PVC Greenhouses for Non-Windy Conditions in Hawaii

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ABSTRACT:

Polyethylene-covered, PVC-arched greenhouses are simple and inexpensive to construct. Methods for constructing two sizes of greenhouses (2.3 m high x 4.4 m wide and 3.6 m high x 8.7 m wide) are described. The smaller size is better able to withstand moderate wind gusts due to its lower profile. Greenhouses should have a center support and only the thicker gauge of PVC (Schedule 40) should be used.

There is a need in Hawaii for simple, inexpensive greenhouses or, more accurately, "rainshelters" because some areas receive up to 500 cm of rainfall per year. Simple designs are possible because heating and cooling equipment are not normally needed in Hawaii's mild climate. Small, arched greenhouses have been constructed with locally-available flexible materials such as bamboo and guava. However, these natural materials lack the uniformity that is available with manufactured products and often have sharp edges from cut branches which puncture the polyethylene cover. Thus, PVC pipe becomes an obvious choice as a building material because it is uniform, widely available, lightweight, has good strength and is not expensive.

PVC pipe is generally unsuitable for straight or gable roof designs because it is flexible. These pipes become rigid when stressed, however, so an arch is the most functional design for a PVC greenhouse.

PVC greenhouses are easy to construct. First, the site must be prepared. The land doesn't need to be level due to the flexible nature of the greenhouse. Irrigation water can be applied more evenly if the land is level, however.

A center support should be constructed to prevent water ponding on the top of the structure and also to provide some stability. The support may consist of a lumber purlin supported by posts every 3-5 m. If a clearspan greenhouse is desired, a cable can be stretched lengthwise between 2 posts located just outside the ends of the greenhouse. You must be aware that cable supports will sag and sway more than wooden supports. If moderate winds do occur occasionally, you would be wise to construct a strong center support.

Lengths of Schedule 40 PVC pipe are cut and glued to the desired

size. We have built 2 sizes of greenhouses - 2.3 m high x 4.4 m wide, and 3.6 m high x 8.7 m wide. For the smaller structures, either 1-1/4 lengths (7.6 m) or 1-1/3 (8.1 m) lengths of 1.9 cm Schedule 40 PVC are glued together. The shorter length is used in cooler, upper elevation climates and the 8.1 m length is used in the warmer climates. For the larger house, two lengths of 2.5 to 3.8 cm pipe are glued to form a single pipe 12.2 m long. There appears to be considerable stress at the center of the pipe length in these arches. Thus, we feel that it is worthwhile to cut one 6.1 m length into 2 sections and glue these to each end of the other 6.1 m pipe. This places the joined ends on the sides where, there will be less stress, and consequently, less chance of separation or breakage at the joints.

Next, parallel strings are stretched on each side of the center support to mark the boundary lines for the pipe locations. A PVC pipe is bent into an arch and each end is pushed into the soil about 30 cm deep. A hole can be made with a steel stake if the soil is hard or rocky. Let the pipe rest loosely on the center support. Arches should be spaced about 1 m apart and tied to the center support.

Side purlins are not needed for the smaller greenhouse but there should be two for the larger structure. Purlins may be 1.9 cm PVC pipe which is tied to the arches in such a way that the purlin will not slide down the arches.

A uv-resistant polyethylene cover is unrolled and the edges along the length of the greenhouse are either sandwiched between two 1.9 x 8.9 cm boards or redwood strips may be used to batten the polyethylene to 3.8 x 8.9 cm boards. Another attachment method is to secure the cover with a polyethylene locking device mounted on a 3.8 x 8.9 cm

board. Actually, attachment of the polyethylene cover may be completed before or after the cover is pulled over the top of the arches. The sides are adjusted so there is a 45-90 cm space between the plastic cover and the soil level. Use narrower plastic or longer arches to increase the air space. An air space is necessary at the bottom or the structure will become too hot inside. Concrete blocks or other weights can be attached to the polyethylene attaching boards to prevent either side of the plastic cover from raising or lowering. The cover can also be secured by wiring to stakes driven into the ground. A small convection air vent can be made in the top of greenhouses in a very warm climate. To do this, two additional polyethylene attaching boards are located at the top center of the greenhouse and they must be separated by an air gap. They may be wired together so it is possible to achieve whatever gap is desired. The air gap will allow some rain to enter but this will not usually be a serious problem if the gap is only 2-5 cm.

There are several ways to attach the plastic cover to the greenhouse ends. The polyethylene may be wrapped around the end arch and secured by clamping with 5 cm slit sections of the same diameter but thinner gauge PVC pipe. Clamps should be placed about every 30 cm. It may also be tied to the arch with string but this requires making a small puncture to place the string through. Another method consists of constructing an A-frame of lumber onto which the polyethylene is attached with wooden battens.

Experience with exposed PVC irrigation pipe has taught us that exposure to sunlight causes PVC to become brittle and reduce its life. We have a PVC greenhouse in a moderately overcast area that is now 6 years old and the PVC pipe is still in good shape. We feel that for

future installations, it would be wise to paint the pipe either aluminum-colored or first black and then white. This would exclude light from the pipes and provide a reflective exterior to keep the pipes cool.

Only thick gauge PVC pipe (Schedule 40) should be used. Thinner pipes will permanently crease and break at stress points when they are bent excessively. For example, we found that thin-wall PVC pipe creased and then broke at ground level when the house was exposed to a moderately light wind.

Our smaller greenhouse is better able to withstand occasional winds up to 50 km/hr. because it has a relatively low profile. The larger structure suffered wind damage under the same conditions. The most serious problem occurs when PVC ribs break or separate at the joints and puncture the polyethylene. This damage occurs at the top center of the arches. If pipe joints are made in the center, it is recommended that they be wrapped with several layers of polyethylene to prevent puncturing of the polyethylene cover should an arch pipe break or separate.

For the larger PVC greenhouses to survive moderate windstorms, it is recommended that they be located in well protected areas, have a strong center support and be somewhat shorter in length (about 15 m).

Material costs for these structures are relatively low. Estimated material costs (Hawaii prices) are \$2.50-\$3.50/m^2 for the small greenhouse and \$3.00-\$4.50/m^2 for the large greenhouse.

References

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