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Rain Shelters for Tomato Production in the Hot-Wet Season

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Introduction

Production of tomatoes during the hot-wet season in tropical and subtropical climates is limited by unfavorable conditions such as high temperature, flooding, strong winds, and high incidence of diseases. These conditions can significantly reduce tomato yields.

Rain shelters protect tomato plants against the impact of heavy rainfall and prevent frequent periods of leaf wetness. The shelters are generally used in conjunction with raised plant beds to minimize flooding and water logging. Sometimes the use of rain shelters can make a difference between harvesting a good crop and harvesting no crop at all (Fig. 1).

Fig. 1. Sheltered crop grows well (left) while the crop outside the shelter is dying (right).

Types of simple shelters

Rain shelters can vary in size, shape, and structural materials. Two types described herein are a single-bed type with an arched roof (Fig. 2) and a double-bed type with an A-shaped roof (Fig. 3). These are constructed with galvanized iron (GI) pipe. The single-bed shelter has a width of 2.4 m, which will accommodate a 1.5-m-wide plant bed with adequate furrows for good drainage. The double-bed shelter has a width of 4.8 m, which will accommodate two 1.5-m-wide beds. Height at the center of both shelter types is 2.4 m, which provides head space for workers and adequate height to grow indeterminate tomato varieties. The length of the shelters is variable and can be adjusted to the row length. The prototype shelters described herein are stand alone structures with a fixed length of 5 m for the single-bed type and 6 m for the double-bed type.

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Fig. 2. Photo and drawing of single-bed rain shelter with an arched roof

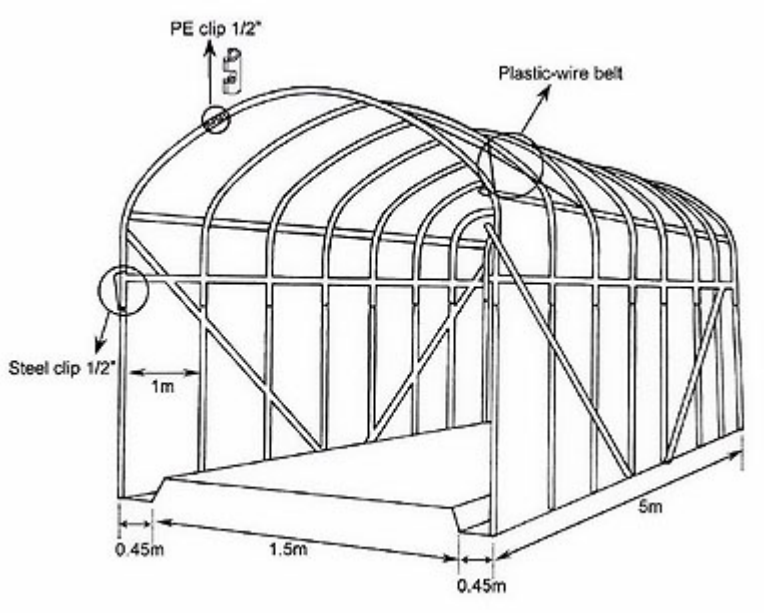
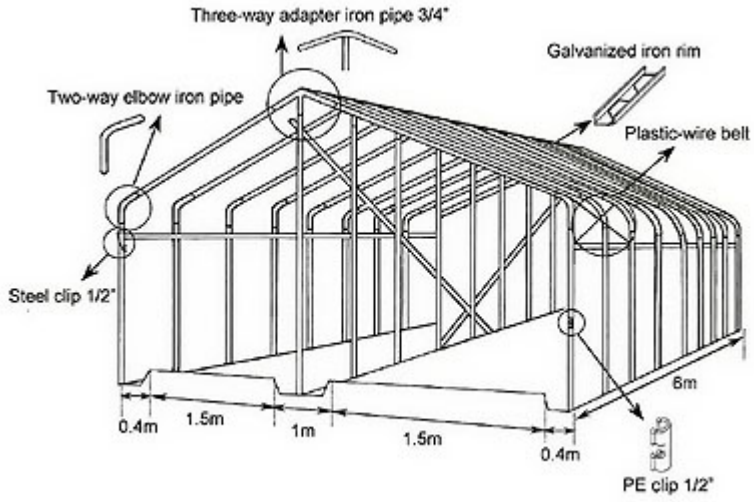


Fig. 3. Photo and drawing of double-bed rain shelter with an A-roof



Components of rain shelters

The structural components of a rain shelter consist of foundation posts (vertical pipes), arches (curved pipes), stringers (horizontal pipes), and braces (diagonal flat irons or pipes) (Figs. 2, 3). The posts and arches are 1/2-inch inner diameter galvanized iron pipes whereas the stringers can be made of lighter material such as galvanized electrical conduit or ridged polyvinyl chloride (PVC) pipes of 1/2-inch inner diameter. Wood or bamboo can also be used to construct semi-permanent rain shelters. The covering materials are made of ultraviolet (UV)-resistant clear or transparent polyethylene (PE) film, 0.1 mm thick. Connecting and fastening materials are made of PE and steel clips (1/2 inch), and plastic-wire belts (Fig. 4).

The structure of a double bed rain shelter consists of components similar to that of a single bed rain shelter, but includes a GI rim (1/2 inch), three-way adapter iron pipe (3/4 inch), and two-way elbow pipe (Fig. 3).

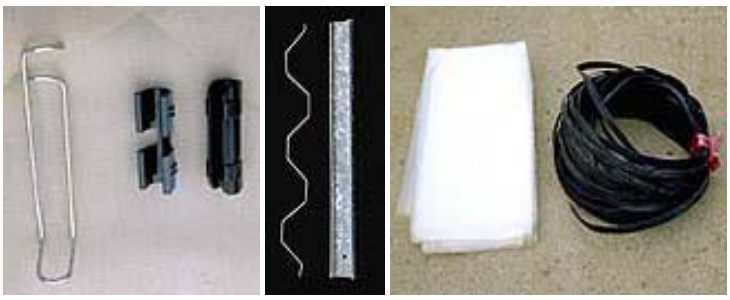


Fig. 4. Components to rain shelters include plastic and steel clips (left), zig-zag wire and GI rims (center), PE plastic film and plastic-wire belt (right).

Constructing rain shelters

A. Single bed, arched top

Principles of construction

Rain shelters should be built to withstand strong wind in locations where severe storms occur. Reinforce the structure against wind by connecting the arched top members and foundation posts with horizontal pipes. Center posts (not in single-bed type structures) sustain the pressure from the top due to heavy rainfall while the side linkage pipes reduce the damage by wind. Secure the covering materials (plastic film) with clips and plastic-wire belts.

Establishing foundation posts

The first step in construction is to mark the position of the posts (Fig. 5a). Dig holes with a post digger and bury the two corner posts 30 cm deep (Fig. 5b). To ensure the same level and height, the two ends of a transparent plastic tube filled with red solution are placed against the posts (Fig. 5c). When the liquid reaches the same height on both ends, the two posts are of the same height. Bury the rest of the foundation posts on both sides of the bed at 30 cm deep about every 70 cm.

Fig. 5. Foundation posts are marked, holes for posts are drilled, and posts are leveled.

Connecting posts

Connect the arch tops into the foot pipes (foundation posts) by inserting both ends at 5 cm to the pointed end of the foot pipe post. Strengthen the two sides of the structure with horizontal side pipes (Fig. 6a). Attach the pipes using steel clips (Fig. 6d). Reinforce the side of the structure by installing diagonal side pipes on both sides (Fig. 6b). Install the center top pipe to the arch top (Fig. 6c).

Fig. 6. Horizontal pipes, diagonal braces, and center top pipes are installed using steel clips.

Installing plastic film cover

Cut the UV polyethylene film cover to fit the arched top roof. For a single bed rain shelter, one sheet measuring 5.3 m long x 3.75 m wide will cover a bed 5 m long. Attach the PE film to the arch and side braces GI pipes using 1/2-inch PE plastic clips (Fig. 7).

Fig. 7. The plastic cover is installed and then secured with plastic clips.

Reinforcing plastic sheets and cover

Use steel clips to reinforce the plastic sheet on the side horizontal pipes and upright post (Fig. 8a). After the plastic sheet cover is secured on all sides, reinforce the top against strong wind by tying with plastic-wire belt (Fig. 8b).

Fig. 8. Plastic sheets are placed over the strucure and secured with plastic-wire belts.

Covering sides

Installation of nylon netting along the sides is optional. The netting may be used to exclude insect pests and prevent rain from blowing in. Usually 32-mesh is used, but 60-mesh netting is recommended if whitefly-transmitted viruses are a problem during the offseason. For a 5.0-m-long single-bed shelter, cut sheets of nylon netting 5.3 m long x 1.8 m high to fit two sides. To cover front and back ends of rain shelter, cut sheets of nylon netting 2.7 m wide x 2.7 m high. Install nylon netting on all sides using plastic clips (Fig. 9a). Secure the bottom of the netting by covering with 10–20 cm of soil (Fig. 9b).

Fig. 9. The side netting is installed and then secured with soil.

B. Double-bed, even span top

The procedure for constructing this shelter is very similar to that of a single-bed shelter, with the most notable exception being the addition of center posts (Fig. 10a). Mark the position of foundation posts on both sides. Drill holes 40 cm deep and insert side and center posts. Cover holes with soil. Put a three-way adapter GI pipe (3/4 inch diameter) on the center post. For a 6-m long shelter, link nine adapters into slats with screws. Link and connect side iron posts to the center post using 3/4-inch elbow pipe. Install the plastic film cover following similar procedures used for a single-bed rain shelter. Strengthen the plastic film cover on side pipes using zig-zag wire clips (Figs. 10b,c). Use plastic-wire belts to secure the plastic cover against strong winds.

Fig. 10. Double-bed structures have center posts and their plastic covers are fixed against side braces with zig-zag wire clips.

Field Preparation and Crop Management

Land preparation and fertilization

Prepare the land by tilling with a tractor or hand tiller. After beds are made, apply basal fertilizer either by broadcast or band. Basal fertilizer rate varies with crop and location, so apply fertilizer based on recommendation for tomato in your area. A combination of organic and inorganic fertilizers, including micronutrients such as boron, is recommended for basal application. A fertilizer rate used for off-season tomato at AVRDC is shown in Table 1. When broadcasted, the fertilizer is incorporated by rototilling before making raised beds. When fertilizer is banded in furrows in the center of the bed, cover the furrows with soil immediately after application.

Table 1. *Recommended fertilizer rates (kg/ha) for tomato production in the off-season*

Time	N	P_2O_5	K_2O
Basal (broadcast, organic)	120	120	120
Basal (band)	60	60	60
Topdress (2 wks after trans.)	60	15	30
Topdress (5 wks after trans.)	60	15	30
Topdress (after 1st harvest)	60	15	30
Total	360	225	270

Constructing raised beds

Construct raised beds using a bed shaper attached to a tractor or a small tiller (Fig. 11). Beds are 30 cm high, 2.4 m wide with a bed top of 1.5 m. Use hand hoes to straighten beds.

Fig. 11. Beds are prepared by using either a tractor or a small tiller.

Plastic mulch

Apply the plastic mulch over the bed immediately after fertilizer application. Use a silver or black plastic mulch (0.010–0.035 mm). Roll the plastic mulch over the bed and secure the side edges of the plastic by throwing soil on both sides of the bed (Fig. 12a). Plastic mulch can also be applied by machine when beds are formed or can be accomplished together in one operation (Fig. 12b).

Fig. 12. Plastic mulch may be installed by manual labor or machine.

Transplanting

For better success, grafted tomato transplants are used during the off-season. Use eggplant rootstocks when flooding or waterlogged soils are expected. Eggplant roots can survive for days under water. Use tomato as a rootstock only if flooding and water logged soils are not expected. Select rootstocks that resist bacterial wilt and other soil-borne diseases.

Drill holes 10 cm deep on mulched beds using a hole puncher and insert tomato transplants. Cover the hole with soil taking care that the graft union (stem joint of rootstock and scion) stays above the soil line (Fig. 13a). The closer the graft union is to the soil line, the more likely adventitious roots from the scion will develop and grow into the soil. If this occurs, soil-borne diseases can bypass the resistant rootstock and kill the plant.

Transplant tomato seedlings on twin rows spaced 80 cm between rows and 50 cm between plants within each the row. To modify the effect of high temperature, cover the bed with rice straw mulch. Apply the rice straw on top of the plastic mulch about 1–2 cm thick or 5.0 t/ha (Fig. 13b).

Fig. 13. Transplants are placed so that the graft union (see arrow) is above ground. Straw is placed around plants to reduce heat.

Pruning and support

Tomato plants should be staked 2–3 weeks after transplanting. When planting an indeterminate variety, support plants by tying side branches with plastic tape on an A-frame bamboo trellis (see Fig. 1). Retain two main stems and prune side branches regularly.

For a determinate variety, use the cradle staking system (Fig. 14). No pruning is necessary.

For both systems, it is important that plants be securely supported on the trellis. This will prevent vines from sliding down and the scion (if grafted) contacting the soil, where it may become infected.

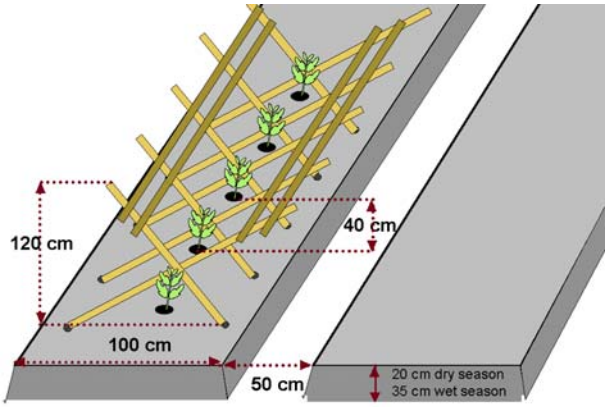


Fig. 14. The cradle staking system is recommended for determinate varieties.

Removing suckers and adventitious roots

On grafted plants, remove suckers that develop on the eggplant rootstocks near the cotyledons (Fig. 15). Remove adventitious roots that develop on the scion before they reach the soil. As stated earlier, to prevent infection from soil-borne diseases, the scion tissue must not come into contact with the soil.

Spraying fruit-set hormone

High temperatures during the off-season can reduce fruit yields. The use of heat-tolerant varieties plus applications of a commercial fruit-set hormone such as Tomatotone or Tomatolan are recommended. Use a 15 ppm solution CPA (ISK tomatotone 0.15% diluted 1:100). Treat each flower cluster one time after two or three of the flowers are open. Apply two pumps of the solution (about 1 ml) per flower cluster using a handheld mist sprayer (Fig. 16) after 3:00 PM.

Fig. 15. Eggplant sucker grows on grafted tomato vine.

Fig. 16. Hormone sprays are applied to promote fruit setting.

Pest management

Diseases and insects can ruin a crop. Common diseases during the hot, wet season include early blight, southern blight, black leaf mold, gray leaf spot (Fig. 17a), bacterial wilt, and bacterial spot. Whitefly-transmitted viruses are emerging as major problems, especially when the season is dry. Resistant varieties, if available, and crop rotation are recommended to prevent most disease problems. Commonly observed insects are tomato fruitworm (Fig. 17b), tobacco cutworm, beet armyworm, and leaf miner. Monitor your crops closely and take appropriate control measures.

Fig. 17. Foliar diseases such as gray leaf spot (left) and insects such as tomato fruitworm (right) are common problems in the hot, wet season.

Maintenance

The plastic cover and side netting will accumulate dust and algae. To keep the materials clean and long lasting, wash them with water or a detergent solution. Add bleach if necessary to kill algae. Use a high-pressure hose to spray water or detergent solution (Fig. 18).

Fix structures promptly whenever damaged. When rain shelters will not be used for year-round cropping, disassemble the components and store them in the shed.

Fig. 18. The rain shelter is cleaned after harvesting is completed.

For more information on cultivating tomato, grafting tomato for off-season production, managing pests, or using fruit-setting hormones, go to the AVRDC web site: <www.avrdc.org>.