# Transplanting

(adapted from NC Strawberry Plasticulture Guide, Ch. 7)

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*Fertility section (just below) adapted from S. Casteel (2004)

**Fertility.** Before transplanting cut-offs in early fall, it is very important to have completed a soil test several months before planting to determine how much dolomitic lime is needed to raise the soil pH and how much potash ($K_2O$) fertilizer to apply before bedding. Nitrogen (N), phosphorus (P), and potassium (K) are the three elements required in greatest quantity for optimal strawberry plasticulture production.

*Nitrogen*. A pre-planting fertilizer mix will provide one-half of the total 120 lb/acre nitrogen (N) seasonal requirement for strawberry production under plasticulture. Thus, it is important to apply *60 lb/acre N in the pre-planting fertilizer mix.* Historically, ammonium nitrate ($NH_4NO_3$) was recommended, but true ammonium nitrate is not available due to much tighter restrictions on this fertilizer. In the NC Sandhills, several strawberry growers use 1,000 lb/acre of 6-6-18 to deliver 60 lb of N and $P_2O_5$/acre. This particular tobacco fertilizer (6-6-18) contains about half of the nitrogen in nitrate form. Because nitrifying bacteria are reduced by fumigants, at least 50% of the nitrogen in the initial fertilizer application should be in the nitrate form.

*Phosphorus*. In general, a $P_2O_5$ application of 60 lb per acre should be incorporated, even on soil with a high phosphorus index. At Clayton Central Crops (20 miles southeast of Raleigh, NC) in the 1990s we evaluated fall applied $P_2O_5$ at 0 and 60 lb/acre to a loamy sand with a high soil P index. The results indicated a significant increase in market yield with the 60 lb/acre fall-applied rate versus no $P_2O_5$ supplement (the control). The yield response from fall-applied $P_2O_5$ may be due to early flower initiation before cooler temperatures arrive. As the soil cools, P becomes less available to the plant. Thus, a fall $P_2O_5$ pre-planting application is recommended in the range of 30 to 60 lb/acre, even on high P index soil (Wikipedia, 2015). Applying 10-10-20 at 600 lb/acre, will deliver 60 lb/acre $P_2O_5$. Likewise, if you are using 6-6-18, then 1,000 lb/acre of this fertilizer blend will also deliver 60 lb/acre $P_2O_5$. On soils that have ultra high levels of phosphorus (typically areas where large amounts of poultry manure have been applied), this application can be deleted.

*Potassium* (K). Soil testing determines the need for potash ($K_2O$)—follow the NCDA & CS soil test recommendation for K. You can make adjustments in the late winter or early spring according to tissue analysis for additional potash application through the drip system. Potassium sulfate is a very good source of $K_2O$ for strawberries (50% to 53%), and it provides some sulfur as well (18%). If the soil test recommends 60 lb $K_2O$ per acre, then a broadcast application of 120 lb/acre of potassium sulfate fertilizer (50 percent $K_2O$) can be applied to meet the crop's potash requirement.

*Other nutrients*. Other nutrients such as boron (B) can be injected through the drip irrigation system, as called for by plant tissue testing, starting at the new leaf growth stage in late winter. At Clayton we begin spring sampling for nutrient monitoring on March 1 in most years. In a very mild winter such as that of 2012–2013, it was possible to start tissue sampling in the third or fourth week of February at Clayton. Pre-planting fertilizer blends that include the micronutrient boron should probably be avoided on most soils. If too much boron is added to the pre-planting fertilizer mix, boron toxicity can occur. On sandy soils it may be advisable to include 1 to 2.5 lb/acre boron in a preplant mix, but *never* exceed this amount.

*Compost.* If applying compost before bed-making in late summer, do your homework first: Nutrient content? Heavy metals? N release pattern? Get advice from your extension agent on issues related to using any animal manure in strawberries.

***Several common questions:***

1. *What if no soil test was taken prior to shaping the beds (next step)*?
   Apply 60 pounds nitrogen (N) per acre, 60 pounds phosphate ($P_2O_5$) per acre, and 120 pounds potassium ($K_2O$) per acre.

2. *When should these fertilizers be applied?*
   Broadcast these fertilizers and lightly incorporate before bedding and fumigation.

3. *Can calcium nitrate be used as a source of pre-planting nitrogen?*
   Yes. If you are using calcium nitrate (15.5-0-0), then 60 ÷ 0.155 = 387 lb/acre 15.5-0-0.

***Shape the beds.*** Avoid using a vegetable bed-maker. Instead, stick with the bed-making equipment that is specifically designed for deep strawberry plasticulture beds. Reddick and Kennco are two of the leading suppliers. A deep bed will produce higher yields and fruit with less soil splash. The 10-inch deep beds mulched in plastic are typically 30- to 32-inches wide at the base and 28- to 30-inches wide on top. Beds are slightly crowned so water will run off and not rest on the plastic. For example, a bed with a 28- to 30-inch top should slope from the center to the edge with a drop of 1.25 inches. Applying straw mulch to the aisles to keep the berries clean is not necessary with 10-inch deep beds. Bed centers are usually 5 feet.

Most machines have some specific advantages, and it is worthwhile to investigate these differences. Almost all of the machines sold will form the bed, fumigate, lay plastic mulch, and install drip tape in one operation. In general, the single-row bed-making and plastic-laying machines are appropriate for most strawberry operations. Be sure that enough soil is pulled up so that the bed has good, sharp corners and no depression in the center (it is not usually possible to get these sharp corners on clay soils). You may find it beneficial

to pre-bed the rows to make sure that enough soil will be pulled up for the bed-shaper; the same disk hillers used for making tobacco beds work nicely for strawberry pre-bedding. The extra pains involved in getting your land "just right" for forming beds, such as laying plastic and fumigating, will pay off in better plant growth in the fall and winter seasons.

***Install plastic mulch.*** Ideally, strawberry beds have the plastic mulch in direct contact with the soil beneath. If there are air pockets beneath the plastic, plant growth will be slow in the fall and winter. Heat from the black plastic will not be conducted into the soil if there are air pockets. In fact, the black plastic will have a cooling effect if it does not make good contact with the soil beneath. In very recent years, most of the NC strawberry industry has transitioned to higher barrier plastic films such as virtually impermeable films (VIF) or mulches that allow very little methyl bromide and other fumigant gases to pass through it. These nearly impermeable films make it possible to significantly reduce fumigant application rates by helping to contain the fumigant within the soil and reducing overall emissions into the atmosphere. Use black plastic 1-mil to 1.25-mil VIF for strawberry plasticulture production. On 5-foot row centers, there are 8,712 linear feet of row per acre, so you will need about 3.5 rolls (2,400 feet) of plastic mulch per acre. For 6-foot centers, 3.0 rolls of plastic mulch will be required per acre. It is important that the plastic fit tightly on the bed and that the edge of the plastic, or the tuck, be held firmly in the soil. These measures reduce the chance of wind getting under the plastic and causing it to blow off or float up and down, which injures plants.

***Install drip tubing.*** Install drip tubing with the orifices facing upwards. The tubing is typically buried 1 or 2 inches deep in the bed center. During installation, several workers should be watching to ensure that the tubing maintains its orifice-upwards orientation. The workers are responsible for assisting if the tubing becomes tangled in the injector and for signaling when the drip tape reel is empty. Tubing ends should be closed off by kinking or knotting until the tubes are hooked up to the system. Growers have the option of using only overhead sprinklers in the fall, but the drip system should be functional by late winter.

***Fumigation.*** Fumigants have been used in combination with plastic mulch row covers since the early 1980s for broad-spectrum soilborne pest and disease control in strawberry plasticulture. New land that has been subject to good crop rotations and best management practices (such as cover cropping and good drainage strategies) can, under optimum conditions, generate yields that are 85% to 95% of the yields in fumigated soil. Weed control, however, can be a serious problem. Strawberry plasticulture production on the same site year after year is generally not advisable without pre-planting fumigation because of potential weed and disease problems. Since methyl bromide has been phased-out nationally and internationally under provisions of the Montreal Protocol, the U.S. research community has been intensively searching for a broad-spectrum replacement fumigant. Go to the website: smallfruits.org (https://smallfruits.org/files/2020/02/2020-Strawberry-IPM-Guide.pdf) to check on the currently labeled fumigants, rates and application suggestions for strawberry plasticulture growers in the South.

Regardless of the fumigant selected, it is important to schedule fumigation *at least* four weeks before transplanting to allow for the 21-day plant-back restrictions for each fumigant

listed in Table 7-3, and to anticipate unexpected setbacks that can occur with weather, such as happened in late summer 2014 (Fig. 7-1). If adverse weather prevents fumigation, it may be better to plant on time and not fumigate than to plant extremely late—*if* the site is fairly free of noxious diseases and weeds such as nutsedge.

Fig. 7-1. Rainy conditions in late August and early September 2014 caused many growers in North Carolina and Virginia to omit pre-planting fumigation so that they could still plant on time. However, on nonrotated land (continuous strawberries), yields will likely be reduced by 20% in spring 2015.

***Schedule fumigation far enough in advance to allow for plant-back.*** Here is a sample schedule for a grower in Zone 6 who wants to set out Chandler plugs in the *second week of September* and who has decided to use a methyl bromide alternative with a 21-day plant-back.

*July, week 4.* Whenever there is adequate soil moisture, begin preparing the soil so you can shape the beds and fumigate in early August. In an unusually dry July, you may be forced to irrigate overhead to get the land ready for chisel plowing and subsoiling. Subsoiling is needed every few years on heavy soils. This should be done in two directions, north–south and east–west, and it needs to be done deeply to loosen the soil and break up the plow layer (at 10 to 12 inches deep). Breaking up this layer will require setting the draft control so the V-ripper doesn't come up easily when it hits the hard spots. This operation requires extra horsepower. Be sure to incorporate your lime at this stage if you haven't done so already. Ideally, the lime should be spread in June, just after the plastic is pulled and the beds are knocked down. *Also, make sure you have on hand all pre-planting fertilizers.*

*August, week 1.* Have fumigant cylinders delivered to the farm and complete fumigation rig safety checks. Check with your fumigant supplier to be sure the cylinders are delivered on time and to ensure that the proper safety checks are used:

- Prepare your Fumigant Management Plan as required by the new regulations. Don't wait until the last minute. Make sure you have required respirators, fit testing, and signs. New buffer zone and notification rules are in effect.
- Install a "blow-out tube" on your fumigation rig—this is an important safety measure in case pressure builds up excessively in the nitrogen tank.
- Before fumigation, pressure-test your fumigation system using only nitrogen (a special connector can be obtained to do this).
- Make sure that the knives on the fumigation rig are open and filters are clean.
- Consult your supplier to determine fumigation equipment specifications (such as orifice size, pressure, flow meter percentage) to achieve proper application rates of the selected fumigant.

*August, week 2.* Broadcast N-P-K fertilizers and disk them into the soil to prevent nitrogen loss. Disk to a depth of 6 inches, breaking up clods until the soil has a "fluffy" texture. Don't use equipment that will compact the soil (a rotary hoe or rototiller may cause compaction). If soil conditions are dry, overhead irrigate .25 inch per cycle until soil conditions are optimum for both bed-making (firm but not clumpy) and fumigation (optimal retention time of product for maximum efficacy). Supplemental irrigation amounts will vary by soil type. Be careful not to overly wet soil.

*August, week 2 – 3.* Shape the beds and fumigate. Lay plastic mulch and drip tape. As the fumigant is injected, the beds should be immediately "tarped" with an embossed 1-mil black plastic mulch film that can be "stretched" by the mulch-laying and fumigation unit to give an extra tight fit over the bed. Also, if rooting your own plugs, now is the time to stick tips. It is time to sow annual ryegrass if you want to ensure erosion control in the field aisles. Plant ryegrass soon after fumigating and before punching holes for planting. The recommended seeding rate for annual ryegrass is 25 lb/acre. (You are only covering half of the area with seed, so this rate is equivalent to 50 lb per acre.) Heavier seeding rates will result in a thick, luxuriant stand that often has to be sprayed twice to get it to lay down.

*September, week 2.* Transplant plugs. Always try to allow four weeks between fumigation and planting, even though the fumigant requires a 21-day (three-week) plant-back. This extra week will provide a "cushion" for possible weather delays.

## Planting and New Plant Establishment (Early Fall)

***Planting period.*** *See* Chapter 5, "Plant Materials and Varieties,*" for planting period recommendations by region for Chandler, Camarosa, and Sweet Charlie.* As a general rule, Albion day-neutral plugs should be set about one week ahead of Chandler (for

next spring cropping). Conditioned, high-elevation Albion plugs are required for transplanting in the first week of September for fall fruiting.

***Plant material.*** Until recently, plasticulture growers could not obtain freshly dug (green) plants until sometime in very late September or early October from northern U.S. and Canadian nurseries. This happens to be the best time of year for transplanting in the lower piedmont and southeastern North Carolina, but earlier transplanting dates are needed to achieve full crops in colder climatic areas, such as the NC upper piedmont (USDA Zone 7a) and mountains (Zone 6b), Virginia, Delaware, Maryland, and New Jersey. Growers in western North Carolina can achieve target planting dates in mid-September by using fresh container-grown strawberry plug plants. You must order your tips or plugs well before planting season. Usually, the cutoff for placing these orders is in May. Tips should be shipped to your farm for plug rooting one month ahead of transplanting. For example, tips will need to be cut in the first week of August for transplanting plugs in the first week of September. Cutoff plants should be transplanted as soon as they become available from high elevation California nurseries. Typically, Camarosa cutoffs are not available until about October 7–9; and, Chandler cutoffs are not normally available until mid-October (Fig, 7-2).

Fig. 7-2. Cutoff plants from high elevation nurseries in northern California are set as soon as they are received by NC growers: A. At this Greensboro farm, Chandler cutoffs are being transplanted in the second week of October. B. This homemade bicycle wheel device is being used to mark holes every 14 inches in the row.

***Plant spacing.*** There are two plant rows per bed (a “double row hill”). Plants between rows are generally offset for improved light and air circulation. There are usually 12 to 14 inches between the plant rows, and 12 to 16 inches between plants in

the row. With 5 ft between bed centers, 17,400 plants/acre will be required at the 12- × 12-inch spacing; 14,900 plants/acre at the 14- × 12-inch spacing; and 13,000 plants/acre at the 16- × 12-inch spacing.

***Storage, handling, and transplanting procedures:***

*Freshly dug plants and cut-offs*. Holding plants at 34 degrees F until planting is recommended. Freshly dug plants and cut-offs may be stored in a cold room at 40 degrees F for one to two days before setting. Storage for a period of a week, or slightly more, requires 34 degrees. Plants in a nursery box or crate are packed tightly enough (typically 500 to 1,000 plants per crate) to make them prone to what is called a ”heat,” rendering them unfit for subsequent planting in the grower’s field. It is very important to cool the plants prior to transit. During hot weather, it may be necessary to run water through the crates to keep plants cool. The freshly dug strawberry plant is hand-transplanted through the plastic mulch in 2.5- to 3-inch slits cut by specially constructed spacing wheels (Fig. 7-3) that also open a narrow hole for planting. This equipment can substantially reduce the time required to set freshly dug strawberry plants (40 hr/acre). A drawback to this equipment is that it makes a larger hole through the plastic film compared to the bicycle wheel method, where only the planting locations are marked in the plastic for hand-setting (Fig. 7-3).

Fig. 7-3. Planting devices: A. Spacing wheel (left). B. Bicycle wheel.

Some root pruning may be needed to shorten roots of freshly dug plants and cutoffs to 5 to 6 inches before transplanting. The plants need to be set so that the midpoint of the crown is level with the soil surface. If plants are set too deep, the plants will be unthrifty, crowns may rot, and plants may die. If planted too shallow, the root system is exposed, which can result in poor rooting and shifting of the plants. Often plants may be set at the right depth but are placed in a small depression; when irrigation is initiated to establish plants, the depression can fill and bury the crown. Alternatively, the plant may be at the right depth but have soil ridged around

the crown. With irrigation, the ridge may erode and expose the roots. A firm plant bed assists in preventing the bed from settling or eroding.

Fig. 7-4. Setting transplants: A. Hand tool for setting (right). B. The same hand tool was used for setting these cutoffs. Note that there is no “open plastic” around the base of the cutoff plants.

Fig. 7-5. Planting wheel cuts: A. Some planting wheels (left) leave very large cuts in the plastic. B. Large holes in the plastic provide entry for weed seeds, and branch crowns may get caught under the plastic as well.

***Instructions for setting freshly dug plants and cutoffs:***

Fig. 1. Curved end at base of roots

Fig. 2. Slide to roots straight down

Fig. 3. Setting plant to correct depth

Fig. 4. Don't cover the growing point

Fig. 5. The tool is 10 ½ inches in length


Fig. 6. Curved end comes in ½ inch.

Fig. 7-6. How to use a hand tool to set strawberry plants.

Step 1. Place the curved end of the hand tool near the base of the roots.
Step 2. Use the tool to "slide" the roots straight down into the hole.
Don't be too forceful as the edge of the tool will cut or otherwise damage the roots; the roots must not be jammed in or be "j-rooted" when set in the hole.
Step 3. Set the plant to its correct depth.

Step 4. Set it deeply enough so that all roots make contact with soil, but not so deeply as to cover the plant's growing point.

*Irrigation for freshly dug plants.* Overhead irrigation should begin as soon as plants are set; no more than 1 hour should elapse. These plants will require irrigation for seven to 12 days after transplanting. Each morning irrigation should be started when plants show moderate wilt and should continue until the hot part of the day has passed. After a few days, irrigation can be initiated a little later in the morning and can be discontinued earlier in the afternoon. The primary purpose of these irrigations is to prevent foliage loss until the root system can develop and absorb sufficient moisture to sustain the plant. Plants should have three or more fully green leaves remaining at the end of the establishment period. Only a relatively small volume of water is required for mist type cooling—we have been successful using .10 inch/hr.

***Storage, handling, and transplanting procedures for plugs***

Extended storage of the plantlets or tips generally is not needed. Northern commercial nurseries can harvest fresh tips weekly from early July through mid-October. The tips are shipped by refrigerated truck to the grower's farm for delivery approximately 35 days prior to field-transplanting. Extended storage of the runner tips is generally not needed. Tips may be stored for up to two weeks at 34 degrees F without deterioration in quality, but you should try to "stick them" as soon as possible after arrival. The boxes (containing around 1,000 plantlets) must be stacked loosely so that the cool air can circulate freely around the boxes. The strawberry tips are living, respiring plants and must be kept cool until the grower is ready to root them under mist. The relative humidity in the cooler should be maintained at around 75% to 80%.

*Root tips with moisture.* Prior to rooting tips, additional plantlet preparation is needed to trim away excess runner-cords. An approximate half-inch runner "stub" serves to anchor the plantlet until new roots develop. Fresh strawberry tips are best rooted under a fine mist that will wet the foliage yet put very little excess water on the soil. Keep moisture on the leaves until the plant is well rooted, about seven to 10 days. As the roots form, the plants can be weaned from the mist and allowed to draw their moisture from the soil. Gradually reduce the mist over two to five days. Two weeks after sticking, you should be able to pull most plants from the cell with the root ball remaining intact. When that occurs, misting can be terminated. These are some general guidelines for mist propagation in an outdoor propagation facility:

- Maintain adequate mist to facilitate quick rooting of tips. If tips flag or wilt excessively, increase misting frequency until plants remain turgid during irrigation intervals. Typical schedules irrigate for 20 to 30 seconds every 2 minutes for the first three to five days, then increase the interval by a few minutes each day as plants tolerate (20 to 30 seconds every 10 to 15 minutes by week two). Misting schedules will vary depending on propagation environment (including indoor vs. outdoor, temperature, relative humidity, and wind).

- Tips should have fully functional root systems after 21 days. To finish the plugs, transition to a watering schedule using either the misting system at lower frequency and longer duration (10 to 20 minutes twice a day) or hand watering.
- Do not fertilize just-planted tips. The fertilizer charge in most potting media will be sufficient until the plants are well-rooted.
- Fertilizer applications can be made to plugs in the third or fourth week of the program. Fertilizer formulations with low phosphorus are desirable to keep plants from stretching (15-5-15, 13-2-13). Apply at a rate of 50 parts per million (ppm) of nitrogen once a day for the last week prior to field delivery and planting. A tray drench with 150 to 200 ppm of nitrogen the day prior to planting is a common practice.

*Use the right rooting medium*. Strawberry plugs should be grown in a specially prepared medium. Many different media are available, but a soil-less medium composed of peat, sand, grit, vermiculite, perlite, polystyrene, or other materials is recommended. You will need about 4 cubic feet of media for approximately 1,000 tips, in 50-cell rigid plastic trays measuring 2.5 by 12 by 20 inches. The 50-cell tray is suggested for small and medium-size strawberry tips. If the tips you receive from your supplier are quite variable in plantlet length, it is well worth the extra step to grade the tips by size into large, medium, and small lots. The large tips should be rooted in 38-cell trays, the medium tips rooted in 50-cell trays, and the smaller tips rooted in 60-cell trays. Sticking large tips (longer than 5 inches) in the same tray with small tips (2 to 3 inches long) will result in light competition and irregular root growth of the smaller, shaded tip plants. During misting, shaded tips are susceptible to botrytis infection.

*Acclimate the plants*. After the misting cycle is complete, move the trays to a fully exposed gravel pad for another two to three weeks of growth and acclimation before field transplanting. During this final field-conditioning phase, a single daily watering is suggested along with a weekly supplemental drench of a complete fertilizer material. A root-bound plug is desirable for mechanical transplanting; plugs for hand transplanting can be set before this stage is reached.

*Transplanting plugs to the field.* The ideal age of the plug for field transplanting is four weeks. Plugs held for six weeks in the trays are not as desirable and may have a slower initial growth rate in the field following transplanting. Plug plants pose less serious problems than freshly dug plants for field transplanting. Pot-mulch planters or vegetable water-wheels can be used to mechanically transplant and water strawberry plugs. Careful size-grading of tip plants will produce more uniform plugs for efficient machine transplanting.

*Depth.* Do not bury the growing point of the plug plant by setting too deeply. Plug plants are not very deep; the root balls are only 2.25 inches in depth for 50-cell trays. Your planting hole should be a little less deep than the length of the plug root ball: A 2-inch hole is recommended for a 2.25- to 2.5-inch root ball. Press the plug into the hole so that the top of the root ball is about even with the soil surface. Even if you are mechanically setting plugs with a water wheel, it is a good idea to have one or two workers following the

transplanter to brush a light layer of soil around the top of the plug's root ball without covering the growing point. This soil layer is helpful in keeping the plugs from "wicking out." Without this slight soil layer, an exposed artificial soil medium will wick moisture out of the plug very rapidly on sunny, windy days.

*Starter solution***.** Tray-grown transplants that have been under a plug propagation nutritional program do not require a starter solution at transplanting. A typical feeding program for plug transplants while they are still in the trays is to apply 1 pound of 20-20-20 per 100 gallons of water (in weeks three and four) before transplanting. This supplies roughly the equivalent of 240 ppm N.

*Irrigation.* A few hours of overhead sprinkler irrigation immediately following transplanting of plugs is recommended. A number of commercial growers in North Carolina use light overhead sprinkling (.10-inch per hr) for the first day (5 hours per day), second day (3 hours), and possibly the third day (2 hours) following transplanting.

**Post-transplanting Care**

*Plant canopy and runners*. Plants should have three or more fully green leaves remaining at the end of the initial three- to four-week establishment period, regardless of whether they are freshly dug plants or plugs. If the "original" leaves on a freshly dug plant or plug are lost to drought stress, plant establishment will be significantly delayed or "set back" and spring yields will be significantly reduced. The number of leaves and total plant leaf area in the late fall and early winter can be correlated with fruit production the following spring.

*Runners in the fall*._Runners that develop in the fall can be removed to prevent competition with crown formation and floral bud development. Avoid removing runners until about three to four weeks after transplanting. Complete a follow-up runner removal operation at six weeks after transplanting if necessary.

*Canopy size*. It is also very important to achieve an adequate plant canopy by late fall as a good leaf canopy acts as an important crown insulator and is the "cheapest" winter protection you can buy. A 6- to 7-inch plant diameter is ideal in mid-December; you do not want the plants to be touching in the row in December as shown in Fig. 7-7 (left). Plants that are 6 to 7 inches in diameter and have at least one new branch crown or "side stem" by mid- to late-December will be on track for producing a good crop (Fig. 7-7, right). In general, it is desirable to produce a plant with four to five branch crowns by early spring for optimum yield and berry size.

It is also very important to achieve an adequate plant canopy by early winter as a good leaf canopy acts as an important crown insulator in winter. An 8-inch plant diameter is ideal in mid-December. For good berry production, each plant should form one or two side stems (the branch crowns) and eight to 10 leaves by mid-December.

*Rooting.* Rooting is active throughout the fall and early winter as long as soil temperature is above 45 degrees F and roots remain healthy. It is important in the fall season to maintain adequate moisture in the beds for active root development. To aid

transplant establishment in October and November, it may be necessary to run the drip system for a few hours every few days during weeks of little or no rainfall.

The roots also serve as storage sites for starch reserves during winter. Growers who "push" fall top-growth with extra nitrogen feeding may be doing so at the expense of starch accumulation in the roots. The stored starch is needed for vigorous growth and flowering in the spring, which will enhance berry size.

Fig. 7-7. Chandler strawberry plants: A. Chandler (right) with large canopy size on December 16, 2002 (less was needed). B. Chandler with small canopy size on December 16, 2002. A floppy disc is 3.5 in wide.

*Fall and early winter fertility*. If beds were prepared as described under "Pre-planting," no fertilizer should be needed after transplanting. It takes strawberry plants (especially freshly dug plants) two to three weeks to establish a new root system, and you should not expect the plant's top-growth to look that healthy and vigorous during this initial period. Thus, growers should not be alarmed if freshly dug plants do not appear to have adequate nitrogen in the first two to three weeks after transplanting—it takes this much time for the plants to establish a new root system that is able to take up the nitrogen, phosphate, and potassium fertilizers applied prior to bedding. After three weeks, you should see the plants "color up" and begin to produce healthy new leaves. If pre-planting fertilizers were not applied, then it will be necessary to begin a fertigation program starting in the third week after transplanting. Pre-planting fertility, however, should never be omitted in favor of a drip fertigation program. In addition, if plant growth is overstimulated with excess nitrogen in the fall, the resulting larger plants and heavy leaf canopy the following spring will cause problems: (1) Larger plants hinder picking—it becomes difficult to find the fruit with large "bushes." (2) Increased disease incidence (mainly botrytis) will occur. (3) Fruit quality and flavor will be negatively influenced by extra thick plant canopies. If the leaves nearest the berries are well-exposed to light (not shaded by other leaves), you can anticipate higher fruit sugars and more favorable remarks from your customers.

**References**

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