COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE

Management of Tobacco Float Systems

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Just over a decade ago the float system of transplant production was introduced to Kentucky tobacco growers. More than 75 percent of all tobacco transplants are now produced by this method. Because this is a relatively new technology, it continues to evolve rapidly.

The float system offers several advantages over conventional plants. The chief advantage is the reduction of labor needs at setting time. Float plants eliminate plant pulling which often slows transplanting. However, the system is not without problems, particularly since it is more prone to diseases than conventional beds. To date, much has been learned by trial and error. The information contained in this publication reflects the current state of knowledge about this system.

Tray Selection

Most trays used in tobacco float systems are made of polystyrene (Styrofoam). The amount of material used in molding the tray determines its density. Higher-density trays tend to be more durable and have a longer useful life than low-density trays, but they are more expensive. An inexpensive low-density tray may be desired for those who sell finished plants and have difficulty getting trays returned or for those who are concerned about potential disease problems with returned trays.

Other than density, the choice of tray comes down to the number of cells desired. The outside dimensions of most float trays are approximately the same (13½" x 26¼"). Generally, as the number of cells increases, the cell volume necessarily decreases. However, the depth of the tray and cell design can influence cell volume (Table 1). Notice the relatively small volume of the 253-cell tray. The first 253-cell trays were 3/8 inch shallower than most 242s and 288s. This is not necessarily true with the trays available now, as the tray manufacturers have begun making shallower trays in all cell numbers. A shallow tray has a reduced cell volume, and the media surface is closer to the water table, increasing problems with water logging of the media.

Note the difference in volume between the 338 and 338D trays; the 338D is a deeper tray. In general, as the cell volume decreases, so does the optimum finished plant size. The choice of tray comes down to maximizing the number of plants produced per unit area, while still producing healthy plants of sufficient size for easy handling. Smaller plants are not a problem for growers using carousel setters, but those with finger-type setters have difficulty setting smaller plants deep enough.

A greenhouse provides a protected environment for growing tobacco transplants, but careful management is required to achieve consistent results.

Some float producers try to maximize plant production per unit area as a means of lowering overhead production costs. High cell number trays have been used successfully to do this by some greenhouse operators, but more time and a higher level of management are needed to grow transplants at higher cell numbers. Disease management is more difficult with high cell numbers and requires better environmental control and diligent spray programs. For most tobacco producers with limited greenhouse experience, a 242- or 288-cell tray is a good compromise.

Trays with lower cell numbers are recommended for transplant production in outside beds. The lack of environmental control—and infrequent clipping of outside beds—makes the use of high cell number trays risky. Since the cost of outdoor bed space is relatively inexpensive compared to a greenhouse,

Table 1. Float trays commonly used in tobacco transplant production.

Cells per Tray	Volume per Cell (cc)	Plants per sq. ft.
200	27.0	80
242	23.5	97
253	16.0	101
288	17.0	115
338	8.6	135
338D	11.2	135
392	13.6	157

there is not as much pressure to produce the maximum number of plants per square foot.

Tray dimensions vary slightly from one manufacturer to another. Be sure that the tray selected matches the dibble board and seeder to be used.

Tray Sanitation and Care

A good sanitation program is critical for consistent success in the float system. For many of the diseases that are a problem in float plants, sanitation is the only defense since rescue treatments are not available. Sanitation of trays is difficult because of the porous nature of polystyrene. As the trays age, they become more porous, and with each successive use, more roots grow into the tray. This allows pathogenic organisms to become embedded deep in the tray where they are difficult to reach with sanitizing agents.

Trays should be rinsed off immediately after setting to remove any media, plant debris, or field soil. Many of the organisms that cause diseases in the float system are common soil inhabitants and field pathogens. After trays have been used to grow a crop of transplants and been to the field for transplanting, they may be contaminated.

Trays may be disinfected prior to storage or just before seeding in the spring. They should be stored indoors out of direct sunlight. **Do not** store trays in a greenhouse where UV light and heat will cause deterioration and damage. If trays have been sanitized prior to storage, store them in such a way as to avoid recontamination. Take appropriate steps to protect trays from damage due to the nesting activity of small rodents and birds.

Disinfectants available are steam, methyl-bromide fumigation, chlorine bleach, and quaternary ammonium chloride salts. None of these has been totally effective in killing all the pathogens. Each has positive and negative points, as discussed below.

Steam Sanitizing

In our studies, steam has been the most effective disinfectant. It consistently does the best job of killing the range of pathogens found in Kentucky. But its costs are high, and some trays are damaged by steaming. Steam is especially recommended for commercial transplant producers. The biggest problem with steaming at the farm level is sufficient control of the steam to hold the proper temperature for the prescribed period of time without damaging the trays. Steaming at 170º to 180ºF for 30 minutes has been successful, but lower temperatures and longer times may also be used. For more information on effective use of steam, contact an Extension plant pathologist.

Methyl Bromide Fumigation

Methyl bromide with 1 percent chloropicrin has been almost as effective as steam in some of our tests. It provides excellent control of *Rhizoctonia* and other fungi on the surface of the tray. It will greatly reduce the level of *Pythium*, but it has not been as effective as steam or proper bleaching, probably because a significant amount of *Pythium* is found embedded in the tray.

Great variation has been found in the amount of control provided within a lot of trays. Three steps are important in this method of sanitizing trays: use an airtight plastic seal, pre-wet the trays, and avoid large stacks of trays. Methyl bromide is heavier than air, so it sinks; therefore, the best results occur with long, short stacks rather than tall stacks.

We have found little control at the low rates. Therefore, the maximum labeled rates (3 lbs/1000 cubic feet) should be used. Trays may be damaged by contact with methyl bromide in the liquid form. Carefully read all labeled precautions and temperature requirements.

Sanitizing with Chlorine Bleach

Chlorine bleach solutions have given high levels of control, but overall this method is not as effective as either steam or properly conducted fumigation. We have found little benefit to using more than a 10-percent solution. Without proper aeration and post-washes, salt residues can cause serious problems, especially with older trays that tend to soak up more materials.

Bleaches work best when the trays are washed with soapy water, then dipped several times into a clean 10-percent solution. This step should be followed by covering the trays with tarp to keep them wet overnight with the bleaching solution. Afterwards, the bleach solution should be washed from the trays with clean water or water plus a Q-salt as listed below, followed by aeration to eliminate the chlorine and salts of chlorine.

Worker safety issues are also important with the bleach method, so take appropriate steps to protect workers. It is important that the bleach solution remain below pH 6.8 and that a new solution be made up every 2 hours or whenever it becomes dirty, whichever comes first. Organic matter deactivates the active ingredients in bleach very quickly.

FUMIGATION OF TRAYS IS POTENTIALLY MORE DANGEROUS THAN FUMIGATION OF CONVENTIONAL BEDS. THERE IS A GREATER OPPORTUNITY FOR GAS TO BE RELEASED INTO AN AREA OCCUPIED BY WORKERS. FUMIGATION IN A ENCLOSED AREA SUCH AS A GREENHOUSE OR STORAGE SHED IS PARTICULARLY DANGEROUS.

Sanitizing with Quaternary Ammonium Chloride Salts

Quaternary ammonium chloride salts are marketed under such trade names as Greenshield, Physan, and Prevent as solutions containing 20 percent ammonium chloride. Although many growers use them, our tests indicate that they are not as effective as some believe. Their greatest benefit is in the final wash and on exposed surfaces in the greenhouse. In all our tests, they have always provided some control, as compared to using soap washes only, but have always been inferior to any of the above-mentioned methods.

Water Quality

Water quality for tobacco float plants has not been a big problem in Kentucky when a fertilizer is used that is well suited for the float system. However, there are a few things to keep in mind. Never use untreated surface water (ponds, streams, etc.) for tobacco float beds. Surface water may contain high levels of disease-causing organisms. Water from most municipal and county water systems has been found to be suitable for use in the float system. In a few water districts, the alkalinity levels have been found to be above acceptable levels.

Water from private wells occasionally has higher than desired levels of alkalinity, with about 15 to 20 percent of the wells tested requiring the addition of acid to reduce the alkalinity to a manageable range. Rarely, there are cases where water quality problems are severe enough to warrant switching to a different water source (Figure 1).

In general, if you use a private well as the source of water for float beds, the water should be tested. Even though the water may be fit to drink, not all drinking water is suitable for tobacco float systems. Testing is available through your county Extension office. A preliminary check of water quality can be made with a Dist-4 meter and swimming pool test strips that measure pH and alkalinity. Dist-4 readings above 1.0 (10 on old meters) or alkalinity above 180 ppm suggest the need for a complete water analysis. For more information on water quality, see AGR-164, *Water Quality Guidelines for Tobacco Float Systems.*

Media Selection

The three basic components of soilless media used in the float system are peat moss, perlite, and vermiculite. Peat is the brown material that is used in all the media to provide water and nutrient-holding capacity. Vermiculite is the shiny, flaky material, and perlite is the white material used in some media. Different brands of media have varying amounts of these components. Some have only peat and vermiculite, others have only peat and perlite, and still others have all three ingredients. Research to date has not indicated any particular combination of ingredients to be superior to the others. Year-to-year variability within the same brand of media can be quite high, so there is a need to continually check and adjust tray filling and seeding procedures each year.

Figure 1. Severe water quality problems are rare, but it is recommended that you check out the water source before building a transplant production facility. Problems caused by poor water quality include salt damage, stunted growth, yellowing of the leaf edges, and, in severe cases, death of the seedlings.

Tray Filling

The most common mistake made with tray filling is overwetting and over-packing the media. Trays that are overpacked will have a tendency to hold too much water. Increased wetness in the trays leads to increased spiral root incidence, more problems with stem and root rot, reduced root growth, and greater algae growth (Figure 2).

One of the reasons that trays are over-packed is to prevent dry cells. Dry cells occur when the media does not reach the bottom of the tray and does not come into contact with the water. When this happens, water will not wick, and the seed will not germinate. A large percentage of dry cells indicates that something is wrong with the filling procedure, and some correction is needed. A few dry cells (1 percent or fewer) should be considered normal. It is better to have a few dry cells than an entire tray of over-packed cells.

To avoid over-packing, remember that many media are now pre-moistened and need little or no additional water to be prepared for tray filling. To test proper moisture content, squeeze a handful of media. When it is released, it should

Figure 2. Large numbers of spiral roots indicate problems with tray filling.

begin to crack open but hold its general shape. If the media holds its shape very tightly, it is probably too wet for filling. At the proper moisture content, the media should flow relatively easy, so trays must be handled carefully during the filling and seeding process to avoid losing media out the bottom of the tray. Excessive loss from the tray bottom will cause dry cells. If this is a problem, add a little more water to the media before filling.

Never apply pressure to the surface of a tray during tray filling. Spread media over the tray surface using a straight edge. The uneven pressure applied by sweeping your hand over a tray can cause a difference in the compaction. To settle the media, drop the tray one or two times from a height of 1 to 2 inches, tap the sides of the tray lightly with a clean stick, or use a rolling dibbler.

If using a machine to fill trays, try to reduce the downward pressure of the media on the trays by using baffles or hardware cloth to keep the entire weight of the media in the soil hopper from pressing on the trays. If you are having a severe problem with spiral root and are using a hopper box, try adding only a bag or part of a bag at a time to the hopper. Research has shown that the media pressing down on the tray can have a significant impact on media compaction. Do not allow the agitator to run continually when trays are not being filled.

After filling, the trays must be dibbled prior to seeding. The dibble mark provides a favorable micro-environment for seed germination. Research has shown that seed germination is much more consistent in dibbled trays than in non-dibbled trays. The dibble board or rolling dibbler should be matched to the brand of tray such that the dibble mark is as close as possible to the center of each cell. The dibble should be ½" to ¾" deep, with relatively smooth sides to allow the seed to roll to the bottom of the dibble. The shape of the dibble is largely a matter of personal preference, although some research has suggested that spiral root incidence was slightly lower in rounded dibbles than in pyramid-shaped dibbles. Both dibble boards and rolling dibblers have been used with success.

Handle the trays with care after dibbling to avoid collapsing the dibble. Trays that were not well scraped after filling often have excess media at the surface that can get knocked into the dibble.

Seeding

There are a number of seeders available for placing individual pelleted seeds into each cell. The most common types are vacuum seeders, sliding plate seeders, and rotating drum seeders. The primary advantage of drum seeders is that they allow continuous seeding and increase the number of trays that can be seeded in a given period of time. They are generally more expensive than either vacuum or sliding plate seeders.

Regardless of the type of seeder used, it must be matched to the size and brand of tray that you have. There are slight differences in the dimensions of trays from different manufacturers. If the seeder is not matched to the tray, seeds may be placed near the edge of the cell where they are less likely to germinate. After seeding, examine the trays to ensure that there is only one seed in each cell. The seed should be near the center of the cell and at the bottom of the dibble. Seeds that fall at the surface or on the side of the dibble mark are more likely to experience problems with germination or spiral root.

Use care when transporting the trays from the seeding area to the float bed. Avoid collapsing the dibbles and burying the seed. After floating, the seed should still be visible in each cell.

Trays should wick water within 8 to 10 hours after being floated. Do not be alarmed if the trays do not completely wick up in an hour or two. Resist the temptation to sink the trays to make them wick faster. This is generally not necessary and, in fact, may cause media to be sucked out the bottom of the tray, potentially creating more dry cells. Allow some time for the trays to wick naturally.

Figure 3. Example of a fertilizer that is suitable for a tobacco float system.

BRAND Z
FERTILIZER

20-10-20

GUARANTEED ANALYSIS

Total Nitrogen (N)	20%
7.75%	Ammoniacal N
12.25%	Nitrate N
Available Phosphate	10%
Soluble Potash (K_2O)	20%
Magnesium (Mg), Total	0.05%
0.05% Water Soluble Mg	
Boron (B)	0.007%
Copper (Cu)	0.004%
0.0036% Chelated Copper	
Iron (Fe)	0.05%
0.05% Chelated Iron	
Manganese (Mn), Total	0.025%
0.025% Chelated Manganese	
Molybdenum (Mo)	0.0009%
Zinc (Zn)	0.0025%
0.0025% Chelated Zinc	

Derived from:

Ammonium Nitrate, Potassium Phosphate, Potassium Nitrate, Magnesium Sulfate, Boric Acid, Copper EDTA, Iron EDTA, Manganese EDTA, Sodium

Outside float beds offer an economical alternative to greenhouses; however, there is a much greater risk of plant loss due to extreme weather conditions.

Fertilizer Selection and Use

Choose a fertilizer that is suitable for use in the float system. Many water-soluble fertilizers sold at garden shops do not contain the proper balance of nutrients in the right form for tobacco transplants. Specifically, avoid fertilizers that have a high proportion of nitrogen in the form of urea. Look for a fertilizer with mostly nitrate nitrogen and little or no urea. Information about the nitrogen source should be on the product label. If it is not there, don't buy that product for the float system.

Research has shown that tobacco transplants do not need a high level of phosphate. Some research even suggests that there is a better balance of top and root growth if phosphate levels are kept lower. Look for a fertilizer with low phosphate like 20-10-20, 15-5-15, 20-5-20, 16-4-16, etc. Figure 3 shows an example label of a fertilizer recommended for the float system.

Over-fertilization of float plants is a common mistake. The recommended level of fertilization is no more than 100 parts per million nitrogen. This is equivalent to 4.2 lbs. of 20-10-20 per 1000 gallons of water. To determine the gallons of water in a float bed, use Equation 1.

When transplants are not developing fast enough, some growers are tempted to add more fertilizer to "push" the plants along. At high rates of fertilizer, plant growth will be very lush, making the plants susceptible to attack by disease organisms such as black leg, pythium, and bacterial soft rots. Black leg is a stem rot disease caused by bacteria, which can develop rapidly (within hours) when plants have been over-fertilized. Under-fertilized plants grow more slowly and are more susceptible to such diseases as target spot, sore shin, and anthracnose.

The incidence of improper fertilization can be reduced by investing in a conductivity meter and monitoring the salt concentration on a regular basis. The Dist-4 meter is the most commonly used conductivity meter. Before use, the meter should be calibrated. To use the meter, measure the reading of your water source prior to fertilization. Most water sources read about 0.3 to 0.5 millisiemens/cm (3 to 5 on older meters) on the meter before fertilization. If your water is higher than 1.0 (10 on old meters), it should be tested (see above).

After testing the water, calculate the amount of fertilizer needed for the bed. Add the fertilizer to the bed and mix thoroughly before reading again. The reading should go up by 0.5 to 0.9 units, depending on the type of fertilizer used. For the most commonly used 20-10-20 formulations, the reading increases by 0.3 units for every 50 ppm N added. The reading obtained after fertilization should be the target level. Check the conductivity of each bed at least weekly. If the reading falls below the target, add more fertilizer. If it is above the target, add water to dilute the fertilizer, and avoid problems with over-fertilization.

To add fertilizer to a bed, mix the water-soluble granules in a bucket with warm water until dissolved. Pour the solution into the bed at several places, and thoroughly mix the water to distribute the fertilizer. Some producers have been using small submersible pumps and PVC pipes to periodically circulate water in float beds. This will ensure an even distribution of fertilizer.

Fertilizer may be added at seeding or within the first 10 days after seeding. Waiting a few days before adding fertilizer will reduce the growth of algae on the tray surface and reduce the chance of salt damage to young seedlings.

Condensation Control

Condensation on the internal surfaces of greenhouses and float beds can result in dripping which dislodges seeds and young plants from trays, resulting in stand loss. The moisture which causes condensation also increases the potential for disease at all stages of production. In greenhouses, the best control of condensation and moisture is through the proper control of ventilation and heating. For more information on ventilation and heating, see ID-131, *Basics for Heating and Cooling Greenhouses for Tobacco Transplant Production.*

Other methods may be used to protect plants from the damage caused by dripping, but they do little to control the cause of condensation or reduce disease potential. Building the greenhouse or bed with a steeper roof pitch will reduce problems because the condensation that forms will have a greater tendency to roll off the sides rather than drip.

Equation 1.

number of trays the bed holds x depth of water in inches x 1.64 = gallons of water

Some growers use bed covers at the plant level to protect plants from dripping. With this method two common problems occur: (1) the plants get too hot, (2) they don't get enough light and have a tendency to elongate or stretch. The plant level covers should be removed as soon as the plants are big enough to protect the cell from damage (about dime size).

Commercial sprays are available that can be sprayed on interior surfaces of greenhouses to help water roll off the sides rather than drip. Some growers with outside beds have taped vinyl corner molding to the undersides of their bows to help channel condensation away from the trays.

Clipping

Proper clipping of float plants aids in disease control and helps to promote uniformity and increase stem diameter. When done properly, clipping does not slow the growth of plants, nor does it contribute to early blooming or ground sucker formation.

Direct-seeded float plants should be clipped the first time when the buds of the plants are approximately 1½ to 2 inches above the tray surface. The first clipping is extremely important to promote uniformity, particularly in outside direct-seeded beds where germination is often uneven. After the first clipping, plants should be clipped every 5 to 7 days depending on growth rate. At each clipping, remove no more than ½ to 1 inch of leaf material.

Plugged plants should be clipped for the first time approximately 1 to 2 weeks after plugging (as soon as the roots have established). The same guidelines apply to clipping plugs as apply to direct-seeded plants. Plugged plants should require only two or three clippings, unless setting is delayed.

When clipping plants, sanitation of the clipping equipment is a must to avoid spreading diseases around the bed. When done properly, clipping actually aids in disease control by opening up the plant canopy to allow for greater light penetration and improved air circulation around the plants. The mower and surrounding frame should be thoroughly cleaned after each use and sprayed with a disinfecting solution of 10 percent bleach or a commercial greenhouse disinfectant. If left on metal surfaces, bleach will promote rust, so rinse all surfaces after 10 minutes of contact time.

The key to effective clipping of float plants is to make a clean cut and remove the clipped material from the area. To accomplish this, use a sharp blade and adjust the mower speed so that the clipped material is lifted off the plants and deposited in the bagger. A high blade speed will result in the material being ground to a pulp and deposited on the trays, thereby increasing the likelihood for diseases. A relatively low blade speed with a sharp blade works best. Dispose of clippings in an area well away from the greenhouse. Gasoline-powered reel-type mowers have been used successfully for clipping plants since this type of mower makes a clean cut of large pieces of leaf and deposits them in a catcher with little or no grinding.

Pest Control in Tobacco Float Beds

EPA has ruled that outside float beds are considered as mini-greenhouses for the purposes of chemical pest control options. This means that only chemicals labeled for use on tobacco in greenhouses can be used on outside float beds. Chemicals that are labeled have specific instructions concerning the contamination of float water. This limits the chemical options available for controlling diseases and insects in these systems.

The first line of defense in controlling pests is exclusion of the pest. A good sanitation program will not eliminate pests from the system, but it will reduce their numbers and reduce the likelihood that they will cause economic loss. In addition to disinfection of trays, a good sanitation program includes removing weeds from around the bed area and cleaning equipment used in and around the beds. Locate the float site in full sun away from tobacco fields, barns, and stripping rooms to reduce the chance of carrying disease over from one crop year to the next.

Orthene 75 SP is the only insecticide currently labeled for use in tobacco float systems. It can be used at a rate of 1 tablespoon per 3 gallons of water per 1000 sq. ft. of float tray area to control aphids, cutworms, and flea beetles. The treatment may also provide some control of fungus gnats and shore flies. Apply evenly to ensure thorough coverage.

The float water of treated beds must be disposed of in the transplant water or through a foliar application made to the field. Since label changes may occur, be sure to read and follow all label directions. For more information on insect control, see ENT-15, *Insecticide Recommendations for Tobacco Beds and Fields.*

Note: Each float tray is approximately 2.5 sq. ft., so 400 trays is 1000 sq. ft.

Control of transplant diseases is achieved through careful management of the production environment, proper fertilization, excellent sanitation, and timely application of pesticides. Both the incidence and severity of diseases in seedling production can be greatly reduced through chemicals involved with fumigation, sanitation, and preventive spray programs. Unfortunately, adequate labeled materials are not available for most disease problems.

Especially critical is the absence of labeled materials for use in the greenhouse and float systems, where the environment, under current production approaches, is highly conducive to disease development due to the root systems' sitting constantly in water. For example, no materials that are highly effective are labeled for use in these systems against the following major diseases: *Pythium* root rot, *Rhizoctonia* root rot and soreshin, *Sclerotinia* collar rot and blight, black root rot, black shank, *Fusarium* wilt and root rot, and bacterial soft rot and leaf spots.

Special Considerations for Outside Direct-seeded Float Beds

Production of tobacco transplants in outside direct-seeded beds is inherently more risky than greenhouse production or plug and transfer. Although the cost of transplants is lower in direct-seeded outside beds (see ID-129, *A Cost Comparison of Three 10-Acre Tobacco Transplant Production Systems*), the chances of plant loss are greater. Although results are related to the uncertainty of the weather, the risk of plant loss can be lowered by good preparation and management.

Growers who are considering direct-seeded float beds for the first time should be aware that these systems require a great deal of management. Direct-seeded float beds require more initial attention than conventional beds or plug-and-transfer systems. During this early growth period, growers should check on the conditions in the bed several times daily and be prepared to take corrective actions if needed. If you work off the farm or have other enterprises that require you to be away from the beds for long periods of time, you may want to consider other alternatives for your transplant needs. However, with the proper commitment, growers can produce high-quality float plants on the farm and lessen their chance of importing certain devastating plant diseases.

One of the problems with outside direct-seeded beds is protection from rainfall. Rainfall will splash seeds and young plants out of the trays (Figure 4). Some producers have tried to remedy this problem by placing a clear plastic over the bed at all times. This can lead to an excessive heat buildup during sunny days and may cause serious plant loss. The best protection from rain losses is to keep a piece of black plastic handy to cover the bed when rain threatens. The use of black plastic lessens the chance that plants will be scorched in direct sunlight. For this practice to be successful, someone must always be nearby to cover and uncover the bed as needed. Black plastic cannot be left on the beds for an extended period of time because the plants will stretch due to low light conditions.

During seed germination, temperatures above 90º to 95ºF can kill or damage young seedlings. Temperatures under polypropylene and punched plastic covers rise rapidly when the sun is out and frequently get high enough to damage plants unless measures are taken to ventilate (Table 2). You can find out about the temperature extremes in a float bed with the use of an inexpensive maximum/minimum thermometer. The thermometer should be placed at plant level and protected from direct sunlight.

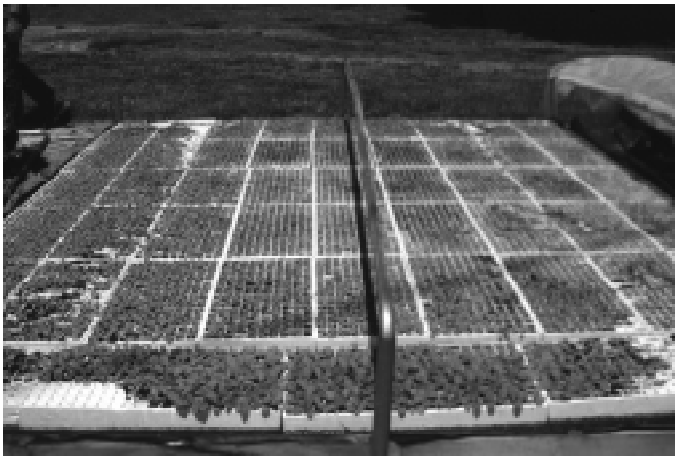

Figure 4. Rainfall and heat can cause significant loss of plants in outside direct-seeded float systems.

If you find that daytime temperatures frequently exceed 90ºF, then consider steps to ventilate the beds. Opening the ends of beds early in the spring may be sufficient to keep temperatures below the critical level. In long beds, the sides may need to be raised to provide adequate ventilation. Remember that when you ventilate the bed and outside temperature is still rather cool, this cool air blowing directly on plants can lead to cold injury and, later, to ground sucker formation. Later in the spring when temperatures are warmer, the covers may be removed. This will also help to toughen up the plants.

Additional freeze protection can be obtained by using 100 to 150 watt light bulbs strung from the top of the bows. Rough service bulbs are recommended. Bulbs should be spaced every 2 to 4 feet down the bed. The use of light bulbs will not keep the plants warm. They are simply a way to gain an extra 2 to 3 degrees of freeze protection. The bulbs should be used in conjunction with an extra cover on nights when a temperature in the low thirties is expected. Any time electricity is used in or around float beds, the circuit should be wired with a ground fault circuit interrupt (GFCI) device to protect against electrical shock.

Table 2. Properties of float bed covers.

Type of Cover	Typar	Continental Float Cover	Vispore	Clear Plastic	Black Plastic
Light transmission	Medium	Medium	High	High	None**
Heat buildup (day)	Medium	Medium	High	V. High	Medium
Heat retention (night)	Medium	Medium	Low	Low	Low
Rainfall protection	Low	Medium	High*	High	High

* With the rough side turned up
** Plants will stretch under black plastic due to low light