

IMPACT OF CLAY DIPPING AND NURSERY HANDLING  
PROCEDURES ON FIELD GROWTH AND SURVIVAL  
OF HONDURAS CARIBBEAN PINE.

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Abstract. A number of handling factors associated with the nursery - field interface of a bare-root Honduras Caribbean pine silvicultural system were studied. Root damage during the lifting operation was shown to have an important effect on field survival and subsequent growth to 24 months. Survival was also affected by exposure of unprotected roots to either shaded or sunny conditions. The use of a clay slurry root dip greatly reduced losses due to the effects of exposure and harsh lifting.

Additional keywords: Root exposure, lifting technique, Pinus caribaea var. hondurensis, P. elliottii.

INTRODUCTION

The importance of producing good quality pine seedlings for bare-root planting has been widely recognised (Napier 1980). The many factors which influence seedling quality may be conveniently segregated into those associated with the "cultural" phase and those associated with the "handling" phase which occurs between lifting from the nursery bed and planting in the field. Problems associated with the cultural phase are often reflected in the visual appearance of plants at the time of lifting and it is possible to improve greatly the performance of planting stock by culling of affected plants at this stage (Shea and Armstrong 1978). Deterioration in quality during the handling phase is not usually manifested by visual symptoms, however, and it is therefore important to monitor handling procedures closely to ensure that stock of apparently good quality will yield satisfactory performance in the field.

Root exposure is the most commonly reported problem associated with the handling of bare-root pines. Wakeley (1954) reported the adverse impact of prolonged exposure on the survival of bare-root slash pine (Pinus elliottii Engelm.) and Slocum and Maki (1956) confirmed a similar trend for loblolly pine (Pinus taeda L.). Barres (1965), working with Honduras Caribbean pine (Pinus caribaea Mor. var. hondurensis Barr. et Golf.) raised under hydroponic conditions, found that exposure of roots for more than 20 minutes resulted in significantly increased mortality while exposure for more than 5 minutes resulted in reduced growth of the survivors.

Root damage during the lifting operation is another important handling factor. Marrero (1965) demonstrated the importance of minimum root damage in the establishment of bare-root Honduras Caribbean pine while Trewin (1981) found that the growth and survival of radiata pine (Pinus radiata D. Don) improved as the level of root damage during lifting was lowered. The interaction between root damage and exposure does not appear to have been reported.

The ability of clay slurry root dips to ameliorate the effects of adverse handling practices has been reported by a number of researchers (Slocum and Maki 1956, Brown 1969, Bacon and Hawkins 1977).

While it is apparent from these studies that there are a number of handling factors which have an impact on the field performance of bare-rooted pines, it is important to define the relative importance of each so that nursery and field managers, when evaluating operational procedures, may concentrate their energies in the areas which will produce the greatest returns.

In southern Queensland an operationally satisfactory winter planting technique for bare-root Honduras Caribbean pine has been developed, involving intensive root wrenching (3-4 weekly), clay slurry dipping, transport to the field in covered steel trailers and machine planting within one day of lifting. Average survival generally exceeds 85% with this technique but occasionally losses may be more than 50% over significant areas, thus necessitating expensive and often unsuccessful refilling operations. Such losses are frequently blamed on excessive exposure of the roots between lifting and planting.

All nursery stock is hand lifted with excess soil being shaken from the roots before immersion in the clay slurry dip. The nature of the lifting/dipping/planting operation is such that roots are exposed to the atmosphere for varying periods of time between lifting and dipping and between dipping and planting. During peak planting periods when large number of stock are handled in the nursery, exposure periods may occasionally be lengthy. Exposure between lifting and dipping is generally in full sunshine and may be up to 10 minutes. Cumulative exposure between the dipping and planting operations may be up to one hour, although it is usually much less. Such exposure is predominantly under shade.

In order to determine the relative importance of these handling factors, a trial was carried out in 1982 in which the effects of sun and shaded exposure, clay dipping, and lifting technique on the survival and growth of bare-root Honduras Caribbean pine stock raised under prevailing operational nursery procedures were investigated.

#### MATERIALS AND METHOD

Seedlings were selected from routine Honduras Caribbean pine stock in the Queensland Forestry Departments' Toolara nursery. The plants, which originated from sowings in August 1981, were subjected to root wrenching at 3-4 weekly intervals after they attained a height of 15 cm. Beds were watered 2½ days before lifting in accordance with routine practice and a 'lifting bar' was passed under the plants to loosen the soil prior to initiation of the hand lifting operation on 28 June 1982.

A factorial layout with three replications of each of the following treatments in a randomised complete block design was adopted:

1. Lifting technique
  - Gentle lifting; plants lifted in bundles and gently shaken to remove excess soil.
  - Harsh lifting; plants lifted individually and roots hit against lifter's boot to remove soil.
2. Clay slurry dipping
  - Dip in clay slurry (0.8 kg clay/litre water).
  - Not dipped.
3. Exposure following lifting
  - Exposure to sunlight for 10 minutes immediately following lifting (before dipping where applicable).
  - Not exposed.
4. Exposure prior to planting
  - 75 minutes root exposure under shade.
  - 45 minutes root exposure under shade.
  - Not exposed.

Under the gentle lifting technique, white rootlets, small root hairs and most mycorrhizae remained intact. Some soil was left adhering to roots. The harsh lifting technique involved hitting each plant three times against the lifter's boot. All soil, as well as the small root hairs, was removed.

All nursery operations were carefully randomised to insure against changes in weather conditions during the lifting and initial exposure operation which extended from 10.15 am to 1.48 pm.

Clay dipping and/or 10 minutes exposure was carried out where required beside the nursery beds. Plants were packed into plastic bags and stored in cardboard cartons under cool conditions overnight.

Weather conditions at the nursery were fine and sunny with an air temperature of 19.0°C at mid-day and an average wind speed of around 5 km/hour. Relative humidity was 34%.

Field planting operations commenced at 9.45 am on the day following lifting and were completed at 1.55 pm. Once again, all procedures were carefully randomised. The specified period of shaded exposure was completed immediately prior to machine planting into 50 tree line plots. Weather was fine and sunny with an air temperature of 18°C at mid-day and an average wind speed of 20 km/hour. Relative humidity was 54%.

The planting site was a well drained, cleared and ploughed yellow earth with a sandy loam texture. Soil moisture conditions were good following a total of 52.8 mm of rain in the four weeks preceding planting. A further 35.4 mm fell in the four weeks after planting.

Survival and height was assessed at 6, 14 and 24 months after planting and the total green mass of 10 stems from each line plots was measured at 24 months. Only the 24 month results are presented in this paper.

## RESULTS

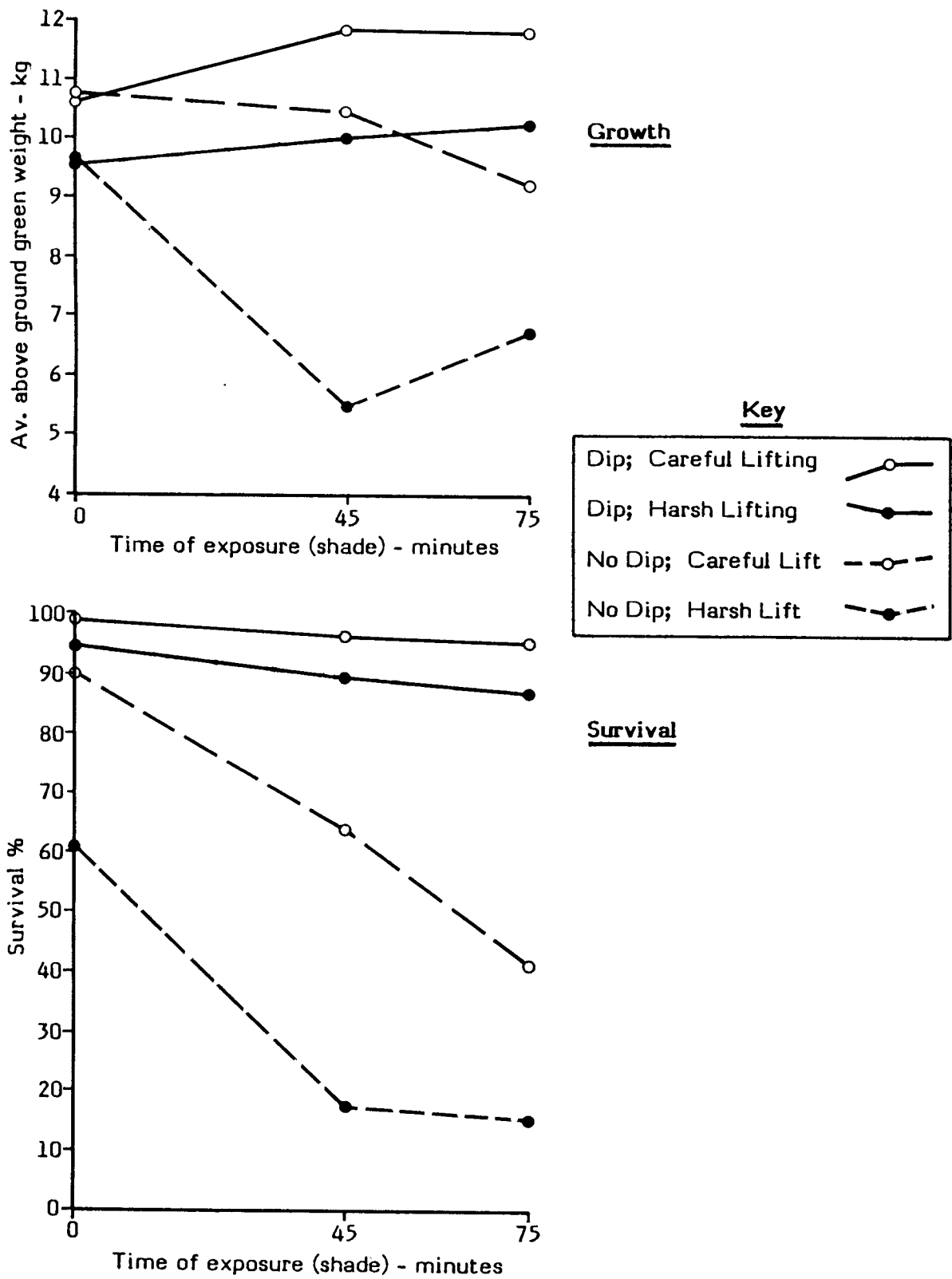
Analysis of variance revealed that all treatments significantly affected survival of the pine at age 24 months. Significant interactions were found between the lifting and clay dipping treatments and between the dipping and shade exposure treatments. Results are summarised in Table 1.

A similar analysis of average green mass at age 24 months revealed that only the lifting and dipping treatments significantly affected this parameter, although the shade exposure x dipping interaction was also found to be significant. Results are summarised in Table 2.

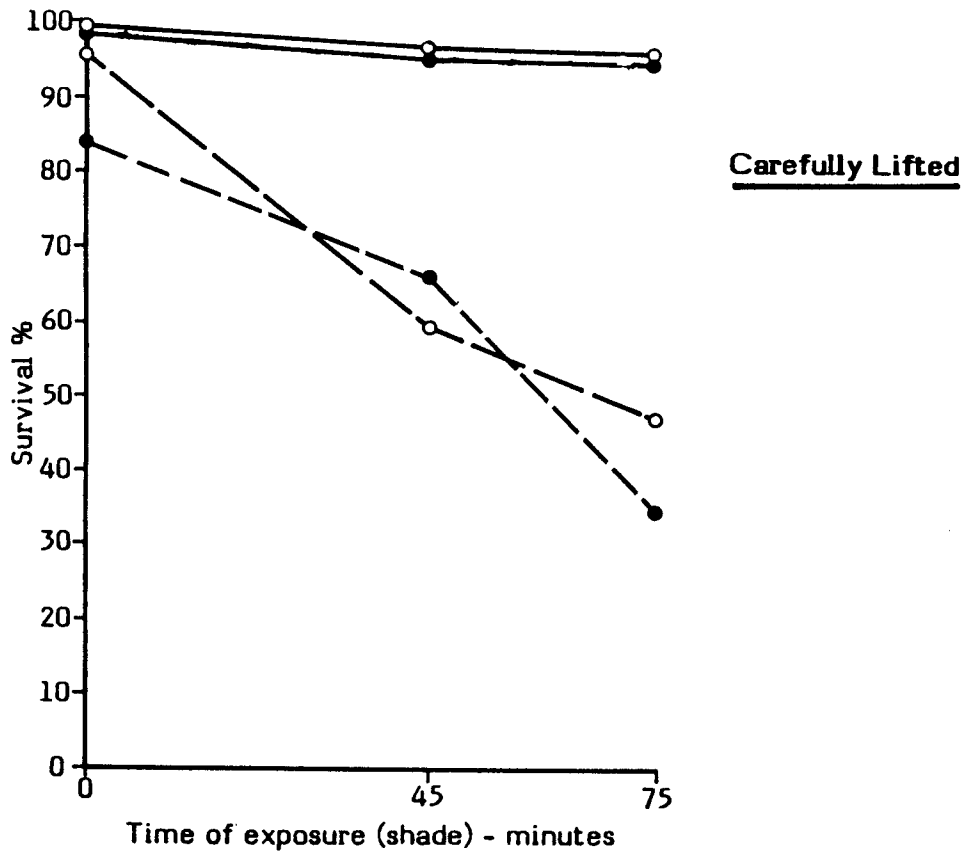
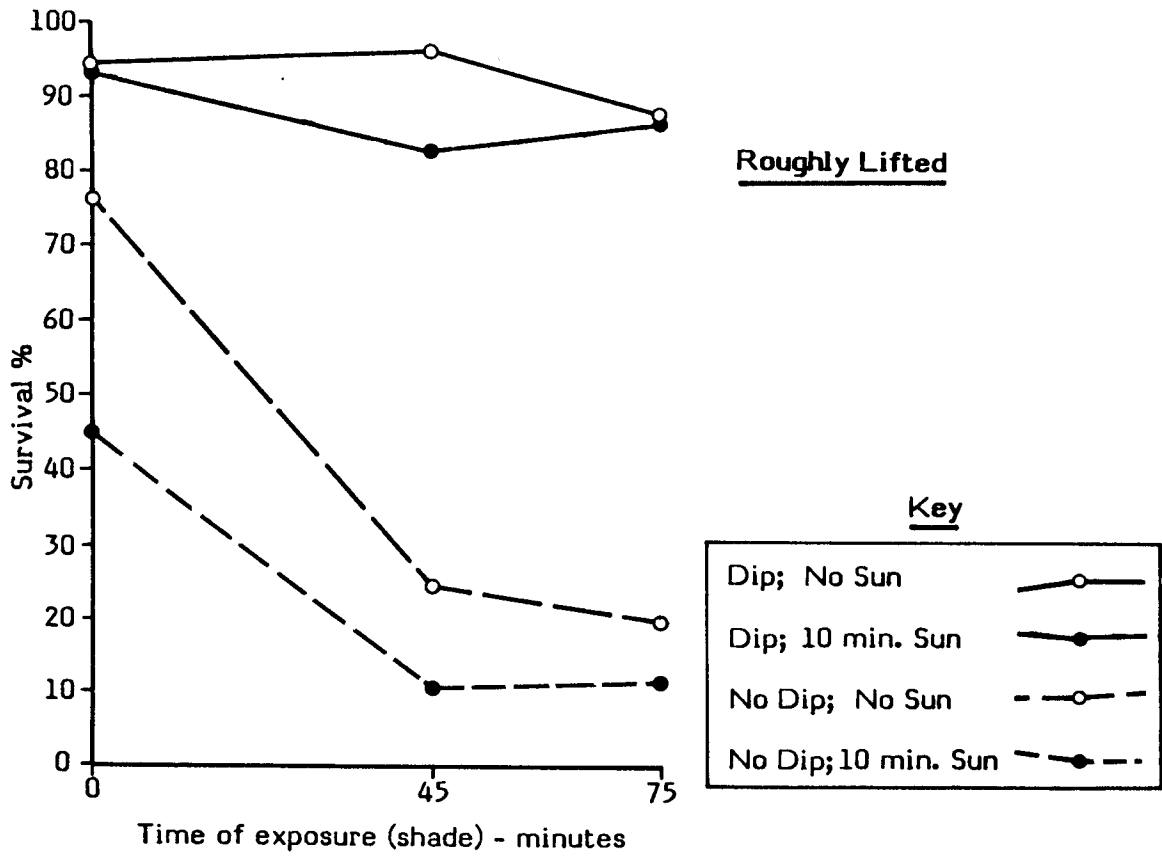
The more important trends identified in the trial at age 24 months are displayed in Figures 1 and 2.

Table 1. Effect of handling procedures on the survival of bare-root Honduras Caribbean pine at age 24 months.

Treatment		Survival %	L.S.D. 5%	
Main effects:				
Lift -	gentle	80.7	***	
	harsh	60.6	8.0	
Dip -	yes	93.3	***	
	no	48.0	6.6	
Sun exposure -	nil	74.4	*	
	10 min.	66.9	6.6	
Shade exposure -	nil	85.9		
	45 min.	66.4	***	
	75 min.	59.6	8.1	
Interactions:				
Clay dipping		Dip	No dip	
Lift -	gentle	96.6	64.7	***
	harsh	89.9	31.2	9.3
Shade exposure -	nil	96.6	75.3	
	45 min.	92.5	40.3	***
	75 min.	90.8	28.3	11.4



**Figure 1:** Impact of lifting technique, exposure and clay slurry dipping on growth and survival of Honduras Caribbean pine at age two years.



**Figure 2:** Effect of clay dipping and exposure on survival of roughly lifted and carefully lifted Honduras Caribbean pine plants at age two years.

Table 2. Effect of handling procedures on average above ground green weight at age 24 months.

Treatment		Green wt. kg	L.S.D. 5%
Main effects:			
Lift -	gentle	10.79	***
	harsh	8.60	1.18
Dip -	yes	10.68	***
	no	8.71	0.97
Interaction:			
Clay dipping		Dip	No Dip
Shade exposure -	nil	10.06	10.21
	45 min.	10.94	7.96
	75 min.	11.03	7.95
			*
			1.67

## DISCUSSION

### Survival

This trial has clearly demonstrated the adverse impact of less than ideal handling procedures on the field survival of bare-root Honduras Caribbean pine. It is apparent that root damage during lifting, or failure to provide protection from exposure, can result in substantial losses under conditions such as those encountered in the trial. Given the better than average soil moisture conditions prevailing and the fact that stock was adequately conditioned and machine planted, it is unlikely that better performance would be obtained in any 'normal' planting season for this geographic region.

The most interesting feature of the study is the interaction between the presence or absence of clay dipping and the survival obtained under the progressively harsher lifting and exposure treatments. The interaction section of Table 1 shows that, where dipping was carried out, survival of the pine was not significantly affected by either the harsh and damaging lifting operation or by root exposure for up to 75 minutes. The average survival of 93.3% for dipped plants falls to 48.0% for the mean of all undipped treatments. Within the undipped treatments, survival falls to less than 12% under the combined effects of harsh lifting, 10 minutes exposure to sunlight and more than 45 minutes shaded exposure (Figure 2). Where gentle lifting was employed and no exposure was permitted, however, a survival rate of 95.9% was achieved with undipped plants (Figure 2) and this is not significantly different from the performance of the best of the dipped treatments.

Under the conditions of this trial, it is apparent that root dipping is unnecessary so long as all handling factors are optimum. Any deterioration in handling practice, however, results in an immediate and substantial reduction in field survival rate.

## Growth

The harsh lifting technique, with its high level of root damage, consistently depressed the growth of those plants which survived to age 24 months. As expected, loss of fine roots during the harsh lifting operation resulted in poor growth performance, irrespective of whether the roots were dipped in clay slurry. Dipping resulted in improved growth performance, however, where exposure of 45 minutes or more took place (Figure 1).

Root exposure to sunlight for 10 minutes after lifting had no effect on subsequent field growth, although the same treatment significantly reduced survival.

## Management Implications

The results obtained in this trial are not unexpected. Field and nursery managers are generally aware of the adverse effects of poor handling practices on survival of bare-root pine plants. They may not be as aware of the relative importance of the various handling factors and it is in this area that the work reported has relevance to the development and implementation of operational prescriptions, particularly those covering the nursery-field interface.

While root exposure has long been considered to be one of the major factors affecting field survival of bare-root pines, it is apparent from this study that root damage caused by harsh lifting techniques is at least as serious as lengthy exposure in its effect on survival of Honduras Caribbean pine.

All plants in the trial were hand lifted but, given the mode of operation of mechanised belt lifters, which remove plants individually and rapidly from the ground. the question of similarity between harsh hand lifting and belt lifting must be raised. While belt lifters integrate well with packaging systems, thus minimising exposure times, the gains achieved through reduced exposure may be lost through increased root damage levels.

It is also relevant that, under the conditions reported, exposure up to 75 minutes has no effect on field growth to 24 months, so long as roots are protected by a clay slurry dip. Harsh lifting, such as that which may occur with a machine, however, results in reduced field growth, irrespective of the application of a root dip.

The importance of a clay slurry dip in the prevention of field losses following the exposure or damage of roots is clearly demonstrated.

## CONCLUSIONS

Under average or better than average seasonal conditions in south east Queensland, a number of factors associated with the handling of 'conditioned', bare-root Honduras Caribbean pine seedlings will strongly affect field survival and, to a lesser extent, field growth.



Root exposure and root damage at the time of lifting will reduce survival and the effects appear to be additive. Exposure to sunlight for 10 minutes reduces field survival by around 7% and this figure rises to 26% for 75 minutes exposure under shaded conditions.

Harsh lifting with its associated root damage reduced field survival by an average 20%, as well as having a similar depressive effect on early growth of the surviving plants.

Root dipping in a clay slurry mixture will greatly reduce the impact of poor handling on field survival, although it will not eliminate the growth losses due to poor lifting technique.

In this study a more than satisfactory field survival of close to 100% was obtained under the best combination of handling procedures. This figure fell to a clearly unsatisfactory 11% under the worst combination of these procedures involving harsh lifting followed by 10 minutes sun exposure and 75 minutes shade exposure without a clay slurry root dip.

Further work is required to determine if there is any adverse effect of mechanised belt lifting on plant growth and survival.

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