

SLASH X HONDURAS CARIBBEAN PINE HYBRIDS: AN OVERVIEW OF NURSERY PRODUCTION SYSTEMS SOUTHEAST QUEENSLAND, AUSTRALIA

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Key Words

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The Queensland Department of Primary Industries (DPI) Forestry has a requirement to produce 4.5 million trees per year for its plantation production program. This stock is raised at DPI Forestry nurseries in the southeast and far north of Queensland. To improve the productivity of its plantation estate, DPI Forestry has invested significant resources in the development of *Pinus elliottii* var. *elliottii* x. *caribaea* var. *hondurensis* (PEE x PCH) F. and FZ hybrid families and clones as well as associated delivery systems, including extensive clonal testing and hedge multiplication programs. More recently, it has commenced small-scale trials to produce "micro-cuttings." Past and present production techniques, including open-root, containerized seedling and cutting systems, and approaches to hedge management are presented in this paper.

PINUS ELLIOTTII VAR. ELLIOTTII X. CARIBAEA VAR. HONDURENSIS HYBRID SEED PRODUCTION

F. hybrid seed production commences with the PCH pollination of PEE monoclonal seed orchards established at Byfield in coastal central Queensland. Seeds can be produced using either controlled or mass pollination techniques.

On account of the very low seed set, controlled pollination is not suitable for large scale production of F. hybrid seed; costs may reach

\$800,000 per kilogram. It is, however, the preferred method for producing small quantities of improved seed for either research programs or the establishment of high-quality family hedge plants. Controlled pollination may also be an option for the operational production of FZ hybrid family seeds because a much higher seed set is likely. Although mass pollinated seeds can be produced at a lesser cost, care is required to ensure that the seed orchard is fully emasculated to avoid contamination. This risk of contamination has caused the DPI Forestry to cease production of mass pollinated F. hybrid seed.

PINUS ELLIOTTII VAR. ELLIOTTII X. CARIBAEA VAR. HONDURENSIS HYBRID NURSERY PRODUCTION

DPI Forestry has developed and refined a range of techniques for seedling and cutting production of PEE x PCH hybrids in open root and containerized systems. DPI Forestry currently produces 3.5 million containerized cuttings per year. Previously, all stock was produced in an open-root nursery. This paper will review the two major nursery delivery systems:

1. Seedling production by seeding directly into containers or open root beds.
2. Cutting production following the establishment of seedling (or cutting) hedges

that are manipulated to produce shoots for vegetative production.

Depending on program requirements, seedlings can be produced either in containers or as open-root plants. Queensland has an optimum planting window from January to July and planting opportunities from October onwards, pending rainstorms, which previously allowed DPI Forestry to utilize both container and open-root systems to satisfy field requirements. The more robust container stock was used for summer planting to avoid the less desirable field conditions, and open-root plants were used for planting during the cooler and milder months. The split systems allowed for maximum utilization of hedge production. In order to extend the potential planting season and minimize possible outplanting risks, DPI Forestry has recently moved towards a fully containerized planting program. Experiences with both container and open-root production systems in the Queensland nursery are reviewed in this paper.

CONTAINER SEEDLINGS

Production

Container hybrid seedling production has a growing cycle of five to six months. Sowing is usually completed in August, and plants are available for planting in January or February. Seed is sown directly into containers using a precision sower. Following sowing, containers are placed into full sunlight and the newly sown containers are monitored for soil moisture three to four times a day. Possible bird damage is controlled by either placing meshing over trays or decoy feeding. Next, germination occurs at approximately two weeks and continues until week four. Finally, at week six germinants are ready for thinning or dibbling.

Irrigation

Irrigation utilizes a boom spray or fixed irrigation system. All of the water is sterilized by a chlorine gas injection system and application rates are monitored on a regular basis to match climatic conditions. Typically irrigation is required three times a day during the summer and is reduced to once a day during the winter months. Size and condition of stock will also effect water needs.

Containers

The most commonly used and preferred container type is the locally developed Queensland Native Tube (QNT) pot (currently manufactured by Statewide Nursery Supplies). The QNT pot (Table 1) was developed in an effort to improve root system structure and management. Its features include:

- Root ribbing to reduce root circling.
- An open base to facilitate air root pruning.
- A long container length to allow the root's core to be planted deeper into field soils.
- Containers to fit into holding trays, improving handling efficiency from the nursery to the field.
- Trays to provide optimum growing densities.
- Removable pots to allow for sorting during the growing cycle and to ease detubing while planting.
- Containers that are recyclable and will last up to ten years.
- Containers that can be steam sterilized.

Table 1. Container Specifications for Queensland Native Tube.

Container Dimensions	Tray Dimensions
Height: 12.5 cm	Size: 36 x 61 cm
Diameter: 5.0 cm	Cavities/tray: 40
Volume: 220.0 cc	Density: ~180 lm ²

Potting Mix

A range of potting mixes are suitable for the production of hybrid pine seedlings and cuttings. The preferred potting mix for both seedlings and cuttings is either 50% perlite and 50% pine bark peat (manufactured peat from pine bark), or a blend of pine bark and pine bark peat. Osmocote provides the chief source of nutrients for the life of the crop. Potting mix is prepared in advance using either a small end loader or in a customized mixer filling machine.

CONTAINER CUTTINGS

Production

Container cuttings are normally set during June and July, October and November, and January and February. These split settings allow for

maximum utilization of available shoots from the hedges. Production of container cuttings is typically a ten to twelve month crop. Currently, 70% to 80% of shoots set will meet planting specifications. The growing environment for container stock features the following conditions:

- Site is protected from wind.
- Shade is provided by a 50% shadecloth.
- Sides are protected from direct sunlight.
- Airflow is good.
- Shade structures are drip-free.
- Temperature does not exceed 35 °C for extended periods.
- Site is free of weeds, algae growth, and molds.
- All irrigation water is chlorinated.

Following the preparation of the mix and filling of trays, the following procedures are adopted:

- Filled pots are placed on benches at waist height.
- Pots are irrigated to full capacity and physical checks are carried out to ensure high moisture levels are achieved.
- A dibble rack is used to ensure holes are centered and at a uniform depth of four centimeters. These trays are only sufficient for approximately thirty minutes of work because irrigation will fill in dibble holes.
- Cuttings are selected, checked to ensure compliance with specification, placed, and firmed with one action into the dibble hole.
- Trays, once they have been set, are drenched within ten minutes to reduce stress and assist with compaction.
- Newly set cuttings are protected from wind and sun by shading with a 50% shadecloth.
- Each tray is tagged, detailing the batch and date of setting.

Use of Rooting Hormones

The use of rooting hormones may be warranted for certain high value clones. However, at this stage their routine use is not recommended.

Irrigation and Conditioning

Cuttings are routinely irrigated for a minimum of two to five minutes each daylight hour. The amount of water applied depends on the type of sprinklers used. Sixteen to twenty weeks following

the setting, a root assessment is carried out to determine strike rates. When a strike rate of 80% has been obtained, conditioning commences in the following order:

- Removing the shadecloth.
- Applying the slow-release fertilizer.
- Sorting stock - when height averages 12 cm, sorted stock is placed into a reduced irrigation conditioning area to harden, encourage mycorrhiza development, and allow root consolidation.
- Conditioning stock for a minimum period of one month prior to being dispatched into the field.
- Requiring a certain number of sortings because not all growth and rooting of cuttings will be uniform.

Insect and Disease Control

Fortunately, hybrid pines in Queensland have few serious insect and disease problems. Strict nursery hygiene is maintained throughout the growing process, including:

- Sterilization of potting mix.
- Use of chlorinated water.
- Sterilization of pots and trays before reuse.
- Chlorine sterilization of benches, floors, and greenhouse films between each crop cycle.

Weed Control

Nursery weed control is achieved by a number of techniques that include:

- Keeping nursery surroundings free of weed seeds by regularly spraying, maintaining a weedless environment under benches and in the immediate vicinity of container stock, and regular slashing and mowing of surrounding areas.
- Removing germinating weeds from pots as soon as possible.
- Testing growing media prior to use in order to ensure that it is weedless.

OPEN ROOT PRODUCTION

Sowing

Sowing during August is performed using a Summit tractor-mounted 8-drill sower, which combines a vacuum drum sower, bed former, and

compacter/roller system, making the sowing a one-pass operation.

Setting

Following soil preparation, beds are formed using a Summit Sowing machine that forms the beds to a height of 10 cm and marks the setting drills. Irrigation is installed at least one full day prior to the commencement of setting to ensure maximum soil moisture is obtained. A pre-emergent herbicide application is applied just prior to setting.

Setting is carried out utilizing four-wheeled carts with seating adjusted to avoid excessive bending.

Setting is performed as follows:

- Cuttings are collected from the hedge production site and placed into cold storage.
- Cuttings are placed into wet hessianed-lined plastic crates that are drenched with water every ten minutes during collection, then drenched four times per day during cold storage.
- Shoots are placed into predrilled holes. With one action, shoots are pushed vertically to a depth of 4 cm and gently firmed around the base.
- Cloche frames covered with a shade cloth are installed immediately behind the setting operation.
- Irrigation is applied continuously during and after the setting operation for five minutes every hour during daylight hours.
- An application of Goal (*oxyfluorfen*) is applied within one week of setting.
- Shoots generally take approximately sixteen weeks to strike roots.
- A visual assessment of rooting is performed weekly after the eleventh week. When 90% rooting has been obtained, a manual root assessment is carried out to confirm rooting, and shade covers are removed.
- Slow-release fertilizer is applied by a tractor-mounted applicator.
- Irrigation is reduced.
- Operations from this point are similar to those for open-root seedlings.

Irrigation

Seedlings

After sowing it is necessary to maintain good soil moisture to assist with germination. Irrigation is required three times per day for ten to twenty minutes. A twenty-minute watering applies the equivalent of 1.5 mm of rain. Windy conditions require more frequent irrigation to ensure that the seeds will not be exposed or dry out.

Germination occurs at two weeks and is normally completed by the fourth week. Irrigation can then be reduced to two waterings per day. Windy conditions following germination require close monitoring of the soil moisture, taking into consideration the time it takes to fully irrigate the total sown area. Sand blasting of young, vulnerable shoots can result in large seedling losses and the multistemming of future stock due to tip damage or loss caused by sand particles.

Cuttings

Cuttings require constant irrigation, from the time of collection until rooting sixteen to twenty weeks later. They are so susceptible to drying out that constant attention is required to ensure that the cutting site retains near maximum moisture levels. Irrigation should be the equivalent of 6 mm of rainfall per day.

Weed Control

Seedlings

Pre-emergent herbicides Dacthal (*chlorthal dimethyl*) and Agaprop (*propazine*) are applied following seeding as well as at six to eight weeks. These applications will hold weed growth until mid-November, depending on intensity of rainfall.

From November, the main weed species are grasses controlled by the overtop spraying of a selective herbicide (Fusilade)(*Fluazifop p-butyl*). Until lifting ends in April, re-application may be required every six to eight weeks for grass control purposes. Some spot spraying, using a knockdown herbicide, might be used to control any resistant weed species.

Cuttings

Following the bed-forming operation and just prior to setting, a mixture of Dacthal and Agaprop is applied. Within one month of setting, an application of Goal is applied. Prior experience suggests that this combination gives excellent weed control for periods of up to twelve weeks,

despite the intensive watering program. Applications of Fusilade may be required to control any grass germination.

Root Pruning

All open-root seedling and cutting stock receive a number of root pruning treatments. Root pruning is an important tool in managing root development and it assists with the physiological conditioning of planting stock as well as the height control. Root pruning aids in the development of a strong, compact, and fibrous root system and it improves lateral root development. It consists of three distinct operations: reciprocating root pruning, lateral pruning, and bar wrenching.

Reciprocating Root Prune

A machine utilizing a sharp, reciprocating blade undercuts the open-root bed severing the taproots at a preset depth. The first root prune is carried out when seedlings/cuttings average 15 cm in height (January), and is continued every four weeks until April.

Lateral Pruning

Lateral pruning, to prune and enhance lateral root development, commences one week following the first root prune. It effectively prunes lateral roots growing across beds.

Bar Wrenching

Bar wrenching is the final tool used in the plant's conditioning process. The large, flat blade that is pulled under the nursery beds at a depth of 15 to 18 cm causes the soil surface to crack and subsoil aeration. This induces a further drought hardening response.

Topping

Topping by a tractor dasher may be required to control height growth. Care is required to ensure that only topping of soft new growth occurs, because topping too low into the woody tissue will result in multi-stemming.

Topping not only reduces and holds stock at a plantable height but it also induces diameter growth and uniform plant height.

Nutrition

Fertilizer additions are aimed to produce optimum growth and maintain the health and vigor of planting stock. Plant growth is carefully monitored during March and April in order to prevent excess

fertilization, which will compromise the plant conditioning process. The aim at this stage is to monitor foliage color and plant conditioning and to also fertilize accordingly. Soil fertility is monitored annually, and applications are amended as required.

Original fertilizer prescriptions for open root cuttings relied on weekly foliar applications of NPK fertilizer. Problems were soon identified, and despite bi-weekly doses and different formulations, it was difficult to maintain optimum nutritional levels. It appeared that rooted cuttings do not have the ability to take up as much of the available nutrients as do seedlings, but respond well to slow-release forms that are available for longer durations. To overcome this problem, NPK is applied in a slow-release form once shade covers are removed. Currently, Osmocote® is applied for three to four months as an over-top dressing.

Lifting

Plants are ready for planting by April. It is expected that 90% of seedling stock and 65% of cuttings will meet planting specifications. Following sufficient rainfall, stock is lifted from the open-root beds. It is then packaged, cold stored, and transported to the field within several days. The lifting process is as follows:

- Beds for lifting are irrigated the day before lifting begins.
- A Fobro Lifter Shaker machine is used to lift seedlings from the open root beds. The lifting process removes plants from the beds, shakes soil from the roots, and places the plants in rows on the bed surface.
- Plants are packed into plastic crates and transported to a packing shed.
- Plants are sorted, culled, root pruned to 15 cm, root dipped, and packaged into plastic crates. Each crate holds 350 to 400 seedlings.
- Plastic crates are stacked onto pallets and stored under refrigeration at 2 °C and 95% humidity until needed; usually one to two days.

During this process it is important to minimize plant exposure to ensure maximum field survival following planting. This is done by strict quality control procedures that are closely monitored by a checklist system.