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Nursery Site Selection and Citrus Tree Production[1]

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SITE SELECTION FOR FIELD NURSERIES

Nursery site selection is of great importance. A nursery site is best located away from developed areas in a place where the frost hazard is minimal, Well drained, virgin soil is preferred and an adequate supply of good quality water is essential. Good access roads to the site and within it are desirable for inspection, cultural operations, digging and transportation. The site should also be free of parasitic nematodes, burrowing nematode and the citrus nematode. Citrus nursery sites must be approved by the Division of Plant Industry, Department of Agriculture and Consumer Services before planting.

NURSERY SITE HYGIENE

It is important to understand the role that sanitation plays in the overall control of disease problems. The single most destructive disease encountered in the nursery is *Phytophthora parasitica*. This fungal organism is one of a group of "water molds," so-called because they spread and grow rapidly under high moisture conditions. Phytophthora is a common soil inhabitant widely distributed even where not producing visible symptoms.

Rhizoctonia is another fungus that frequently causes "damping-off" in seedbeds in warm weather. Under favorable conditions these organisms cause damage to the roots and lower stems of seedlings, rendering them unfit for further use. They are spread by the movement of infested soil, splashing of rain and irrigation water, or by heavy runoff from infested areas.

Sanitation practices incorporated into the daily work schedule as suggested below can greatly reduce disease incidence in the nursery:

- Clean equipment before bringing it into the nursery and confine it to nursery use.
- Do not move contaminated soil or equipment into fumigated areas.
- Remove diseased plants and isolate the area before disease can be spread.
- Remove plant residues as soon as possible after digging trees.
- Use only healthy seedlings for lining-out, discarding any plants with evidence of root or stem rot.
- Keep storage or holding areas free of debris and periodically treat with fungicides to reduce disease spread.

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In addition to soil fungi, the exocortis viroid presents a special sanitation problem. The disease, when present in a plant, can be spread to other plants on budding knives, clippers and hedging shears. To prevent this, each budder should be supplied with a small container of sterilant (ten percent household bleach, the active ingredient of which is sodium hypochlorite), to disinfect knives and clippers when propagating or pruning. This should become a closely supervised procedure as this disease affects many scion rootstock combinations that can result in unproductive grove trees.

LOCATION

The seed bed should be located in an area separated from the main nursery. This will avoid run-off from irrigation or heavy rain that may introduce disease organisms into the seeded area and in greater control of water relations. Seedlings for lining out can often be produced in seed flats on raised benches in the greenhouse areas in a short time, with better and healthier root systems than those grown in the ground.

BED PREPARATION

Previously cropped areas may require fumigation for the control of nematodes, diseases and weeds. Soil acidity should be a adjusted to pH 6.5-7.0 during land preparation. Seedbed fumigants have at times resulted in irregular seedling growth following germination which may be characterized by stunting and nutrient deficiency symptoms, particularly those of phosphorus. The problem has been associated with the lack of mycorrhizal fungi in fumigated nurseries as these fungi are very sensitive to methyl bromide. Experimental inoculation of citrus seedlings with such fungi in fumigated soil has virtually eliminated the problem and actually resulted in spectacular growth increases in California. While some inoculation work has been conducted in Florida, large scale field trials have not been conclusive. Seedbed aeration by cultivation following fumigation and heavy preplant applications of phosphate have been found to reduce the occurrence of this problem. Seedlings should be closely observed for poor growth and bronzed leaves. Bronze leaves are a symptom of phosphorus deficiency.

SEED SELECTION

The careful selection of seed for planting is a very important factor in the ultimate performance of the tree. Carrizo and Troyer citranges are capable of transmitting blind pocket and concave gum viruses to seedlings through the seed from infected mother trees. Seedlings from off-type trees do not react to diseases and growing conditions in the same way as standard true-to-type selections. For these reasons, seed should be selected from established seed source plantings chosen for uniformity and freedom from viruses.

SEED PREPARATION

While the best seed germination may be expected when seeds are planted immediately after extraction, storage is often necessary in order to plant certain species at the desired time. Seeds should be extracted and washed with clean water and surface-dried in a cool, shady place on a clean wood or screen surface.

Some treatment needs to be made to reduce allimism and Bluegreen Mold in storage. Seeds may be stored for several weeks in the refrigerator at 40°F packaged in plastic refrigerator bags. There are sources of true-to-type virus indexed seed in Florida and California, the locations of which may be obtained from the Citrus Budwood Registration Bureau.

PLANTING TIME

While citrus seed may be planted at any time of the year, late winter and spring are most suitable. Strong winds during this period may cause damage to young seedlings from blowing sand; therefore, the planting of cover crops such as oats and rye between rows is commonly practiced to reduce this effect. Seeds planted after May 15-30 will emerge under weather conditions most favorable for the development of "damping-off" diseases, possibly resulting in a poor survival of the young seedlings.

PLANTING

Seed may be planted by hand in open furrows approximately 1 inch deep, scattered evenly in the bottom of the furrow, or a planting board may be used to ensure that seed is spaced evenly at a uniform

depth. While this method takes much time, it results in straighter, more uniform seedlings with less benched root formation and makes maximum use of available seed. Broadleaf types such as sour orange, rough lemon and *Citrus macrophylla* should be planted further apart than varieties with small leaves such as Carrizo citrange, *Poncirus trifoliata* or Cleopatra mandarin. Width of rows should be adapted to equipment used for nursery operations. Commercial seed planters are available but must be adapted for use in citrus seed beds.

GREENHOUSE PRODUCTION

A production system for citrus nursery trees has been developed based on reusable plastic tubes or trays for raising rootstock seedlings, a commercial growing medium, plastic containers for the budded trees and operation within an enclosed heated and cooled plastic covered greenhouse. Plants suitable for microbudding can be produced in 3–4 months with a finished plant available in about 12–14 months. The system is flexible and offers advantages in the conservation of time and space and better control over water application thus better disease control.

IRRIGATION

Most commercial citrus nurseries are irrigated by permanent overhead sprinkler systems. The design of such systems is important to ensure the even distribution of water. Such even distribution assumes additional importance if the system is to be used for the application of fertilizers. Uneven distribution will lead to considerable differences in amounts applied, with consequent injury to or deficiency in plants receiving the higher or lower amounts. However, utilization of irrigation systems for frost protection and "fertigation" should not be attempted without the benefit of sound engineering. A carefully managed water system is essential for the production of healthy seedlings. The use of excessive irrigation has been found to be the cause of many nursery problems. The frequency of seedbed irrigation depends upon soil type, temperature, rainfall and size of seedlings. Frequent light watering is required for newly planted seedbeds. As seedlings become well established, less frequent heavier applications should be made to maintain maximum growth. Prolonged wet soil conditions, high humidity and crowded seedbed conditions are conducive to the development of soilborn Phytophthora and Rhizoctonia fungi with resulting severe seedling losses. Certain citrus species such as sweet orange, rough lemon, Milam, Carrizo citrange, and Cleopatra mandarin are more susceptible to root diseases than others and demand careful attention. After seedlings have emerged, irrigation should supplement rainfall to maintain soil moisture.

New systemic fungicides show great promise for the control of Phytophthora root rot in citrus nurseries. Two of these products Ridomil and Aliette, have been approved for use in nurseries.

Fungicides should be applied judiciously and according to label direction, with more frequent applications required during periods of active growth and frequent rainfall, particularly during the summer months. Over use of Ridomil has resulted in resistant strains of Phytophthora and lack of disease control.

Control of fungus diseases can be most effective when sprays are applied on a regular basis before infection is apparent.

FERTILIZATION

Fertilizer programs are difficult in citrus nurseries because of the rapidly changing growth stages. Rates given represent guidelines only and individual nurserymen will formulate their individual programs.

Since excessive fertilizer applications have been the rule rather than the exception, it is prudent to note that continual luxury consumption of nutrients and resulting vigorous vegetative growth will enhance the incidence of diseases, especially in seedbeds. Excessive fertilizing may result in leaching of nitrogen into the subsoils and contaminate well fields. Soil tests should be made at least once a year to determine the status of Ph, calcium, phosphorus, copper and total soluble salts.

When the seedlings are 1–1 1/2 inches high, the first light application of a low analysis mixed fertilizer should be made to the seed bed. Use approximately 200–500 pounds of fertilizer per acre, depending upon natural soil fertility. Fertilizer is best applied prior to or following an irrigation or good rain.

Foliage should be thoroughly dry before application to prevent leaf burn. Fertilizer should be applied at 3–4 week intervals, with a gradual increase to a maximum 12 months old. A ratio of 1:1:1, with 15–20 percent of the nitrogen derived from organic sources, is recommended. Liquid fertilizations may be applied through the irrigation system.

PREPARING SITE AND SEEDLINGS

The area to be used for growing the nursery trees should be thoroughly tilled, leveled and cleared of all roots and perennial weed residues. Necessary soil amendments should be added at this time to adjust the pH 6.5–7.0. As with the seedbed, this site should be in a carefully selected location.

When seedlings have reached 3/16–1/4 inch in diameter, they are ready to be transplanted or "lined out" in rows for budding. Seedlings held in the seedbed for as long as a year are more likely to be infected with root diseases and scale insects due to crowding. Large seedlings, especially those of trifoliate hybrids, are harder to transplant successfully, with the resultant expense of resetting.

Seedlings should be dug from the row with spades or mechanical equipment. Care should be taken to leave as many roots undamaged as possible. Tops should be pruned to manageable propagation and extremely long or damaged roots removed. When digging, "off-type" seedlings should be discarded, and plants showing any degree of diseased roots or stems culled at this point. Use of diseased seedlings can only result in production of diseased trees and spread the disease to other areas of the nursery. Seedlings should be graded into 2 or 3 sizes and planted in the nursery rows by size groups. This procedure results in a high percentage of uniformity for a budline. This practice will require less labor and yield a higher percentage of salable trees making more efficient use of nursery growing area.

SETTING OUT LINERS

The size of the nursery area and type of cultivation will dictate to a large extent the row spacing and distance in the row that seedlings should be set. Current practice is to plant seedlings as close as 4–6 inches apart in the rows as opposed to the former practice of 12 inches. While close planting makes maximum use of available land, trees that are to be held more than one season in the nursery may be more susceptible to scale insects and diseases as a result of shading and poor air circulation near the soil surface. Effective spray coverage is also less likely to be achieved under crowded conditions.

Liners may be set at any time of the year; however, small seedlings set in March or April are often large enough to bud by fall. Dormant buds can be forced to grow in the spring to a size large enough to be moved by mid to late summer. Seedlings as large as 1/4–3/8 inch set in the late summer or fall can be well established by march or april of the following year, so that trees budded at that time will be ready for movement by fall.

The soil should contain adequate moisture before lining out for planting furrows to remain open. Liners may be set mechanically or by hand; however; with either method it is important not to plant liners any deeper than they grew in the seed bed. The soil should be packed firmly around the roots leaving no air pockets. Frequent light irrigations, 3/8–1/2 inch per application, should be applied until seedlings become established. This is especially important during the warm summer months. Irrigation can be scheduled at 1/2–1 inch per week as needed to supplement rainfall.

Seedlings should be fertilized within 2–4 weeks after lining out, with an initial application of about 50 pounds per 1000 seedlings of an 8-2-8 mixture or approximate equivalent analysis. The seedlings should be fertilized every 3–4 weeks and when approximately 3 months old, may receive 75–100 pounds of fertilizer per 1000 trees. High analysis fertilizers should be used with caution as plant damage can occur.

WEED CONTROL

In the past, weed control has undoubtedly been the most costly production practice in the nursery operation. Although fumigation offers excellent weed control for some weeks after the operation, severe weed reinfestation will follow. Such weed growth will quickly get out of hand, compete with seedlings, and hinder nursery operations. Although costly, hand weeding operations are sometimes necessary. Cultivation is practiced with equipment modified for nursery use; however, care must be taken not to damage the plants and tillage depth should be kept to a minimum.

While herbicides are now commonly used in commercial nurseries, it should be remembered that citrus in young stages of growth in the nursery is very susceptible to these materials.

Pesticide manufacturers are hesitant to seek herbicide registrations for nursery use due to the low volume usage compared with the high per acre dollar value of the crop. It is essential that weed growth be controlled preferably at germination, since lower

herbicide dosage rates are likely to be more satisfactory.

Spot treatment of isolated dense areas of weed growth may be done using contact or systemic-type herbicides provided young seedlings and budlines are adequately shielded from the spray. The application of herbicides through the sprinkler system is not an approved method of application for nurseries.

WEED AND SPROUT CONTROL

During the growth of the budded tree, weed growth should be kept under control with labeled herbicides, using extreme care not to injure the bud. In the absence of rainfall, 1–1 1/2 inches of supplemental irrigation should be applied each 7–10 days. Irrigation should be applied more frequently but at a lighter rate during the hot summer days. Rootstock sprouts should be broken or cut routinely, since they retard the vigor of the young bud. Rough removal of large sprouts will result in open wounds through which disease organisms may gain entrance or leave scars. A white latex base formulation of naphthaleneacetic acid (NAA) at concentrations of 1/2–1 percent has shown some promise in controlling rootstock sprout growth on established budlines, and non-bearing citrus trees. The material should not be applied to areas of the trunk with green bark or to foliage. While good coverage of the area to be treated is required, spray application to the point of runoff may result in tree growth inhibition and/or injury.

NUTRITION

When the bud is 3-5 inches in length, fertilizer may be applied at the rate of 50 pounds of a 6:6:6:4:0.5:0.5 (N:P:K:MgO:MnO:CuO) or equivalent analysis mixture per 1000 trees. By the time the bud reaches the top of the stake, a similar fertilizer may be applied at the rate of 100 pounds per 1000 trees every 4-6 weeks until about September 15. From time to time during the growth of the nursery tree, nutritional sprays may be applied if soil tests (for copper) and visual symptoms (zinc and manganese) so indicate.

COLD PROTECTION

Most commercial nurserymen in central Florida with field nurseries employ cold protection practices, with both irrigation and heat being used as the need arises depending on environmental conditions. Cold protection for field grown nursery stock is commonly provided with overhead irrigation. One quarter of an inch to one third of an inch per hour is usually adequate for protection from freezing weather. Good water distribution especially on the north and west sides of the nursery is very important.

Power supplies of gas or diesel engines are preferred over electric due to the uncertainty of electric power during peak loads that occur during cold weather.

Sprinklers that are not affected by ice formation are essential for continuous operation. Use of large volumes of water for extended periods (2–3 days) make it essential that the site be well drained.

PROPER HANDLING

Quite often, priorities and equipment use will dictate the time of grove planting. The time of cutting back and digging the trees in relation to the growth cycle should be considered. Trees cut back and dug just before the new growth cycle usually respond best after transplanting in the grove. Those dug during or immediately after the growth flush may result in weaker growth. This difference in growth performance of the tree may be explained by a maximum storage of carbohydrates in the roots in the first case and a depletion in the latter. The use of antitranspirants (materials which reduce water loss from trees) sprayed on trees after cutting back, before digging, has shown some promise for improving the performance of trees after transplanting into the field. Shortly before digging trees, tops should be cut back to the scaffold branches (hat-racking) preferably leaving some foliage intact. Trees are then dug mechanically with a tractor drawn subsoil blade in most larger commercial nurseries, or with a straight-edged nursery shovel.

Trees should then be stored in a closed truck body or in the shade under cover and subjected to continual sprinkling with water to insure that root systems are not allowed to dry out.

Spring, summer and fall planting should be associated with certain problems, including extended periods of drought, intense heat stress and the advent of cold weather, respectively. Instances of tree loss during the months of July, August, and September have been attributed to heat stress, associated with insufficient rainfall or supplemental irrigation.

COMMON CAUSES OF TREE LOSS

In many instances, the death or unsatisfactory growth of recently planted young grove trees has been attributed to negligence in handling at some stage between the nursery operation and tree planting. Desiccation of the feeder root system due to inadequate watering, exposure to wind and heat after digging, during transport and before planting will result in root death and consequent inability of the young tree to recover from the shock of moving. Great care should be taken to ensure that trees are delivered to the planting site in a healthy condition, and that the grower is adopting sound planting and post-planting care procedures. This, of course, includes the very critical watering phase of the operation. When tree mortality occurs some weeks after planting, it is always difficult to determine whether the grower or the nurseryman should accept responsibility. The grower or some other knowledgeable individual should be present at the planting site to inspect the trees on arrival and determine whether they are in satisfactory condition and meet the terms of the contract.