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RESEARCH & INNOVATION CENTRE

Growing in RootSmart™

This guide is intended to help growers incorporate the RootSmart system into production practices for tree propagation.

About RootSmart

The RootSmart propagation system improves tree growth and performance by reducing the development of misdirected roots (ascending, descending and circling roots) during the early stages of container plant production.

Picture 1: The RootSmart propagation system.

When roots grow toward the wall in solid-sided containers they are deflected off the impermeable surface into a different direction, altering the ideal formation of lateral roots. Ideal root systems for woody perennials have lateral roots radially-oriented around the tree's trunk to provide the best soil anchorage and equip the tree with an efficient system for resource gathering.

The RootSmart tray works with bounded transplantable plugs (plugs) to promote air-pruning. With its wall-less and bottom-less design, the tray offers a surface area 95 per cent exposed to air while still providing the crop with adequate moisture and access to nutrients.

RootSmart system instructions

Choosing the proper growing media

Species have different root systems and grow at different rates, so selecting growing media should be tailored to the characteristics of each plant. Selecting growing media with high water holding capacity and water availability is particularly important for mitigating the tray edge dry out effect that may occur.

AMA Grow Mix performed well for several tree species in a scientific study in comparison to mixes with increasing amounts of coir.

Select finer rather than coarser growing media since the former tends to have a greater water and nutrient holding capacity.

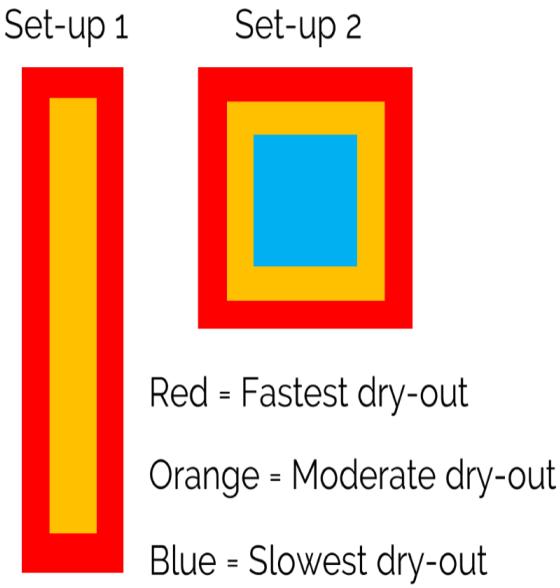


Figure 1: The same area (and number of RootSmart trays) are depicted in Set-up 1 and Set-up 2. Set-up 2 is a more effective configuration for water conservation as the edge area of the block is smaller.

Tips

- AMA Grow Mix is a good mix to choose
- Select finer growing media as it works best with the RootSmart system

Set-up tips

- Raise the trays off the ground to allow an adequate air flow underneath if they are in a high humidity, low air flow environment
- Trays should be blocked together by species with a minimal edge-to-interior ratio of blocks to reduce edge dry out (See Figure 1)
- Protect the tray edges using barriers to reduce edge dry out

Watering

It is advisable to not overwater the RootSmart system. The plugs need to dry out to a certain degree, without being dry to the touch to ensure roots are effectively air-pruned. Throughout the growing season, the plugs should regularly be allowed to dry out more than may be typical of other propagation systems.

Testing at Vineland has demonstrated that the tray's edges will dry out more quickly than the interior cells of the tray.

Picture 2: Poplar taproot pruned by RootSmart.

Watering and fertilization tips

- Check moisture levels when appropriate – not on a fixed schedule
- Water in the morning and evening if possible when temperatures and winds are lower to minimize water loss
- Determine the correct amount of water needed and observe fertilizer losses by measuring the leaching fraction from trays throughout the growing season

- Gently water (using a finer spray and/or less volume at once) to keep the plugs intact since they are loosely held in the trays especially at early stages of production. A cautious use of water pressure is important to avoid damaging the plant and plugs.
- Water the edges more frequently or with more water to manage the edge dry out effect
- Cyclic watering is recommended (apply less water more frequently) to prevent dry out and nutrients exiting the trays
- Incorporate slow release fertilization and/or organic amendments to help improve the availability of nutrients

Picture 3: The bottom of the RootSmart tray.

Handling

The legs on the tray are a critical feature for air-pruning as they elevate the tray to ensure air moves below the plugs and prunes off taproots to encourage lateral root formation and branching.

The legs may prevent the tray from sliding on the ground easily so pushing trays around may disrupt the plants and plugs. The tray also features a lid that snaps on and should not be removed during production as it holds the plugs loosely in place while keeping the tray rigid.

Picture 4: The legs on the RootSmart tray raise it off the ground to allow for air flow underneath the bottom of the plugs.

Tips

- Lift and shift the trays rather than pushing trays around on the ground
- Leave the lid on during the production cycle to maintain a stable position of the plugs

Timing the production cycle

The production cycle length for the RootSmart system may differ from other commonly used systems. The species you are growing and production practices will influence the growth rate of the plants and in some instances, shorten the production cycles.

With the first few usages of RootSmart it is advisable to pay close attention to start and end dates as well as the production

practices used as they relate to the production cycle timelines. Given that some species may grow more quickly in the RootSmart tray, it is important to check the roots and avoid overly humid conditions. These practices can promote roots growing across cells and into the adjacent plugs (i.e. wandering roots). This situation makes it more challenging to remove plants from the tray and can also damage roots.

Tips

- Record start and end dates to track the length of the production cycle
- Observe roots closely near the end of the cycle and monitor the humidity to prevent wandering roots
- Determine the next step in the production cycle and adjust when appropriate. Plants should not be left too long in the tray which can slow growth and reduce development

Transitioning to containers

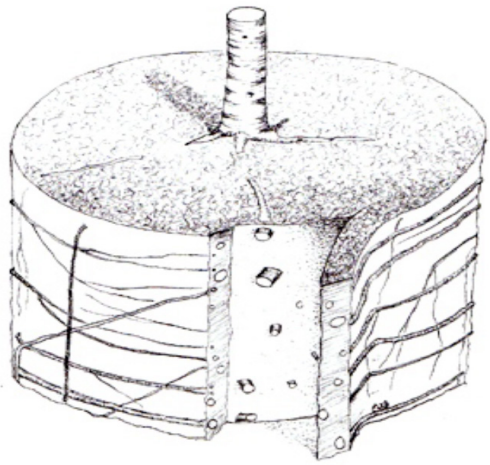
Vineland researchers and others have demonstrated containers promoting well distributed and undeflected roots cannot correct a container imprint damage formed during a previous production phase. Selecting the proper container is only one aspect of the container-grown best management practices for developing well distributed root systems. It is important to continue managing the health of the well distributed root system developed by RootSmart throughout the container plant production until the tree is market-ready.

Shelf-life

The timing for shifting liners is critical. Plants should be shifted to larger containers before non-correctable root defects form. The shelf-life in container production refers to the fact that if trees are left in containers too long, their roots will continue to develop and become misdirected. Assigning a best-before date helps determine when a tree needs to be shifted or sold.

Root correction

To maintain the root system produced by RootSmart throughout container production, roots should be inspected to determine if any corrections are needed regardless of the container type used. Shaving or root pruning is an effective method to correct root defects. Slicing root balls from top to bottom is not as effective because it can leave misdirected roots intact if the cut is made before the deflection occurs. Slicing also commonly misses downward directed roots.



Picture 5: Detail of root ball shaving of container-grown liners for sizes 1 g and greater from Gilman and Kempf (2009).

This information helps to inform the shelf-life strategy. In addition to shifting liners appropriately, the following steps outline key techniques for reducing or eliminating root defects when liners are shifted to larger containers (adapted from Gilman and Kempf 2009).

Root correction steps

- In larger containers, and particularly when using containers with walls, shave off the outer edge of the tree root ball before shifting to prevent misdirected roots
- Tease the roots at the periphery and spread roots out laterally in the larger container substrate
- Remove (by shaving) the bottom of the root ball

Container selection

Trees and shrubs should be planted in containers that minimize root defects and encourage branching of the root system inside of the root ball. Certain species perform better in specific containers, so fine-tuning the container selection based on production needs is important. Examples include air-pruning plastic containers, fabric containers which also air-prune to a degree, biodegradable/natural materials and containers that use light to manage root systems.

Picture 6: There are many containers available on the market. Root management best practices should be used regardless of which container is selected.

Considerations when selecting containers

- Choose containers that allow for some contact between the air and the growing media to encourage air-pruning
- Avoid containers with smooth plastic sides that encourage root circling
- Consider using containers that 'trap' roots inside woven materials and will then prune off when removed from the container at planting

Transitioning to the field

For a successful transition from nursery to field, proper site preparation is required and includes cultivation, vegetation management (initial and over the growing season) and infrastructure set-up such as drip line irrigation systems.

Soil preparation

Preparing the soil before transplanting will provide a good start for the seedlings. Soil that is loosened and contains an adequate level of available nutrients and organic matter will provide a good environment for root systems to grow.

Weed management

Excessive vegetation in proximity to the newly planted seedlings will compete for water, nutrients and light and can stunt seedlings' growth. Weed management is also important as it provides a habitat for wildlife, pests and diseases that can damage the newly planted seedlings.

Tips

- Use cultivation and pre-emergence weed control to prepare the field before planting
- Use mulch or coco disks as well as trunk guards around newly transplanted seedlings
- Incorporate organic matter into newly prepared soils

- Practice weed management especially in the first two seasons after transplanting. At this stage, young tree roots will be vigorously exploring the soil for resources, and weeds will be competing with trees for the water and nutrients.

Irrigation
The transplanted seedlings require irrigation since the transplanted plugs (often container peat-based media) will dry out more quickly than the field soil.

Tips
- Install an infrastructure for irrigation gentle cyclic watering
- Check the moisture of the plugs to determine if watering is necessary until roots have grown into the field soil

Planting considerations
Planning out when you are going to plant seedlings into the field is important to consider, to ensure seedlings have the opportunity to root into the field soil as quickly as possible. Containerized seedlings have flexibility because they can be successfully transplanted into the field as long as they are in proper conditions and the nursery field is ready to receive them.

Trees are ready for transplanting when stems are lignified enough to allow for the removal from the tray without injury and when plugs are firm enough to hold together during handling.

Fall planting
Fall transplanting may work well when plugs are well prepared and the field is ready. Trees with active root tips have the ability to expand their root systems in the nursery bed after transplanting which helps promote a rapid development the following growing season.

Picture 7: The proper timing of lining out plugs will help ensure a successful transition.

Transplanting in the fall can be hindered by soil moisture or early frost which can damage recently transplanted and improperly hardened seedlings.
- Prepare your soil over the summer and add soil amendments to allow time for the soil to settle before planting
- Early fall may be a better time to plant in locations where frost can cause soils to shrink and swell. This will allow newly planted trees to root into the field before the winter and reduce the chance of plugs popping out of the ground or heaving in the winter.

Spring planting
- Spring transplanting of plugs can be challenging since seedlings must be held during the winter which can reduce vigour

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at the time of planting if stress is endured in the winter months. Spring transplanting is generally only recommended if the crop is specifically grown for spring transplanting or if crops initiated in the spring and reared during the summer do not meet the desired size and condition for late summer or fall transplanting.

- Plants will still need adequate moisture even during dormancy and adequate airflow to minimize the conditions promoting disease
- If possible, prepare your field in the fall and add in soil amendments to allow time for the soil to settle before planting

Late summer transplanting

Late summer transplanting can be successful if seedlings have reached a desirable size and can promote late season root and shoot growth in the field after transplanting.

Picture 8: Monitor the root tips exiting the plug to help determine when it is time to shift to larger containers or move plugs to the field.

Generally, seedlings destined for late summer planting will need to be sown in early March to accommodate the transplant timing. However, some experimentation will be required as certain species will be better suited to this production cycle and reach a suitable size for transplanting by August.

- Soil for the transplanting field will need to be prepared prior to the August planting date
- Transplanting seedlings will require attention during the dry season as the plug substrate will dry out more quickly than the surrounding field soil

Other considerations

- Do not plant the plugs too deeply. The paper should be just slightly below the soil line when the plug has been transplanted.
- Leave plugs intact during planting which will allow roots to grow through the paper into the soil

Post-transplant care

Once seedlings have been transplanted, adequate water must be provided to the root zone to firm the soil around the plugs and eliminate air pockets. Routine watering will depend largely on the season as well as the soil composition, local climate and requirements of the crop.

For more information on this research update, please contact:
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