A Steel Reinforced, Concrete Filled PVC Pipe Shelter for Vegetable Seedlings[1]

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Abstract. A simple, easy to construct, 6 m long x 1.5 m wide seedling shelter is described. PVC pipe (5 cm diameter) filled with concrete and reinforced with a steel bar comprises the basic framework. The bench is also made with PVC pipe (4 cm diameter) filled with concrete and a steel bar and is designed to hold rigid seedling trays. The roof consists of arched PVC pipes which are covered with plastic sheeting. Sides are covered with a screen for insect and wind protection.

INTRODUCTION

Vegetable seedlings should be protected from wind and rain (1). They require adequate light and react adversely to high temperature buildups which are common in tropical greenhouses.

PVC rainshelters are inexpensive and easy to construct, but they lack durability during windy periods (2,3). Large, wide structures become very hot in temperate summers or in tropical conditions (5); however, excessive heat buildup does not occur under narrow rainshelters (4).

[1] This study was conducted at AVRDC while the senior author was on sabbatical leave. The assistance of J.H. Chen and T.K. Lin is greatly appreciated.

The purpose of this study was to design a structure of non-corrosive materials which is simple and inexpensive to construct, does not build up excessive heat and can withstand windstorms or be easily repaired following severe storms such as typhoons.

Methods and Materials

A 6 m long x 1.5 m wide rainshelter was constructed. The following discussion will describe the construction process.

A 1.58 m steel rod (13 mm diameter) was placed through a 1.5 m long PVC pipe (5 cm diameter x 3 mm wall thickness) such that the rod extended 4 cm from each side of the pipe. The pipe was then filled with concrete and allowed to harden. Small holes (2 mm) were drilled in the pipe at 25 cm intervals to facilitate air and water escape during the process of filling the pipes. Since the pipe sagged somewhat under a heavy load, it may be advisable to either add a larger steel bar or a triangular arrangement of 3 bars. Tee fittings were glued onto the ends of these pipes and a nail (5 cm long) was placed through the steel rod extending beyond the pipe and into the tee. When the nail becomes embedded in concrete, it provides some added horizontal cohesiveness to the structure. PVC pipes (93 cm long and 5 cm diameter) were embedded 25 cm deep into concrete footings (40 cm deep x 30 cm diameter) at spacings of 2 x 1.5 m. Before the concrete footings solidified, the tee fittings of the 1.5 m long cross members were glued onto these upright members.

PVC pipes (110 cm long and 5 cm diameter) were then glued into the tees and a steel rod was placed into the pipe which was then filled with concrete. Thus, the steel, concrete and glued fittings bonded the 3 pipes into a solid H-shaped unit. It may be advantageous to have the steel rod extend into the concrete footing; this can be accommodated by placing the rod into the PVC pipe at the time of pouring the footings. Wooden cross braces were placed between the outside and their adjacent H-shaped units to provide horizontal support.

Non-reinforced upper structural members, 2.3 m long, were assembled by gluing a 42 cm and 2-70 cm PVC pipes (5 cm diameter) into a tee fitting; the unattached ends of the 70 cm PVC pipes were glued into tee fittings oriented 180° from the center tee fitting; 30 cm PVC pipes were glued into the horizontal open ends of the tees. This entire member was fit and glued onto the steel and concrete upright structural members.

An upper and two outer purlins were constructed by gluing non-reinforced 1.95 m long PVC pipes (5 cm diameter) into tees; open ends of the upper structural members were inserted into the appropriate tee fittings. PVC pipes (1.6 cm diameter) were inserted into holes drilled into the side purlins and were placed over and supported by the upper, center purlin, thus becoming bowed rafters. Plastic roof sheeting was placed over the bowed rafters and attached to the side purlins by clamps fabricated from 20 cm long, thin wall (2 mm) PVC pipe.

Benches were made by reinforcing 6 m long PVC pipe (4 cm diameter x 3 mm wall thickness) with steel and concrete. Six of these pipes were wired to the bench support structural members.

A clear screen was installed on the outside of the structure to provide some protection from wind and insects. The screen was clamped to the structural members with PVC clamps. A PVC pipe (1.6 cm diameter) filled with sand provided a convenient weight to prevent the screen from blowing around. The floor of the seedling area was covered with crushed rock to facilitate drainage and sanitation of the area.

Results and Discussion

This structure has several noteworthy features. First, it is simple to construct and the materials are readily available. Since the main framework is steel reinforced concrete, it is fairly resistant to windy conditions. The structure is designed so that only the plastic roof covering would be lost during a moderate wind. This is not catastrophic since replacing the plastic sheeting of this structure is a very easy process. It is likely that all the non-reinforced members could be destroyed from a heavy wind such that only the reinforced upright members would remain. Repair would still be far easier than complete reconstruction.

On September 18, 1986, typhoon winds blew for 5-6 hours with maximum windspeeds reaching 36 m/sec. Only the plastic roof covering was destroyed from a shelter located in a semi-protected location; there was no damage to the other components.

Moisture and chemicals commonly found in a seedling house environment will not corrode or rot a plastic structure. However, sunlight may cause PVC pipes to become brittle. Therefore, the PVC pipe should either be uv treated or painted dark to protect against uv caused degradation and then painted white again to provide for maximum light reflectance.

Pipe benches were designed to support rigid trays. The PVC pipes also would not be expected to rot or corrode, are easy to clean and allow a maximum of air movement through the seedling area. When 2 pipes supported a seedling tray load of 54 kg between supporting members, the pipes sagged as much as 3.2 cm. If this amount of sag is unacceptable, an additional support may be added under the PVC pipe or else larger diameter PVC pipe and/or steel rod may be used.

The narrow 1.5 m width of the structure permits access from either side and no covered area is wasted by aisles. The 1.5 m width represents a compromise because a very narrow structure is desired for cooling purposes whereas a wide structure is desired for economy of building materials. Air temperatures at a 50 cm height above the benches were only 1.1 degrees higher than ambient temperatures when the windspeed was 4.5 m/sec. For cooling purposes, it is important that there is an open space of at least 1 m between adjacent structures.

The plastic roof may be removed or replaced easily and quickly. This provides the grower with the flexibility for hardening seedlings by removing the plastic cover several days prior to transplanting.

The small size of the structure allows the possibility of having individual seedling houses for individual uses. For example, individual researchers usually prefer their own seedling houses. Likewise, a grower may prefer individual structures for each of his crops since this will permit customized watering and fertilization schedules.

Literature Cited

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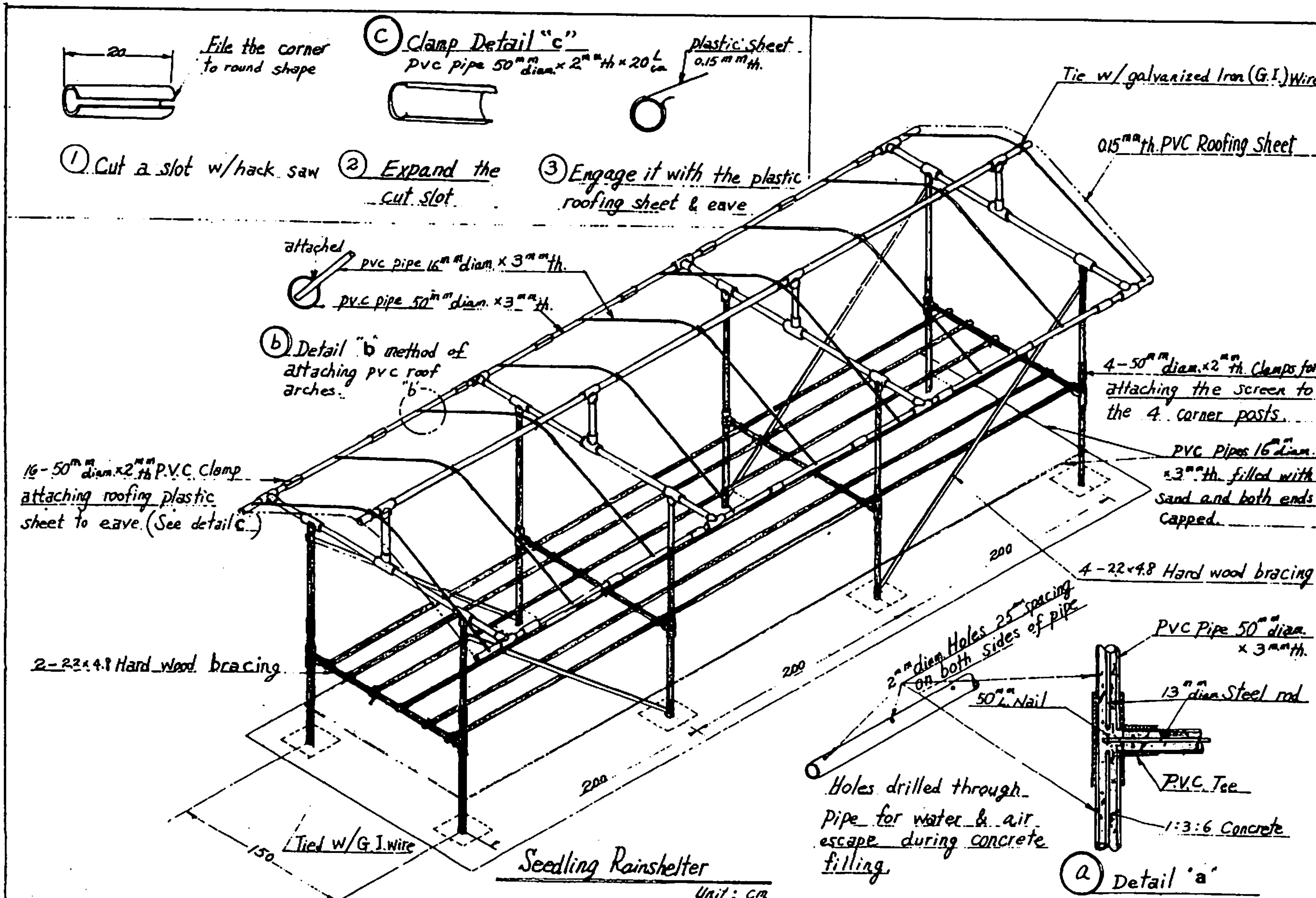
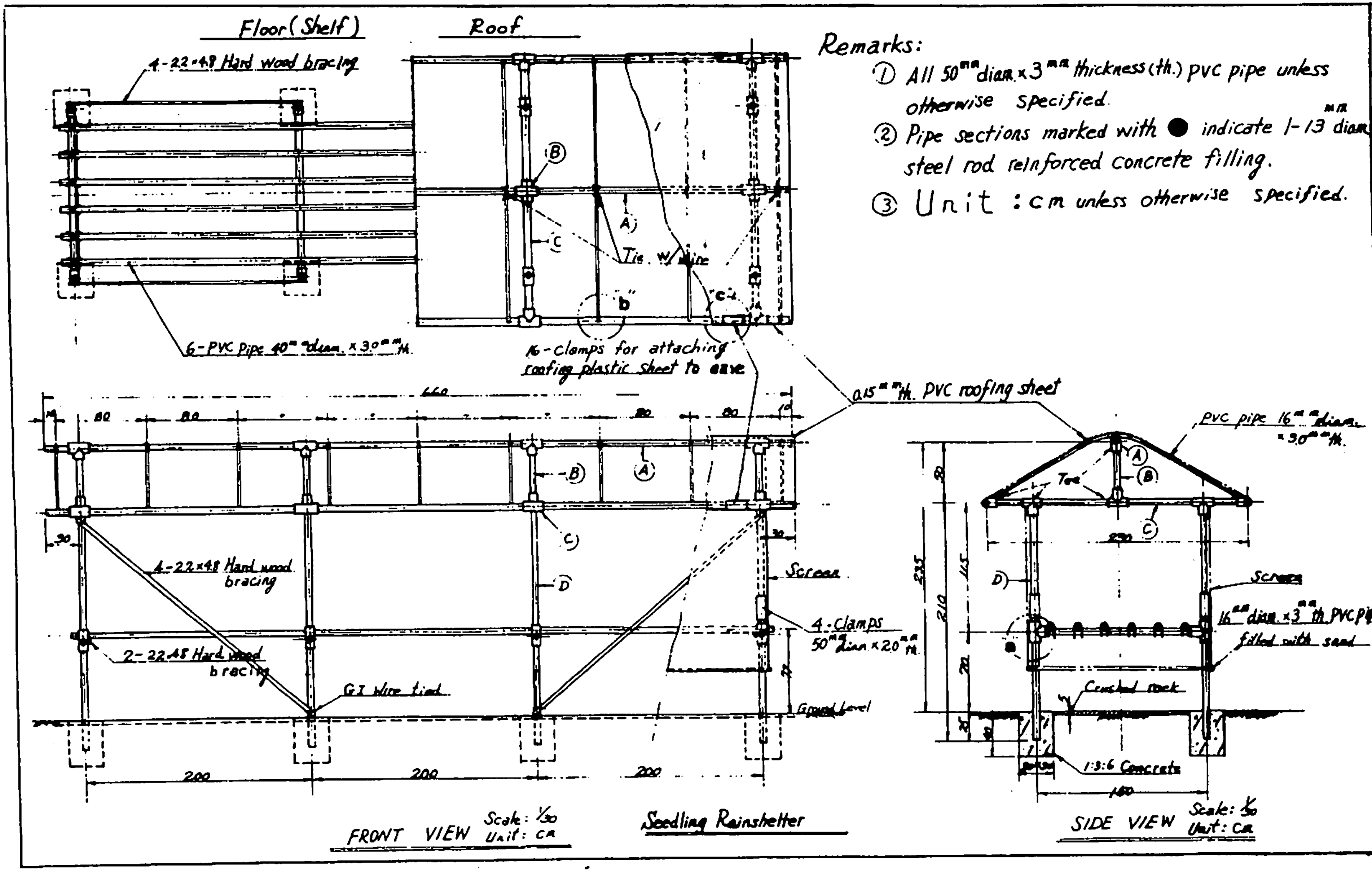


Seedling Rainshelter

Unit: cm


Floor (Shelf)
Roof
Remarks:
① All 50mm diam. x 3mm thickness (th.) PVC pipe unless otherwise specified.
② Pipe sections marked with ● indicate 1-13mm diam steel rod reinforced concrete filling.
③ Unit : cm unless otherwise specified.
4-22x48 Hard wood bracing
6-PVC Pipe 40mm diam. x 3.0mm th.
Tie w/wire
"b"
"c"
16-clamps for attaching roofing plastic sheet to eave
0.15mm th. PVC roofing sheet
PVC pipe 16mm diam. x 3.0mm th.
Tee
Screen
16mm diam x 3mm th PVC pipe filled with sand
Crushed rock
1:3:6 Concrete
4-22x48 Hard wood bracing
2-22x48 Hard wood bracing
G.I. Wire tied
4-Clamps 50mm diam x 2.0mm th.
Ground Level
FRONT VIEW Scale: 1/30 Unit: cm
Seedling Rainshelter
SIDE VIEW Scale: 1/30 Unit: cm