P I N E N U R S E R Y

M A N U A L

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PINE NURSERY MANUAL

1.1 INTRODUCTION

This nursery manual describes the many operations necessary to successfully grow Pinus radiata seedlings and cuttings to specifications at the Plant Propagation Centre, located at West Manjimup.

The Manual is to be used by the nursery manager as a guide to meet production targets.

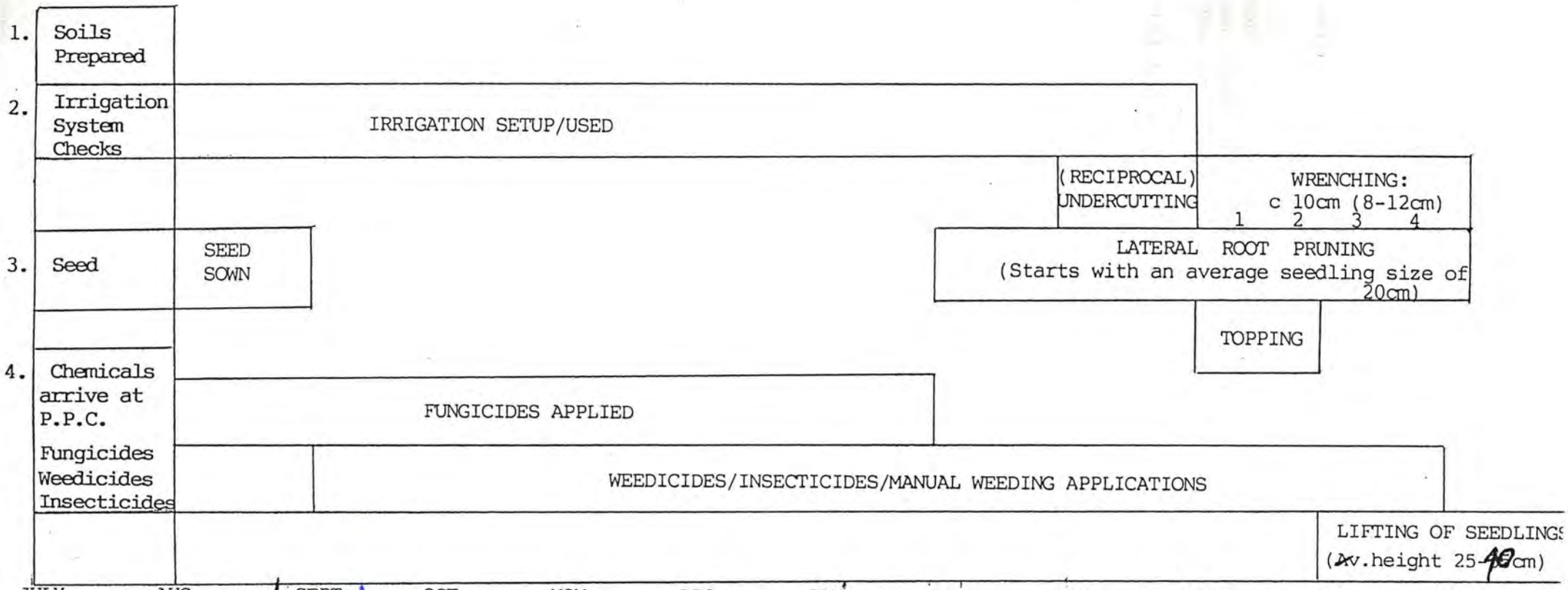
1.2 OBJECTIVE

The objective of the nursery is to raise sturdy, healthy, free of persistent defect 1-0 Pinus seedlings and 1.5-0 Pinus radiata cuttings from elite genetic seedlots. These seedlings should have ample fine roots, being rich in mycorrhizae, and capable of survival along with rapid early growth when planted out.

These plants should be produced at the lowest practical cost.

Operations are to be conducted in accord with Figure 1.1 - Critical Operations Schedule.

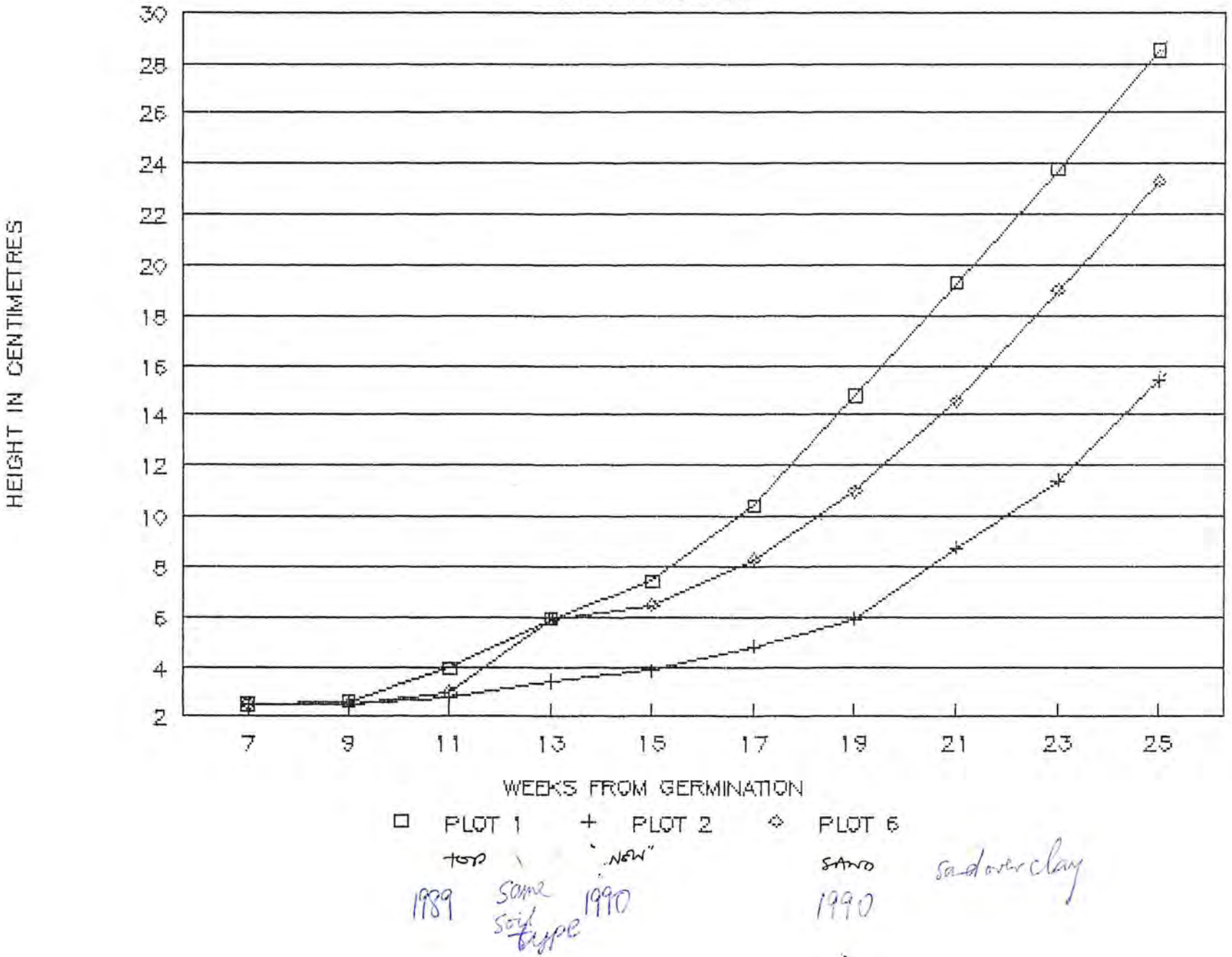
FIG 1.4 CRITICAL OPERATIONS, PINE NURSERY

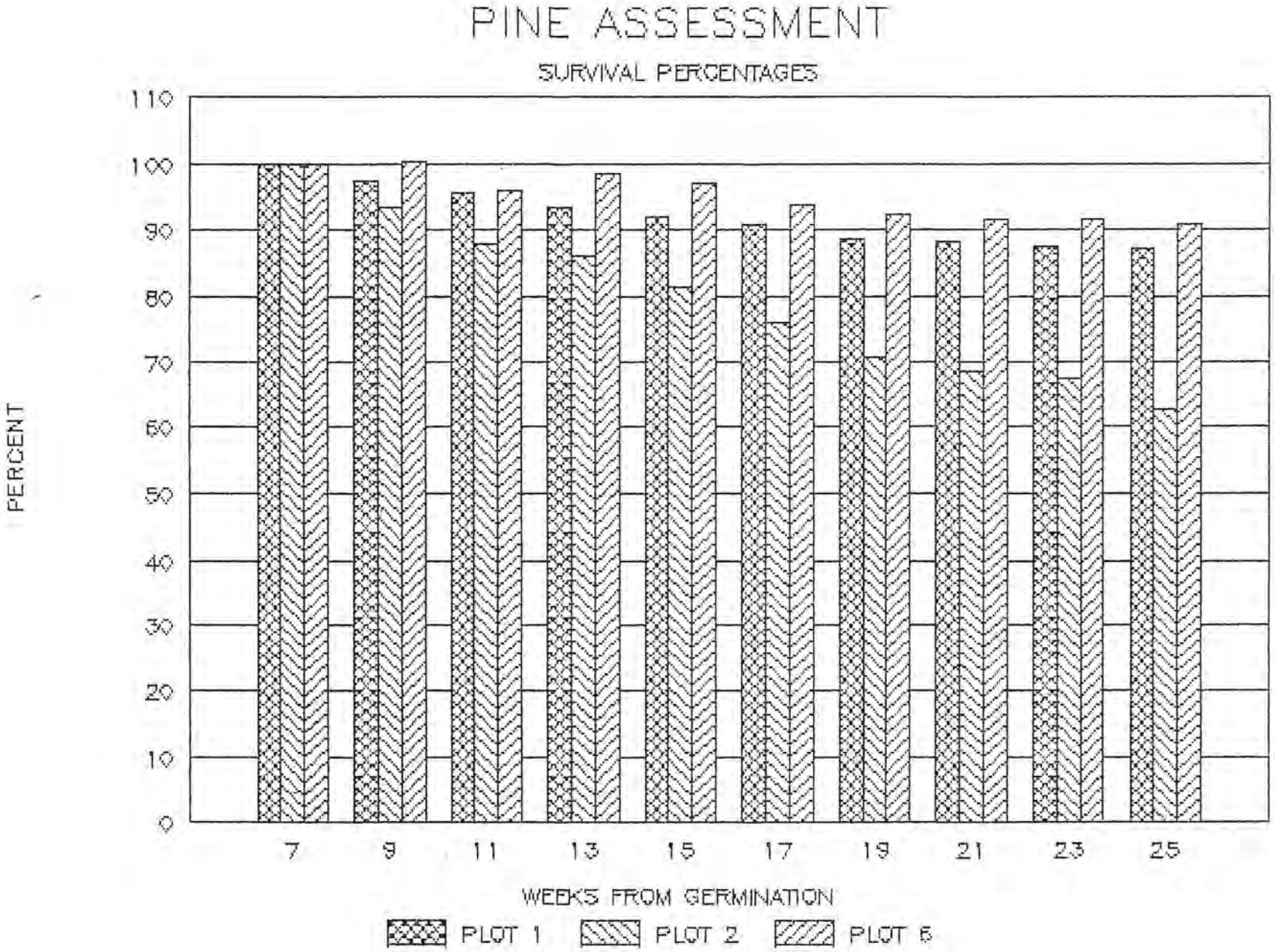


Phase 1: "Preparation" and checking of equipment.
Phase 2: "Sowing" and promoting early growth.
Phase 3: "Conditioning" and hardening of seedlings/cuttings for quality specificcations.

PINE ASSESSMENT

GROWTH RESULTS

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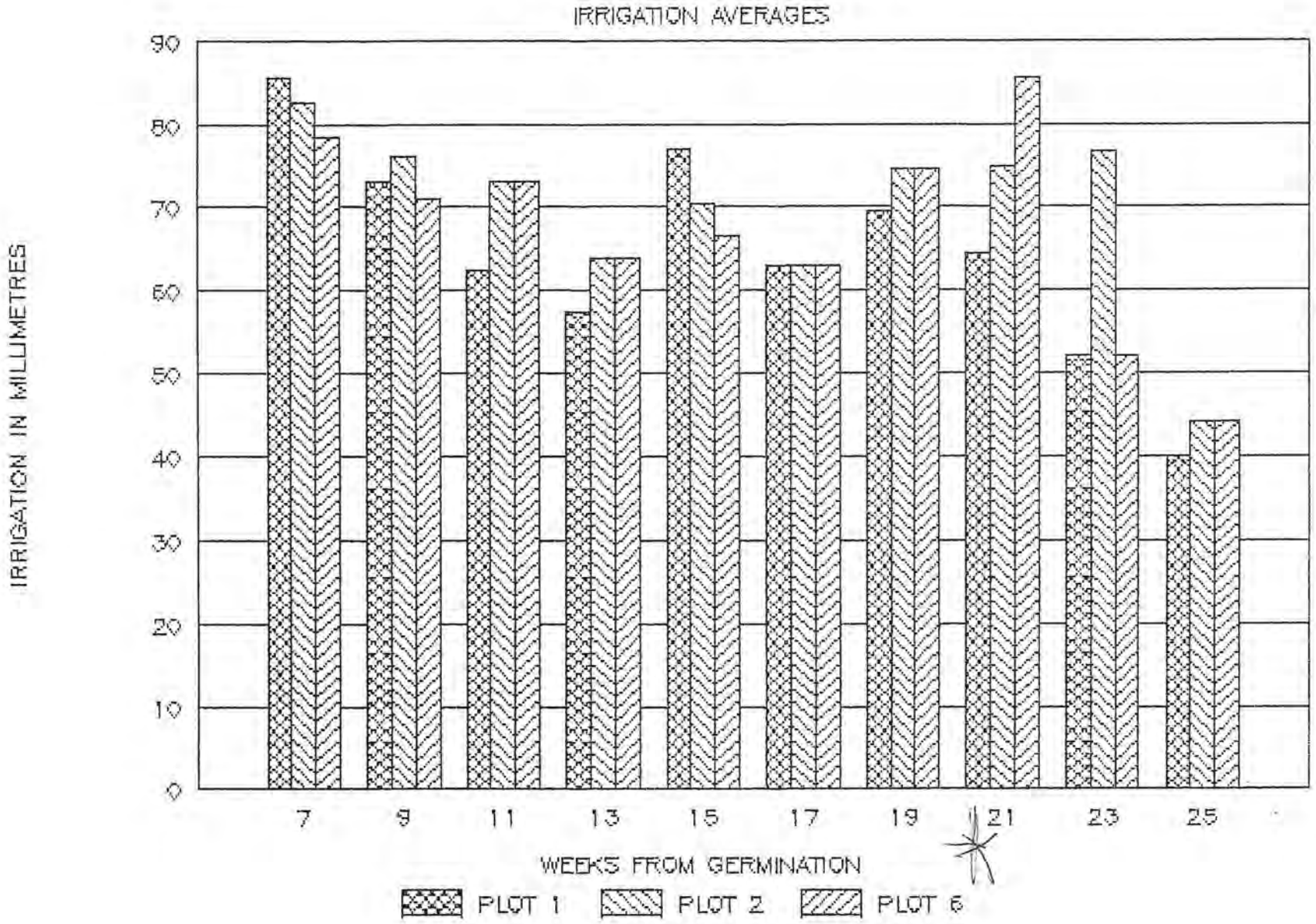
PINE ASSESSMENT



1.3 SPECIFICATIONS

For detailed descriptions see "Specifications for Pinus Radiata Planting Stock".

Height:	desirable minimum	20	cm
	optimum	28-35	cm

Stem Diameter:

Seedling Height	Stem Diameter
22 cm	3.0 mm
30-33 cm	3.5 mm
33-38 cm	4.0 mm

Roots: fine roots, minimum

10 cm long for every 5 cm^2 of projected root system.

Tap root 10-12 cm long

Bark: optimum, hardened bark to within 5 cm of tip, colour greeny brown.

Defects: Not culled - bends, unequal forks.

Culled - equal forks, mechanical injuries, pathological damage, mineral deficiency.

HEIGHT/ROOT Collar Diameter: Ratio of 60 desired.

NOTE: For further details on seedling quality:
Refer Appendix 1.

2.1 SEEDLING PRODUCTION

All seed will be tested for germinate capacity and sowing rates will be recommended to obtain approximately 150 plantable (saleable) seedlings per bed metre. In the absence of germination test information, an average of 15,000 saleable seedlings per kg of seed should be assumed.

2.2 SEED SOWING

(a) Pre-treatment of seed.

Seed is to be soaked in water for 48 hours prior to sowing. No coolstore stratification is to occur.

(b) Ground Preparation

(i) Seedbeds should be cultivated to a fine tilth before sowing. Ploughing should not extend to depths greater than 25 cm.

(ii) No areas should be deep ripped other than wheel tracks, headlands etc.

(iii) Incorporate to a depth of 15cm the specified fertilizers a minimum of 4 weeks prior to sowing. Care is required to ensure that this is evenly distributed, otherwise patchy unhealthy seedlings and/or uneven sized seedlings will result.

(iv) The standard fertilizer mixture is expressed in kg. per nursery bed in ha.

CSBP HORTICULTURE SPECIAL (9%N, 4%P, 8%K) 300 kg/ha

Additional fertilizers added per advisory service recommendations.

(c) Sowing

(i) The Agricola vacuum seeder is to be used for all sowing operations. Sowing 6 rows at a spacing to give 150 seedlings per lineal bed metre, viz. 60 square centimetres "space" per tree. This equates to 25 seedlings per lineal row metre.

(ii) Sowing depth on lightly rolled or "bed formed" beds should be 0.5cm.

(iii) Time of Sowing: Sowing operations should be completed as early as practicable, e.g.. mid-September.

2.3 NUTRITION

The foliar fertilizers should be dissolved in large volumes of warm water. e.g. 1000 l/ha, mixed thoroughly and applied at specified rates per nursery bed area in ha.

Fertilizers should be applied as prescribed when plants are actively growing. After seedlings have reached a height of 5 cm there may be monthly applications of:

CSBP NPK RED	100kg/ha (13%N, 6%K, 16%S)
Aquasol	10kg/ha (23%N, 4%S, 18%K, 0.01%B), 0.06%Fe, 0.15%Mn, 0.06%Mo, 0.05%Zn, 0.05%S, 0.16%mg)
Nitrophoska Blue Special	10kg/ha (12%N, 5.2%P, 14%K, 0.05%B, 0.1%Mn, 0.02%Zn, 7.0%S, 5.6%Ca, 1.2%Mg)

If required, include the following applications:

Magnesium sulphate	20kg/ha
Sulphate of Ammonia (fine grade)	10kg/ha

Nitrophoska Blue Special, Magnesium Sulphate, Sulphate of Ammonia and Aquasol should be applied as a foliar spray in cool conditions.

Fertilizers are always best applied on cool, moist days, especially when showers are expected.

Beds must be weed free at the time of application. The appearance of stunting, chlorosis, necrosis or general ill health should be reported. (See Reporting Section).

Fertilizers will not be applied after seedlings reach an average top height of 20 cm. and seedling "hardening" has commenced, except in the case where specific nutrients are required for post-lifting requirement (e.g. trace element requirements) or to redress nutritional imbalances - see Hardening and Plant Size Control.

2.4 HARDENING AND PLANT SIZE CONTROL

Seedling Conditioning

Crop production strategy should be to raise the required number of seedlings to a mean seedling height of 20cm by early March and then to manipulate the crop to minimize new shoot production and maximize new lateral root production.

Lateral pruning should be initiated in late February to a depth of 15-20cm and then the crop should be irrigated heavily until the soil reaches field capacity. These operations initiate the seedbed cultivation at depth, ensure a favourable distribution of soil moisture throughout the bed and prepare the crop for rapid recovery after the severe shock of undercutting.

From March, seedbeds should be irrigated again to field capacity and the crop undercut at 10-12cm below the soil surface with a reciprocating wrencher. Seedling tap roots should be neatly cut with a minimum disturbance of any roots or soil above this level. The operation should be carried out with a sharpened 5cm wide blade with constant monitoring to ensure its correct tension, horizontal alignment and optimum reciprocating speed. Successful undercutting requires seedbeds raised at least 15-20cm at the time of undercutting. A tractor with "super crawler" gears is required to maintain 0.5km/hr constant forward speed while operating the wrencher at its specified constant 540rpm in order to minimize any dragging action in the operation.

Undercutting operations should be carried out under overcast conditions and completed beds should be irrigated prior to nightfall.

Subsequently wrenching operations should be carried out at 2-3 weekly intervals.

This operation is carried out in a similar manner to the undercutting operation but using a wider and thicker blade. Wrenching is carried out after irrigation at the same depth as undercutting but with an increasing blade angle and forward speed at each subsequent treatment. These operations aim to retard any apical taproot growth, aerate the soil, further stimulating lateral root growth while restricting any succulent shoot growth.

Lateral pruning should be repeated in March to restrict lateral root growth extending into adjacent seedling drills.

In March and April, irrigation should be kept to the minimum required for wrenching and crop health in order to promote crop hardiness.

Regular nutritional checks are required during crop hardening e.g. Nitrogen applications may be necessary due to chlorophyll losses.

2.5 LIFTING

(i) Damage to plant roots by rough handling and exposure must be minimized and checked continually. This is one of the major causes of slow early growth. Do not tap the roots during lifting to remove soil. Tapping removes many fine roots and mycorrhizae and causes root injury. To remove soil - shake the roots only.

(ii) Boxes should be stored in a dry condition to increase their "life". Watering of plants packed in plastic bags is unnecessary and in fact encourages the growth and rapid spread of fungal diseases.

Pine seedlings contain large amounts of water and will raise the humidity in the plastic bag to 100% and thus prevent the drying out of seedlings.

Do not water in seedlings packed in plastic bags unless requested by NURSERY SUPERVISOR.

2.6 ASSESSMENTS

For detailed information see "Nursery Assessments - A Guide to Management". The accuracy of an assessment should be approximately +/- 5%. Assessment plots should be established at random after sowing and there should be four germination counts. There should be at least three assessments of the growing stock. The final count to be recorded in March.

Assessment plots should measure 100 x 135cm. Each plot measures one lineal metre of seedbed.

2.7 MYCORRHIZAL INOCULATION

Spore Suspensions of RHIZOPOGON LEUTEOLUS are to be prepared by macerating 100gm air dry sporophores in 200ml distilled water in a food blender and diluting this suspension to 61. with distilled water.

10kg batches of stratified seeds are to be covered with the spore suspension in 20 ltr seed containers, the batches are then shaken for 5 minutes to ensure even distribution of the spores, excess liquid drained off and then the seed is air-dried on plastic sheeting immediately prior to sowing.

Inoculation of the seed beds directly, with boomspray application, should only be conducted when all other options are thoroughly exhausted.

2.8 WEED CONTROL

Pre-emergent weed control: Immediately after sowing, seedbeds are to be sprayed with chlorthal and propazine at 10kg and 1kg a.i./ha respectively.* At ground rupture, just prior to seedling emergence, roundup at 41/ha (product) should be applied over the seedbeds.

Cultivation of seedbeds should be avoided as it will reduce the effectiveness of the pre-emergent weedicides.

THE NURSERY IS TO BE KEPT "WEED FREE".

Early pine sowing and pre-emergent weed control measures outlined may enable the crop to become well established before emergence of any weed crop. In the event that weeds do become established then use an appropriate cost-effective option.

Pre-Emergent Weedicides

(a) Chemical Name: Glyphosate

Commercial Name: Monsanto Roundup 360 gm ai/l

Use: It is to be used prior to sowing of pine seed and green crop. If all the seed is well covered it may also be used after sowing and prior to the crop emergence. Do not apply if rain is expected within 12 hours and do not use if dew causes droplets to run off weed foliage. Mix with clean water only. Do not mix with other herbicides.

	Dose	Application Method	Dilutent	Total vol/ha
Pre-crop Emergence	1.5kg ai/ha	Boom	Water	200 litres
Paths etc.	1.5kg ai/ha	Knapsack	Water	50 litres

Commercial Preparation	Boom 1.5 Kg ai/ha		Knapsack 1.5 Kg ai/ha	
	Prod	Water	Prod.	Water
Roundup 360 gm ai/ha	4.01	450 l	0.15 l	15 l

* See Chemical Users Manual; Herbicides Manual smf '728' Safety Manual.

(b) Chemical Name: Chlorthal

It has no affect on the germination of pine seeds. It does inhibit germination of weed seeds, but does not control all weeds. Avoid cultivation after chlorthal application. Apply immediately before first watering or rain after sowing crop. If necessary, a second application should be applied 5-6 weeks after pine emergence. Seedling beds should be inspected at least every week.

Light cultivation and waterings prior to the second application is desirable for the best results.

The mix should be agitated by mechanical means or by-pass pump during application. It is most effective in cool weather.

Dose	Application Method	Dilutent	Mixture Total vol/ha
7.5 Kg ai/ha	Boom	Water	1100 l

Commercial Preparation	Application per hectare Boom Spray 7.5 Kg ai/ha	
	Product	Water
Agchem Dacthal W75 750 gm ai/kg WP	10 Kg	1100 l

(c) Chemical Name: Propazine

It is a herbicide applied after pines have emerged. If necessary, apply only after the pine germinates are 8-12 weeks old. It is a pre-emergent herbicide for the control of broadleaved and grass weeds. Agitate mix mechanically or with by-pass pump. Propazine should only be applied to a pine crop once, as it has residual effects upon the germination and growth rates of Pinus radiata.

Dose	Application Method	Dilutent	Mixture Total vol/ha
1.0 Kg ai/ha	Boom	Water	500 l

Commercial Preparation	Application per hectare Boom Spray	
	Product	Water
Ciba Geigy Gesamil 50WP 500 gm ai/Kg WP	2 Kg	500 l

Pine

Chemical	Spring sowing	Autumn sowing
Glyphosate	May-October	March
Chlorthal	Sept.-October November-December February	March, December
Propazine	January-February	

General

The efficiency of residual weedicides such as propazine is optimal during the germination to the 2-3 leaf stages of weed growth.

In most cases, weeds which have grown beyond the 4-5 leaf stage will be resistant to dose rates and control cannot be expected. Successful use depends upon correct dosage, clean water, the correct time of application and the repeated application as/if necessary. Important also is the use of uncontaminated equipment and its application under the most practicable, ideal weather conditions available.

Post-Emergent Herbicides: (See Chemical Users Manual)

Chemical Name: Goal

Goal is a post-emergent herbicide recommended for the control of broadleaved weeds and grasses.

It can be used at rates from 50-1000 millilitres (Product) per hectare without crop damage.

Chemical Name: Fusilade

Fusilade is a post-emergent herbicide for control of "C4" grasses only. It can be used from the period of three weeks after crop emergence.

Chemical Name: Tribunil

Tribunil is a post-emergent herbicide for control of a broad range of broad leaved weeds. It can be used at rates from 700-2000 grams (Product) per hectare without crop damage. Its repeated application will not affect crop growth.

Chemical Name: Velpar(L)

Velpar(L) is a broad ranged herbicide for use on pine cuttings. Application rates from 0.5-2.5 litres per hectare will not produce crop damage.

2.9 ROTATIONAL CROPPING

Nursery sections should be cropped for a maximum of three consecutive years and then sown to a suitable grass pasture for 2.5 years before a further cropping with pine seedlings. The pasture phase is essential to ensure soil organic humic levels and structure are maintained and if possible improved.

2.10 DISEASES

CONTROL OF NURSERY DISEASES (FUNGAL)

No seed to be coated with fungicides prior to stratification.

Spring sown nursery beds should be drenched with fungicides as set out below. The first application should be just prior to sowing to control pre-emergence damping off, viz. Pythum and Phytopthora problems. The nursery beds should be drenched again as problem arises.

Autumn sown nursery beds should be drenched just prior to sowing, and as required. Drenching of nursery beds during the winter is unnecessary, unless problem arises.

Chemical used:	Ridomil MZ contains Ridomil 4%WP and Mancozeb 64% WP
Application rate:	First drench 10.0Kg of Ridomil MZ mixed in 1000 litres water per ha. Subsequent drenches 20.0 Kg of Ridomil MZ mixed in 1000 litres water per ha.
No.of applications of both chemicals:	Spring sowing - 1 Autumn sowing - 1

Method of application:

1. Weigh out required amount of fungicide.
2. Pre mix powder into a smooth thin cream with sufficient water to ensure that all particles are thoroughly wetted. Ensure that the cream does not stand for more than one hour.
3. Make up volume of cream to the desired amount of clean water (1000 L/ha).
4. Apply fungicide suspension with conventional boom sprays.
5. It is desirable to water seedbeds for 15 minutes following fungicide treatment to facilitate movement of chemicals into the rooting zone.

To minimise problems associated with Sphaeropsis apply Bavistin at 1Kg/ha in 1000 litres of water per hectare, starting from 1st October, 1989. This should be controlled at three week intervals.

PHYTOPHTHORA CONTROL IN NURSERY

For all pine cuttings taken for production use, the minimum height above ground level is 1.0 metre. This is pursuant to the "U.C." Handbook recommendations.

Advice in this regard should be directed to Dr Elaine Davidson, Pathologist, Department of Conservation and Land Management, Como.

ROTATION OF CHEMICAL ADDITIONS

The application of routine herbicides / fungicides / insecticides should be on a rotational basis to avoid the build-up of resistance by pathogens in the nursery.

The effectiveness of these applications should be closely monitored relative to their interactive influence with cultural practise.

2.11 CONTROL OF NURSERY DISEASES (INSECT)

The crop should be inspected at least twice weekly for seedling mortality from emergency.

A preventative insecticide programme should continue from emergence for 14-16 weeks using an appropriate registered insecticide - refer Chemical User's Manual No. 70.

2.12 DRAINAGE WORKS

1. Deep ripping is not effective in improving drainage. There is to be no general deep ripping of production areas.

2. Wheel tracks are to be ripped prior to undercutting, and as required.

3. Tynes should be used to break the crust between the rows of pine seedlings to facilitate the infiltration of irrigation water. The seedling beds should be first tyned when the seedlings are 5cm high, in January. Tyning should be continued at intervals throughout the growing season.

2.13 IRRIGATION

Seedbed surfaces are to be kept moist at all times during the emergence period (5-6 weeks after sowing) with tri-weekly irrigation, if necessary. Water pressure should be maintained to ensure droplet size and splash force is kept to a minimum on the bare seedbeds.

Soil moisture should be raised to field capacity each week by rain and/or supplementary irrigation until February. That is, the equivalent of 50mm/week, after allowing for effective rainfall. Subsequently extra irrigation should be kept to a minimum needed in the "conditioning" treatments of undercutting, wrenching and lateral pruning.

Weekly records must be kept of rain and irrigation supplements.

2.14 MONTHLY WORKS PROGRAMME

JULY

(i) Continue lifting.

(ii) Check equipment prior to sowing.

(iii) Assemble boxes.

(iv) Cultivate beds after lifting if dry.

(v) Pruning of windbreaks overhanging headlands.

(vi) Prepare weekly lifting summary.

(vii) Soil preparation to be commenced. Shallow tyne ripping. Base Fertilizing. Non-residual weedicide application, if necessary.

The vibrating harrows are to be used for final soil preparation.

(viii) Complete lifting and despatch of planting stock. Complete annual report "Nursery Record of Operations".

(ix) Cleaning of sheds.

(x) Maintenance of Agricultural and Irrigation Equipment in readiness for sowing.

(xi) Mowing of grassed areas if required.

(xii) Pre-sowing fertilizer to be incorporated in top 15cm early in this month.

AUGUST

(i) Soil preparation is to be completed for spring sowing of Pinus radiata.

(ii) Bed forming and rolling out of beds.

(iii) All sowing to:
obtain 25 seedlings per metre of row, to be completed by the middle of this month.

(iv) Establishment of assessment plots.

(v) Irrigate until germination is completed to keep seedbeds moist. Moisture content of top 10cm of soil to be maintained between 12% and 20% (ODW). Water potential greater than 0.5 mpa.

(vi) Daily check of seedbeds for any fungal, vermin or insect damage.

(vii) Ensure that drains are kept clear.

(viii) Pre-emergence weedicides Roundup (1.5Kg ai/ha) and Gesamil (1Kg ai/ha) applied as required. Apply Dacthal at 10 Kg (ai/ha) shortly after sowing, before first watering.

(ix) Grassed areas to be mowed.

(x) Cultivation of fallow areas if ground condition suitable.

(xi) Sow green crop if ground conditions suitable.

(xii) Weed control of 2-0 stock.

SEPTEMBER/OCTOBER/NOVEMBER

(i) Inspect spring sowing areas daily.

(ii) Continue irrigation checking soil moisture.

(iii) Continue weed control. Apply Dacthal at 10Kg (product)/ha 3-6 weeks after germination if required - see instructions on use of weedicides.

(iv) Fertilize green crop at time of sowing with 120Kg/ha superphosphate.

(v) Check, clean and store seedling equipment.

(vi) Grassed areas to be mowed.

(vii) Assessment of germination.

DECEMBER

(i) Continue irrigation as required, aiming at a minimum soil moisture content of 12%.

(ii) Weed control to continue.

(iii) Final assessment of germination and forward to Silviculture Branch.

(iv) Grassed areas including outside boundary fences to be mowed.

(v) Plough fire breaks.

JANUARY

(i) Continue weed control. Apply if necessary Propazine at 1.5 Kg ai/ha when pine germinates are 8-12 weeks old.

(ii) Continue irrigation as required.

(iii) Grassed areas to be mowed.

(iv) Repair of buildings and equipment

(v) Maintenance of headlands, drains and roads.

(vi) Slash and plough rotational crop.

(vii) Inter row cultivation as required using tynes.

(viii) Fertilizing of spring sown crops as prescribed, using Aquasol sulphate of ammonia and Nitrophoska Blue Special.

FEBRUARY

(i) Continue irrigation of spring sown crop as required.

(ii) Propazine/Dacthal to be applied following inter row cultivation, if required.

(iii) Weed control of fallow areas with cultivation.

(iv) Grassed areas to be mowed.

(v) Inter row cultivation as required.

MARCH

(i) Continue irrigation if required.

(ii) Ripping wheel tracks in between seedling beds prior to undercutting.

(iii) Undercut 1-0's, 1.5-0's and 2-0's subject to weather conditions and irrigate.

(iv) Check and order all requirements for lifting.

(v) Top prune 1.5-0's and 2-0's.

(vi) Assessment of growing stock.

(vii) Side pruning to 15cm of spring sowing.

APRIL

(i) Continue undercutting, irrigate.

(ii) Final assessment of all stock.

(iii) Check equipment prior to lifting and set up packing shed.

(iv) Undercutting should take place once every three weeks. Minimum one root pruning and one sidepruning before lifting. To be completed 6 weeks prior to lifting. Undercutting is very important in helping plants to form fine roots and to become hardy. To be effective it must be carried out during a period of active growth. Undercutting, however, also injures the plant roots and a period of 6 weeks must be allowed for roots to heal.

There is also a tendency in some years to wait too long until seedlings have reached a desirable height. Undercutting late in the season may be quite ineffective and may cause defects. It is preferable to plant smaller seedlings that have been undercut at the right time.

Topping: If lifted in autumn, allow one month recovery period,
if lifted in winter, allow 2 months recovery period.

(v) Weed control of fallow areas with Roundup as required.

MAY

(i) Complete undercutting of spring sown areas.

(ii) Commence lifting after frosts have started.

NB. 1-0 lifted in May and early June should not be stored in boxes for more than one week.

(iii) Check for fungal and mechanical damage.

(iv) Check tractors and all lifting equipment weekly.

(v) Drainage of water logged areas.

(vi) Mow grassed areas.

(vii) Assessment of autumn sowings.

JUNE

(i) Lift stock.

(ii) Keep records of lifting and despatch of all stock, by compartment and seedlot.

(iii) Prepare weekly lifting summary.

(iv) Check deviation from assessments.

(v) Check boxes, order more liners if necessary.

(vi) Plant ornamentals.

(vii) Clean spoutings on buildings.

(viii) Check and store irrigation material that is no longer required.

JULY

(i) Continue lifting, do not store lifted seedlings for more than one week.

(ii) Prepare weekly lifting summary.

(iii) Check deviation to assessments and report.

(iv) List fertilizer requirements for next season.

(v) Check equipment and list spares required.

2.15 NOTES FOR THE PRODUCTION OF 1.5-0 BARE-ROOTED PINE CUTTINGS

The generalized production of Pinus radiata cuttings from stool beds is shown in Table 1. Production techniques at the PPC will, in general, follow the pathway:

(1) Genetically improved cuttings will be outplanted, without pinning to the ground.

(2) First and second order cuttings will be directly installed into outside nursery beds in May-August.

The operations critical to the propagation of fascile cuttings is shown in Table 2.

SETTING OF CUTTINGS

First and subsequent order cuttings will be taken from established (outside) mother stools during the period May to August.

Specifications:

These cuttings will be approximately 100-120mm long with a diameter range of 3-8mm.

Procedure:

The setting of cuttings will be conducted by trained staff during cool and overcast conditions.

The procedure should be:

(1) Preparation of seed beds as per the sowing of pine seedlings.

(2) Marking of seedbeds in a configuration of six rows per bed with an inter-plant spacing along the row of 75mm.

(3) Cuttings are taken from mother stools and, wherever possible, set prepared beds that day.

(4) At the completion of each work unit or at least each day, an appropriate misting irrigation system is used to cool and moisten beds.

(5) The growing and conditioning of cuttings after October is as per the growing and conditioning of seedlings.

(6) A series of trials is currently in progress to verify appropriate herbicides to be used in the control of weeds in the cuttings crop.

SPECIFICATION FOR LIFTING:

For detailed descriptions see "Specifications for Pinus Radiata Planting Stock".

Height:	desirable minimum	20	cm
	optimum	28-35	cm

Stem Diameter:

Cutting Height	Stem Diameter
22 cm	3.0 mm
30-33 cm	3.5 mm
33-38 cm	4.0 mm

Roots:	fine roots, minimum 10 cm long for every 5 cm^2 of projected root system. Tap root 10-12 cm long
Bark:	optimum, hardened bark to within 5 cm of tip, colour greeny brown.
Defects:	Not culled - bends, unequal forks. Culled - equal forks, mechanical injuries, pathological damage, mineral deficiency.
HEIGHT/ROOT	Collar Diameter: Ratio of 60 desired.
NOTE:	For further details on cutting quality: Refer Appendix 1.

FERTILIZER REGIME

A. PINE CROP

(1) 4 Weeks prior to sowing of P. radiata.

Blood and Bone (5% N, 5% P)	200 Kg/ha
CSBP Horticulture Special - (9% N, 4% P, 8% K)	300 Kg/ha
(Dolomite) Lime	800 Kg/ha

(2) If required when P. radiata is growing actively, viz. 5cm to 20cm HT: Prior to hardening.

Magnesium sulphate	20 Kg/ha
Aquasol	10 Kg/ha
Nitrophoska Blue Special	10 l/ha
Sulphate of ammonia	10 Kg/ha
CSBP NPK Red	100 Kg/ha

B. RYECORN

At time of sowing:

CSBP NPK Red	200 Kg/ha

C. BARLEY

At time of sowing:

CSBP NPK Red	200 Kg/ha

APPENDIX I

SPECIFICATIONS FOR PINUS RADIATA PLANTING STOCK

Nursery stock should be sturdy, healthy, free of persistent defects, of a size to suit a particular environment, with ample fine roots rich in mycorrhyzae, capable of survival and rapid early growth when planted out.

The quality of nursery stock is controlled in the nursery by a number of factors such as row spacing, seedling density, seed size, fertilizing, irrigation, disease control, weed control, undercutting, side cutting, topping, time of sowing, seed treatment, storage etc. Our understanding of nursery techniques and practices enables us to produce seedlings to an acceptable standard by manipulating the above factors.

At this stage of our knowledge we still assume that certain quality attributes are related to the macroscopic features which can be described. The fundamental knowledge which will ensure that physiological requirements are met is still limited. The standards discussed below are a useful guide, but until the criteria are backed by more acceptable results from field trials they are not precise tools.

However there is no doubt we all know what a good plant should look like and conversely, what would be unacceptable. How are these recognizable features described so that they may be used to grade large numbers of seedlings?

Size: defined by length, of shoot and of tap root.

Hardness: defined by diameter of stem, woodiness of stem, lack of soft new growth.

Health: colour, appearance, acceptable root structure.

STANDARDS

Size: There is sufficient evidence that plant height alone is not a precise measure to set as a standard even when considered along with root quality (root-shoot ratio, fibrousness).

Researchers found in spruce and fir that quality grading gave meaningful survival results only when size was related to root collar diameter, stem length/total plant weight ratio and number of buds.

German standards list size, habit, rooting quality and health as criteria. The last three of these are subjective and not readily quantified.

British Standards for forest trees define heights and minimum stem diameters with root systems containing a reasonable proportion of fine fibrous, or, where appropriate rootlets and shall be adequate to the age and size of the plants. Plants should have a vigorous leading shoot and be healthy.

*Minko showed that dead topping increased with the size of unwrenched, sturdy seedlings and that mortality was lowest in the 30-38cm classes. Rabbits and competition caused severe losses in seedlings 12-28cm high. Mortality of seedlings greater than 38cm increased rapidly with size and was probably caused by moisture stresses. Mortality was highest in the first two years after planting.

The mortality of undercut seedlings in a bracken area dropped from 18% for 30cm seedlings to 12% for 52cm seedlings and increased to 50% for 75cm seedlings.

This information indicates that undercutting conditioned seedlings to withstand higher moisture stresses.

Minko's experiments also show that for sites of both high and nil competition 28-35cm seedlings produce the best height and diameter growth.

Smaller seedlings grow relatively faster than the larger seedlings, but mean height and diameter measurements for 5 years indicate that the smaller seedlings will never catch up.

Machine planted seedlings are inserted with a section of the shoot buried and are also planted at an angle to the vertical. As a consequence the protruding shoots of seedlings smaller than 22cm are usually insufficient to promote rapid plant development and large losses may occur. It is definitely recommended to cull seedlings smaller than 22cm.

Seedling size (measured as height of plant) increases as seedling density increases. However as seedling density increases, stem diameter decreases and obviously some other measure is required.

* Mr George Minko, DCFL, Wangaratta Region.

Seedling size involved the inherent variability in a seedlot. This variation may be as much as 30% between the largest and the smallest seedlings and we really do not know the cause of this. Some evening up can be obtained by shortening the germination period and grading of seed by weight.

Hardness: As a practical parameter stem thickness has few equals. Most workers can recognize diameters related to objects frequently handled and stem diameter at root collar is a useful measure for standardizing prescriptions of quality.

Minimum stem diameters:

Shoot length	22cm	30-33cm	38cm
Stem diameter	3mm	3.5mm	4mm

Seedlings with a smaller diameter stem will not support themselves and are more sensitive to fungal, insect and vermin attack.

There is a tendency in nurseries to wait until seedlings are near standard before hardening them off by root and side pruning, topping or otherwise. This is a dangerous practice because there is no doubt that hardened seedlings survive and grow much better when planted out. In fact it is almost impossible to harden seedlings too much.

The Forests Research Institute, New Zealand, recommends a minimum stem diameter of 8mm for 30-38cm stock.

The stem should have hardened bark to within 5cm from the top (greeny brown).

Health: Roots - Root structure is not easily defined. "A reasonable proportion of fine roots" begs the question. Root-shoot ratios are not satisfactory either. The length of the tap root and of secondary roots are of secondary importance only. Survival in the field depends on the amount of fine roots and a minimum of 10cm of fine roots to every 5cm of the projected root system is suggested. An abundance of fine roots is recommended and can be stimulated by repeated undercuttings. One undercutting doubles the ratio of the fine roots to lateral roots. Undercutting is inexpensive and should be carried out several times not only to produce fine roots, but also to harden the seedlings. A hard seedling with an abundance of fine roots has the best chances for survival and produces the best growth.

Defects - Bends, unequal forks and remicorns should not be culled out and their reappearance in the field largely depends on the planting site affecting the vigour of the tree and not on the initial form of the tree.

Bends are the result of an early moisture stress in the nursery beds, mechanical injuries, wind, rain, hail or machinery.

Unequal forks and ramicorns are genetically controlled to some extent only. Others develop while plant is recovering from some sort of injury, such as loss of leading apical shoot. A similar injury is not likely to reoccur and the seedling could be planted out.

Late development of terminal bud causes similar defects. This defect may reoccur but cannot be regarded as serious as it may only affect peeler log quality.

Equal forks should be culled. Minko showed that 77% of these revert to a single leader.

Diseased plants, plants ring barked, shoots, roots pulled off, showing mineral deficiency should be culled.

SUMMARY

The desirable features of planting stock have been discussed and are described below. The factors controlling seedling production can be manipulated to grow seedlings that have a better chance of survival and rapid early growth in the field.

The objectives are to produce this type of planting stock and cull seedlings not meeting the minimum requirements.

Height	-	desirable minimum	20cm
		optimum	28-35cm
Stem diameter	-	minimum	3mm

Stem Height	Diameter
20-30cm seedling -	3.0mm
30-35cm seedling -	3.5mm
35-40cm seedling -	4.0mm

Roots - Minimum

fine roots 10cm long for every $5cm^2$ of projected root system.

Tap root - 15cm.

Bark - optimum, hardened bark to within 5cm of tip (greeny brown).

Defects - Not culled: bends, unequal forks, ramicorns.

Cull: equal forks, mechanical injuries, pathological and entomological damage, mineral deficiency.

APPENDIX 2

NURSERY ASSESSMENTS - A GUIDE TO MANAGEMENT

Introduction

Efficient management of a nursery requires an accurate knowledge of the size and quality of the growing stock and the effect of seed quality, insects, fungi, cultural techniques and climatic conditions on the germination and growth of seedlings. As it is impractical to make complete counts of the growing stock, it is necessary to adopt an adequate sampling technique.

The intensity of the survey should be determined by the accuracy required, the purpose of the assessment, the experience gained in the preceding years through comparison of sample assessments with actual numbers of seedlings lifted and the amount of time and money available for an inventory.

Less accurate estimates are required during the growing season to guide the nursery manager in a well established nursery on the current requirements of the growing stock for optimum performance. More intensive and accurate surveys should be made in autumn to obtain estimates on the quality and quantity of the growing stock to within 4-5%. In a developing nursery it is advisable that all surveys be intensive to gain accurate information and experience for planning in future years.

In the past little use has been made of laboratory seed data, in adjusting seeding rates, etc. and no information has been collected on the field performance of seed.

The Objectives of an Inventory

Inventories provide information on:

(a) The performance of seedlots in specific nursery compartments.

(b) The size of the growing stock.

(c) The quality of the growing stock.

(d) The effect of pathogens, insects, nutrient deficiencies etc.

The generic, physiological, pathological and mechanical characteristics of seedlots can be examined in the laboratory and the germination and growth of these seeds could be examined under actual field conditions and related to the above seed characteristics. This information can then be used to predict the performance of seedlots in these compartments and allow the nursery manager to adjust his techniques to procure optimum seedling yields.

Relationship - Laboratory and Field

Seed testing rules prescribe optimum conditions for maximum germination and state that the ultimate object is to indicate the planting value of the seed. But conditions in the nursery can never be as favourable as those in the laboratory because potential soil pathogens are ubiquitous and adephic factors are frequently sub-optimal.

With increasing emphasis on maximum yield and profitability per unit area of land, the importance of attaining optimum plant populations is becoming more apparent, but attempts to obtain standard populations by calculating the seeding rate from results of a germination test will always be frustrated when the percentage emergence in the field is unrelated to laboratory germination. Thus it is important to increase our knowledge of the nature of seed vigour and to evaluate pre-planting test methods.

The extent of variability between samples in their reaction to different sites and conditions must be determined before any vigour test can be prescribed which will be valid over the wide range of conditions under which P. radiata seed is sown. Because of the variability it will be impossible to predict accurately the percentage emergence of a sample in the field from any form of test. Results from field tests have shown that low vigour samples are more sensitive to adversity and therefore more liable to fail in the field than high vigour seed. It should be possible to establish vigour levels, based on the measurements of seed characteristics in the laboratory which have been related to emergence and growth in field trials under a range of adverse climatic conditions. No test will provide the nurseryman with a guarantee that the seed will always emerge well because occasionally conditions will be too drastic for seed to survive, but it should help to minimize failures to achieve optimum plant populations.

Definition of High Vigour

Ideally all seed should be vigorous and there should be no problem. All seed within a seedlot should keep well when stored, when sown, they should germinate simultaneously and without delay, they should be free from seed borne diseases and neither the seed nor the subsequent seedlings should be susceptible to microbial interference. The seedlings should be mechanically strong enough to penetrate the soil that is compact through cohesion when wet or covered by a hard crust when dry, and they should be capable of establishing themselves despite a wide range of environmental conditions such as extremes of dryness and wetness, of cold and heat.

While still drawing on its own reserves, the seedling should be capable of drawing on these rapidly and of building up whatever metabolites and tissues are required for a plant to reach the autotrophic state. The growth rate (increase in dry weight) of the young photosynthesizing plants should be high and each should be capable of rapidly filling the area allocated to it and of producing the desired plant in a short space of time.

Causes of Vigour

The lack or loss of vigour can be due to a number of distinct, though interacting causes.

1. Generic i.e., varietal.

2. Physiological and cytological - premature harvest deterioration of all membranes, lack of vital cell constituents or inability to utilize these, detrimental changes in the chromosomes, tendency to permanent damage after temporary anaerobiosis.

3. Pathological - seed borne diseases, inroads by xerophytic storage fungi, susceptibility to extraneous usually soil borne micro organisms.

4. Mechanical - faulty harvesting, extraction and handling of seed.

Manifestations of poor vigour

Lack or decrease in vigour can express itself in a number of important ways:

1. Rapid deterioration in storage (which may express itself in turn through any of the following).

2. Narrowing of the environmental conditions under which a seed will germinate.

3. A longer time lag before seeds show signs of germination. Reduced germination energy, speed or uniformity.

4. Greater susceptibility to colonisation by relatively harmless saprophytic organisms.

5. Slow and abnormal growth of resultant seedlings.

6. Low yield.

It should be noted that all these, storage vigour (1), germination vigour (2, 3), microbial resistance (4) and seedling vigour (5,6) may be affected before germination percentage declines.

The importance of vigour

There is ample evidence to show that vigour in its many aspects is of considerable importance to the field establishment of seeds. The difficulty of carrying out and interpreting vigour tests has led to the current situation. The advent of precision seed drilling, the high costs of seed, and propagation, the demand for plants closely controlled for size and the control of size by population density, the advent of drilling seed by number, all required seeds that germinate reliably and virtually simultaneously and produce strong growing seedlings.

Research

Research into meaningful seed tests, including correlations between tests and reality with special reference to seedling establishment and seedling growth rate in the field is necessary. These investigations should include causes of failure for seeds to emerge.

It cannot be over-emphasized that there are always two sides to the problem - the quality of the seed and the quality of the environment, which are never mutually replaceable and must be complementary. Ultimately it is always the weakest link in the complex chain of crop establishment that is the vital one.

Assessment Plots

In conjunction with laboratory information the data collected from assessment plots over a number of years can be used as a guide on the field performance of seed of known quality at a given location. This historical record of seed germination and growth will enable the nursery manager to relate laboratory data to field emergence and growth. The performance of seedlots can then be predicted more accurately and techniques can be adjusted to obtain optimum seedlings yields.

Assessment plots can be established at the time of sowing. These plots should be examined three to four times during the germination period and two to four times for the inventory of the growing stock.

Establishment of Plots

The plots are to be randomly located prior to planting and be established immediately after sowing.

To install the plots, the location should be fixed after sowing and before seed covering. The 100cm x 135cm frame is dropped at right angles to the bed and markers should be inserted at the corners. All borderline seeds should be removed in or out so that there is no discrepancy during germination counts. The seeds should be counted, recorded and then receive the same mulching as the rest of the bed.

Records

At least 4 germination counts should be made in the first 50 days after installation of the plots. The count should be made between the 10th and 30th day and a final close examination at the end of germination.

During counts any dead seedlings should be examined and the cause of death noted. These dead seedlings should be added to all subsequent counts so that total germination is shown.

For the inventory the 135 x 100cm frame is placed over the bed twice so that its corners touch markers 200cm apart. The effective assessment plot is therefore 135cm x 200cm in area. Seedlings should be counted and classified.

Intensity of Sampling

A 5% accuracy is suggested at this stage. At a seedling production of 6 million plants, this would give an accuracy of 300,000 plants.

To determine the number of plants required to obtain a 5% accuracy one needs to look at previous assessments and calculate the standard deviation. The number of plots for the germination phase may be about one quarter of the number required for the survival and growth phases. Variation during these latter phases are usually much higher, but may eventually decrease as techniques, management and experience improve.

Summary

Inventories can be used to provide accurate information on the size and quality of the current growing stock and the effect of seed quality, pests, cultural techniques and climatic conditions on the germination and growth of seedlings.

Attempts to obtain standard populations from the calculation of seedling rate based on germination tests have always been frustrated because field emergence was unrelated to laboratory germination. Seed vigour is discussed at some length with reference to its causes and manifestations.

Data collected at the nursery over a number of years may be more accurately related to actual seed quality as determined in the laboratory. Seedling rates and other treatments can then be adjusted accordingly to maximize yields and profitability per unit area.

An assessment technique is proposed for McGeary nursery to achieve the outlined objectives. A 5% level of accuracy is recommended with four germination counts and several growing stock counts.

Randomization of Plots

Divide nursery beds into groups of four (4) beds. Calculate total length of these four beds and number of plots required for a x % assessment. Plots are 100cm wide across the bed.

e.g.	Bed 5	100 metres
	Bed 6	100 metres
	Bed 7	100 metres
	Bed 8	100 metres
	TOTAL:	400 metres.

A 1.0% assessment of 200 metres length of bed is 1 plot (2.0 metres in length).

Location and Marking of Plots

1. Plots are located at random on paper.

   Information required is:

   (a) Plot number
   (b) Bed Number
   (c) Distance of plot from both ends of bed

2. Rows should be clearly numbered in the field at both ends.

3. By survey (50m tape) roughly mark position of plots in beds.

4. Permanently mark location with steel peg and labelled marker.

TECHNICAL PERSONNEL

Diagnostic Feature	Individual	Organisation
Fungal Disease	Dr Elaine Davidson	CALM
Tissue and Soil Sampling	Dr John McGrath	CALM
Insect Control	Mr Stewart Learmonth	Dept of Agriculture (Manjimup)
Nursery Technique	Mr Simon Penfold	CALM
Equipment Supplies	Mr David Benson	Australian Forest Supplies (Vic.)
	Mr Tim Parker	Plix Packaging (NZ)
Nursery Contractors	Mr Ken Blakers	Horticultural Management (WA)
Chemical Supplies	Mr Peter Barnesby	CSBP (WA) ELDERS (WA)

COMMON WEEDS IN SEEDLING CROPS

COMMON NAME	BOTANICAL NAME
Grass weeds	
Barley grass	Hordeum leporinum Link
Barnyard grass	Echinochloa crus-galli Beauv.
Crowsfoot grass	Eleusine indica gaertn.
Johnson grass	Sorghum halepense Pers.
Liverseed grass	Urochloa panicoides Beauv.
Love grass	Eragrostis spp.
Native millet	Panicum decompositum R.Br.
Pigeon grass	Setaria spp.
Quack grass	Agropyron repens Beauv.
Rhodes grass	Chloris gayana Kunth
Silver grass	Vulpia bromoides (L) S.F. Gray
Stink grass	Eragrostis cilianensis (All.) Link
Summer grass	Digitaria sanguinalis (L.)Scop.
Wild oat	Avena fatua L.
Wimmera ryegrass	Lolium rigidum Gaud.
Winter grass	Poa annua L.
Clubrush	Scirpus spp.
Nutgrass	Cyperus rotundus L.
Toad rush	Juncus bufonius L.

COMMON NAME	BOTANICAL NAME
Broadleaved	
Bathurst burr	Xanthium spinosum L.
Bindweed (black)	Polygonum convolvulus L.
Cape-weed	Arctotheca calendula Druce
Chickweed	Stellaria media Vill.
Chickweek (Mouse-ear)	Cerastium viscosum L.
Cleavers	Galium aparine L.
Clover	Trifolium spp.
Cotula	Cotula australis (Les.)Hook f.
Corn spurry	Spergula arvensis L.
Cudweeds	Gnaphalium spp.
Deadnettle	Lamium amplexicaule L.
Dock	Rumex spp.
Fathen	Chenopodium album L.
Fumitory	Fumaria spp.
Goosefoot (Clammy)	Chenopodium pumilio
Heliotrope (common)	Heliotropium europaeum L.
Hoary cress	Cardaria draba (L.) Desv.
Innocent weed	Cenchrus tribuloides L.
Indian hedge mustard	Sisymbrium orientale L.
Loosestrife	Lythrum flexuosum
Marshmallow	Malva parviflora L.
Noogoora burr	Xanthium pungens Wallr.
Nettle	Urtica urens L.

Broadleaved weeds (cont'd.)

Nightshade (black-berry)	Solanum nigrum L. sens lat.
Persicaria	Polygonum persicaria L.
Pigweed	Portulaca oleracea L.
Poppy	Papaver spp.
Potato-weed	Galinsoga parviflora Cav.
Prince of Wales feather	Amaranthus hybridus L.
Ribwort	Plantago lanceolata L.
Saffron thistle	Carthamus lanatus L.
Shepherds purse	Capsella bursa-pastoris (L.) Medic.
Sorrel	Rumex acetosella L.
Sowthistle (Common)	Sonchus oleraceus L.
Stagger-weed	Stachys arvensis L.
Storksbill	Erodium spp.
Swinecress (Lesser)	Coronopus didymus Sm.
Thornapple	Datura stramonium L.
Variegated thistle	Silybum marianum Gaertn.
Virginian peppercress	Lepdium virginicum L.
Wild radish	Raphanus raphanistrum L.
Wireweed (Hogweed)	Polygonum aviculare L.

BOOMSPRAY CALIBRATION AND MAINTENANCE

Calibration

To measure and calculate output per hectare, fill the tank to overflowing with water, then operate the spray unit over a strip 200 metres long which has been accurately measured with a tape. The ground speed of the tractor should be the same as the speed which will be used in spraying the crops (about 5km p.h.). Note the gear and throttle setting or tachometer reading. After spraying 200 metres, measure the amount of water used by either re-filling the tank or checking the level with a calibrated dip stick. A gauge on the side of the tank is ideal.

The output per hectare can now be calculated from this equation:

Equation 1

$$\frac{\text{Litres used} \times 50}{\text{Boom width in metres}} = \text{output in litres per hectare}$$

For example, if a boom is 5m wide and puts out 45 litres over 200 metres then -

$$\text{Output} = \frac{45 \times 50}{5} = 450 \text{ litres a hectare}$$

The amount of herbicide required for one tank of spray mixture can then be calculated from the following equation:

Equation 2

$$\frac{\text{Tank capacity (litres)}}{\text{Output (Litres per hectare}} \times \begin{array}{l}\text{Litres or kilograms of herbicide required per hectare of crop (C)}\end{array} = \begin{array}{l}\text{Litres or kilograms of herbicide required for one tank}\end{array}$$

For example, if the spray unit has a tank of 225 litres capacity and the output of 450 litres per hectare, than if 2 litres of herbicide are to be used per hectare -

$$\frac{\text{225 litres (tank capacity)}}{\text{450 litres per hectare}} \times \begin{array}{l}\text{2 litres per hectare of crop}\end{array} = \begin{array}{l}\text{1 litre per tank}\end{array}$$

Strip spraying

Some growers cultivate between rows and spray a strip over the row. This requires extremely accurate calibration of the spray unit, and the exact width of the sprayed strip must be known. The application rate now becomes the quantity per hectare sprayed rather than hectare of crop, and further calculations are necessary:

Equation

Width of strip sprayed / Distance between drill rows	x	litres of herbicide required per hectare of crop (C)	=	litres of herbicide required for strip sprayed (S) a hectare of crop

For example, if a 130mm strip is sprayed in a crop sown in rows 390mm apart then -

130mm strip sprayed / 390mm between rows x 2 litres (C) = 2/3 litre a (S) hectare

Substitute S for C in equation 2, for strip spraying to give the amount of herbicide to add to the tank.

Operation of spray units

Keep the tractor speed constant. Output through the spray jets is governed by the quantity of spray delivered by the pump, so, if even distribution is to be obtained over an area, a constant ground speed must be maintained. Check pressure from time to time. Watch out for blocked nozzles and clear them immediately. Is the agitator system or re-cycle system working correctly?

Periodically check and clean line strainers and sediment bowls.

Do not stop the tractor in the crop with the spray unit in operation.

Make sure that a sufficient volume of spray is returned to the tank to maintain agitation.

Do not overlap rows as this will double the application rate.

Spray maintenance

The pump:

1. Fill grease cups and use grease guns on all nipples before use.

2. Regrease every four hours.

3. After spraying, drain the tank and pump through at least 45 litres of clean water to flush pump units.

Vat and hoses:

1. Check all hose connections for tightness.

2. Inspect for leaks in the hose line.

3. Fill only through the strainer provided on top of tank to ensure that no solids enter to block either the pump or jets.

Boom:

1. Check all hose connections and clips to tightness.

2. Inspect hoses for wear, cracks and fatigue. Replace promptly where required.

3. All swivels should be positioned to suit the particular spraying operation, and locked in position to ensure that there are no leaks.

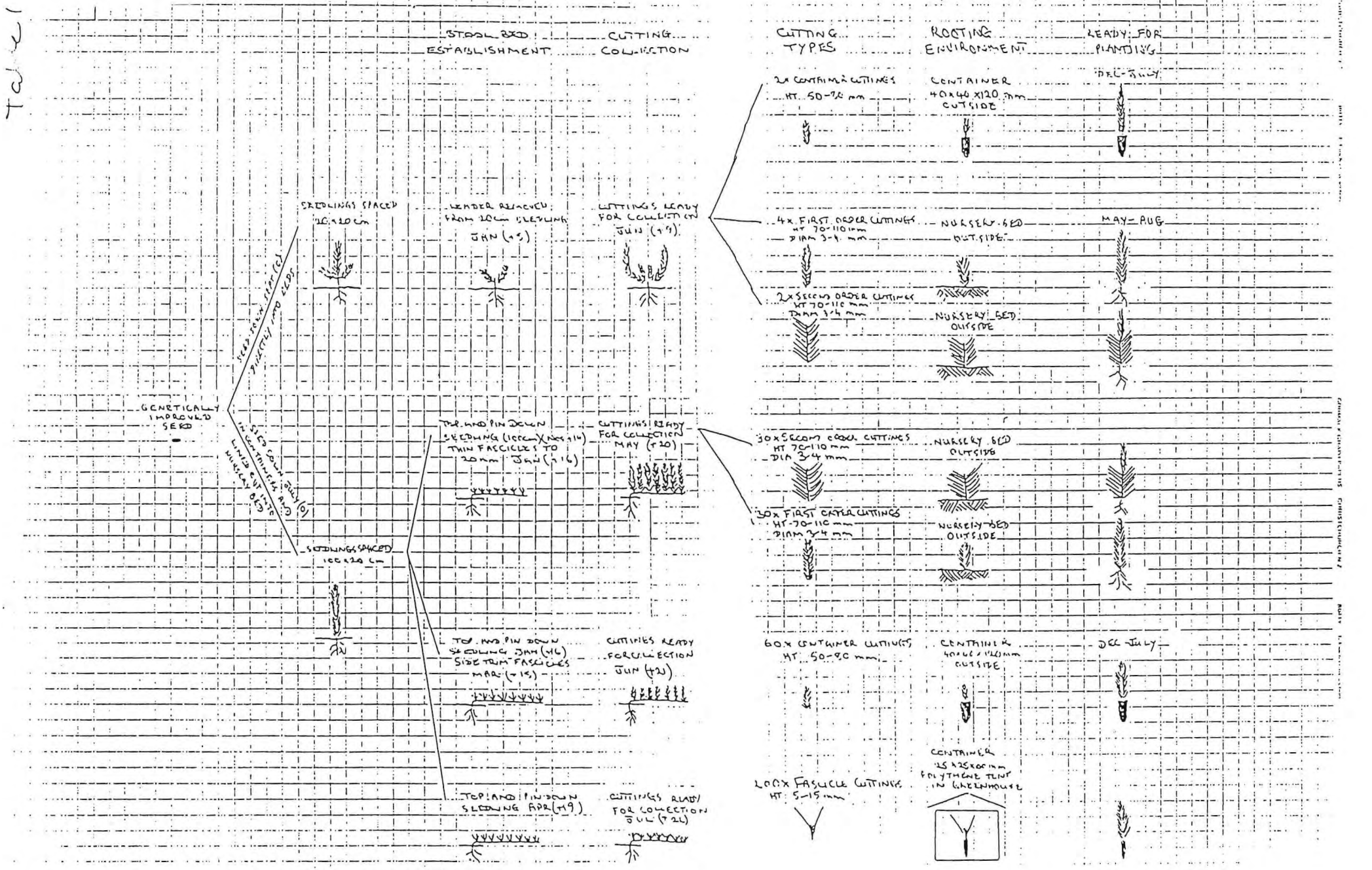
4. Check jets for blockages and clear them by reversing the jets. Never put jets in your mouth to clear a blockage. Always clear them by pumping water through the jet or by a blast of air from a compressor if available. In the field, a sharpened match stick will free small blockages. Metal probes damage jets.

5. The strainer in the master filter assembly should be removed and cleared after each spraying period.

6. Strainers in the jet bodies should be removed and cleaned with an old tooth brush or other suitable brush every month.

7. All adjusting screws to have one or two drops of oil regularly.

8. Jets should be replaced annually for general spraying and a new set kept for herbicide application only. If possible, reserve one spray unit for insecticides and fungicides and another for herbicides. Never use spray machines in vegetable crops which have been used for spray hormone-type herbicides such as 2, 4-D or 2,4,5-T.

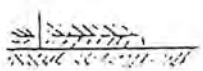

STOOL BED ESTABLISHMENT
CUTTING COLLECTION
CUTTING TYPES
ROOTING ENVIRONMENT
READY FOR PLANTING
GENETICALLY IMPROVED SEED
SEEDLINGS SPACED 10 x 20 cm
SEEDLINGS SPACED 10 x 20 cm
SEED SOWN SPARSELY IN WELL PREPARED NURSERY BED
SEED SOWN EVENLY IN WELL PREPARED NURSERY BED
LEADER REMOVED FROM 20cm SEEDLING JAN (+5)
TOP AND PIN DOWN SEEDLING (10cm x 10cm) THIN FASCICLES TO 20mm JAN (+16)
TOP AND PIN DOWN SEEDLING JAN (+16) SIDE TRIM FASCICLES MAR (+15)
TOP AND PIN DOWN SEEDLING APR (+9)
CUTTINGS READY FOR COLLECTION JUN (+3)
CUTTINGS READY FOR COLLECTION MAY (+20)
CUTTINGS READY FOR COLLECTION JUN (+2)
CUTTINGS READY FOR COLLECTION JUL (+2)
2x CONTAINER CUTTINGS HT 50-70 mm
CONTAINER 40x40 X120 mm OUTSIDE
DEC-JULY
4x FIRST ORDER CUTTINGS HT 70-110 mm DIAM 3-4 mm
2x SECOND ORDER CUTTINGS HT 70-110 mm DIAM 3-4 mm
NURSERY BED OUTSIDE
MAY-AUG
30x SECOND ORDER CUTTINGS HT 70-110 mm DIA 3-4 mm
30x FIRST ORDER CUTTINGS HT 70-110 mm DIAM 3-4 mm
NURSERY BED OUTSIDE
60x CONTAINER CUTTINGS HT 50-90 mm
CONTAINER 40x60 / 120mm OUTSIDE
DEC-JULY
CONTAINER 25 x 25 x 60 mm POLYTHENE TENT IN GREENHOUSE
100x FASCICLE CUTTINGS HT 5-15 mm

PINNED DOWN STOOL

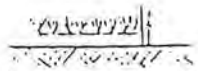
Sow seed in containers in glasshouse

Move containers outside

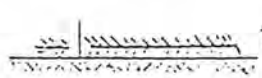
Line out into a prepared nursery bed 20 cm x 75 cm spacing



Top and pin down



Harvest: remove stem with developed fascicles

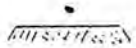


Top and pin down Harvest

TIME SCALE (MONTHS)

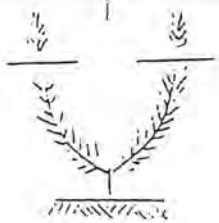
0 SEPT 1 2 3 4 JAN OR FEB 5 6 7 8 9 10

MULTI LEADERED STOOL

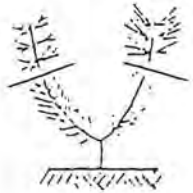


Sow seed in a prepared nursery bed 15 cm x 15 cm spacing

Remove the leader to make a multi-leadered tree



Remove the top of each leader

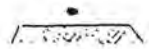


Harvest

TIME SCALE (MONTHS)

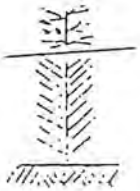
0 SEPT 1 2 3 4 5 6 7 8 MAY 9 10 JULY

SINGLE LEADERED STOOL



Sow seed in a prepared nursery bed 20 cm x 8 cm spacing

Remove the top



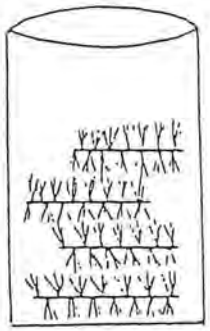
Harvest

A HARVESTING

(1) Remove the stem with developed fascicle buds.

(2) Place in a polythene bag (keep wet).

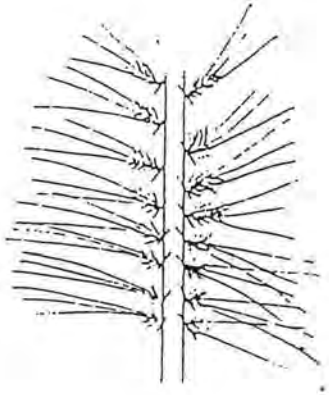
(3) Place in bag in coolstore (4°C for 2-48 hours).

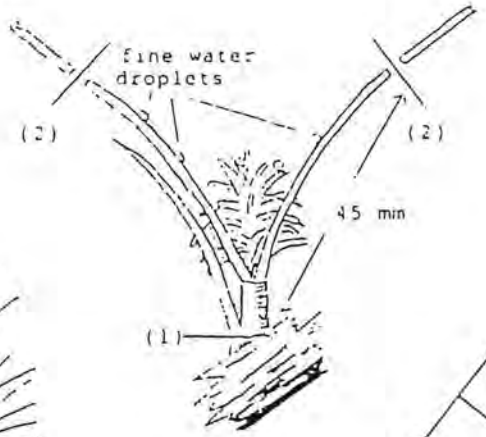


B TRIMMING

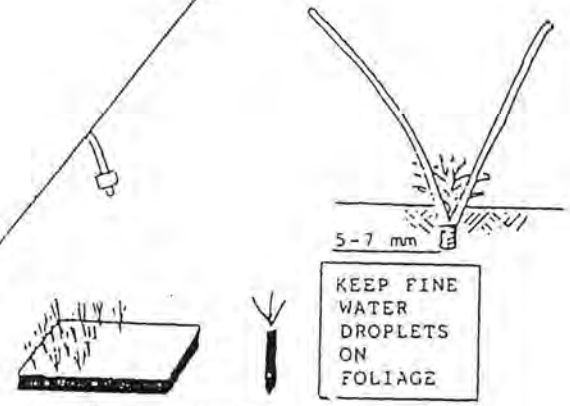
(1) Cut developed fascicle buds off the harvested stem into a bowl of water.

(2) Trim the fascicles' needles to 45 mm.





C SETTING

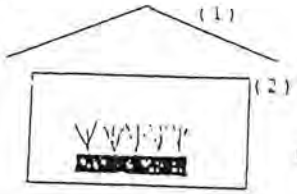


POTTING MIX	FERTILISER
2 Peat 5 mm 1 Pumice sieve 1 Perlite	MAGAMP* 500 g/m^3

*Magnesium ammonium potassium phosphate

7:17:5:12 (Mg)

D ROOTING ENVIRONMENT

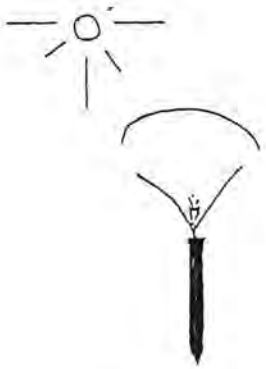


(1) Glasshouse
Night 16°C
Day 25°C

(2) Polythene tent
Night 16°C
Day 25-27°C
90-95% R.H.

Shade and water cooling of frame may be needed.

ROOTING IN 6 - 10 WEEKS

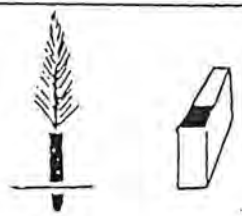


Shade for 3 weeks

Containers of rooted cuttings are hardened off (cuttings getting used to outside conditions)

CUTTINGS SUBSIST UNTIL FOLLOWING SPRING WITH MINIMUM NUTRIENTS - OCCASIONAL FOLIAR FEED TO MAINTAIN CONDITION

Apply liquid fertiliser until 20-25 cm tall, then fertilise to maintain health only



Trim the base of the soil plug off before packing

Dispatch to forest

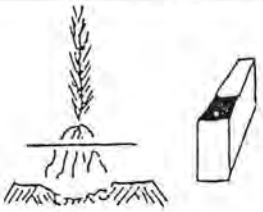
SPRING YEAR 1

WINTER YEAR 1

Shade for 3 weeks after transplanting

Cutting removed from container; base trimmed; transplanted into nursery bed

Fertilise and condition by undercutting, wrenching and lateral pruning



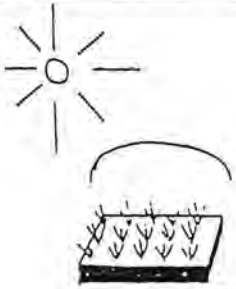
Lift and trim roots before planting

Dispatch to forest

SPRING YEAR 0

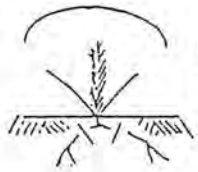
SPRING YEAR 1

WINTER YEAR 1



Shade for 3 weeks

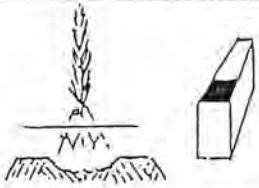
Trays of rooted cuttings are hardened off



Shade for 3 weeks after transplanting

Cutting removed from tray; bare rooted cuttings' roots trimmed; transplanted into nursery bed

Fertilise and condition - see above - as required



Lift and trim roots before packing

Dispatch to forest