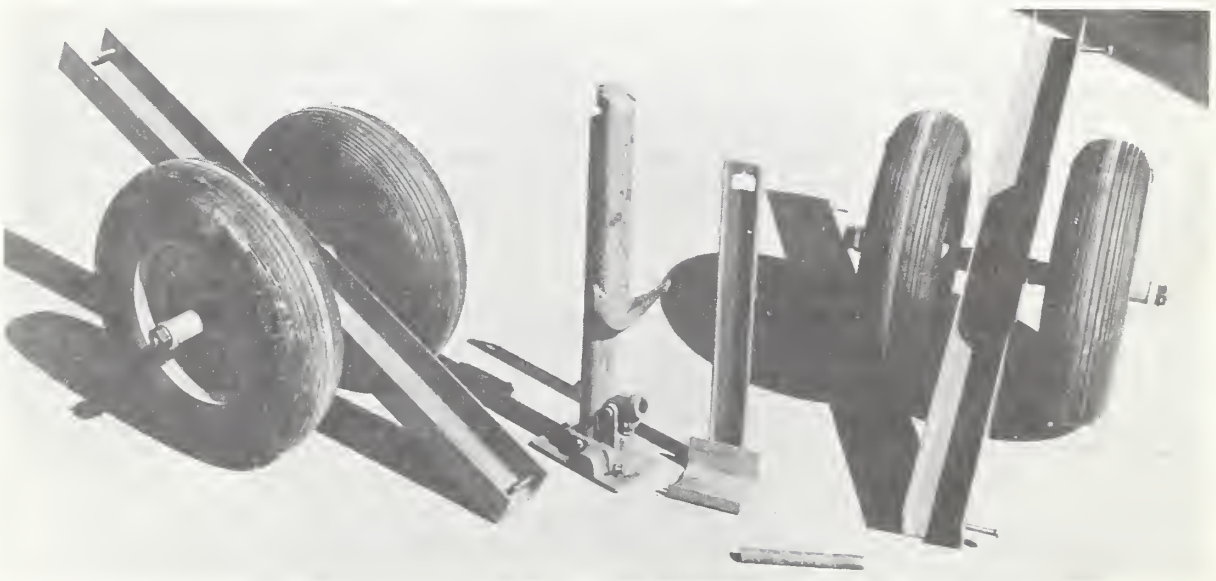


Figure 3.--Wheeled carriages and lifting-jack mechanism for portable cage.

of the whole unit. We also found it necessary to wire the cage to long metal fenceposts driven into the ground to a depth of 18 to 24 inches to hold the cages in "whole-gale" force winds.

Several cages may be bolted together end to end by using a spacer made from "1 by 8" and "2 by 2" lumber. The spacer is bolted between the cages in place of the end walls. The first cage must be completely erected, then an end wall should be removed, a spacer inserted, and a second cage attached to the first. At least one end wall must be used during erection of additional cage sections until the braces and plates are installed. The unwanted end wall may then be removed.