FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EVALUATION OF THE GROWTH AND ROOT MORPHOLOGY OF CONTAINER-GROWN CUTTINGS PRODUCED BY FORENZA

J. D. Tombleson & J. A. Turner

Report No. 60 May 1999

FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EXECUTIVE SUMMARY

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A trial to evaluate the growth and incidence of topple of container-grown radiata pine cuttings produced by Forenza was established in 1996 on an exposed, fertile, ex-farm site at Moonlight Forest, Gisborne. Bare-root cuttings and seedlings were also incorporated into the trial for comparison with the container-grown cuttings. In 1998 the two-year-old trees were excavated and the roots assessed. Results showed that the container-grown cuttings had a similar mean height and diameter to the bare-root seedlings but were significantly shorter (29 cm shorter) and had a significantly smaller average diameter at breast height (6.1 mm smaller) compared with the bare-root cuttings. The container-grown cuttings had the least percentage of topple (6.3%) compared to the bare-root cuttings (8.8%) and seedlings (17.5%) although the difference between the cutting stock types was not significant. The container-grown cuttings and bare-root seedlings had superior taproots compared to the bare-root cuttings, however, the lateral root distribution was similar for all three stock types. Container-grown cuttings also had a considerably lesser percentage of roots orientated at a horizontal angle or above (26.7%) compared to 45.3% and 45.7% for the bare-root cuttings and seedlings respectively. The container-grown and bare-root cuttings had a similar average number of sinkers of 5.2 and 5.1 respectively, but less than the bare-root seedlings which had an average of 7.4 sinkers. However, while the cuttings had fewer sinkers, their total basal area was significantly larger, with the container-grown cuttings having more than twice the sinker basal area of the bare-root

seedlings. Also the container-grown cuttings have a greater ratio of basal area of sinkers to root collar basal area than the bare-root seedlings.

Root morphology of the bare-root seedlings in the trial at Moonlight Forest was compared with conventional root-conditioned seedlings planted in toppling trials established at Ngaruawahia, Waihi and Feilding. Results showed that the bare-root seedlings grown at Moonlight Forest had similar taproot scores but poorer lateral root scores compared to the three other sites. The seedlings grown on the Moonlight Forest site had similar vertical root distribution scores to Ngaruawahia but were superior to trees grown at the Waihi and Feilding sites.

Wetter sites in Moonlight Forest were distinguished by a ground cover of Yorkshire fog grass (*Holcus lanatus*), which contrasted with drier sites of brown top grass (*Agrostis tenuis*) cover. The root morphology of container-grown cuttings and bare-root seedlings grown within the 'dry' soil of the Moonlight Forest trial was compared with the same plant types grown on 'wetter' soils outside the trial area. An assessment of the trees grown on the 'dry' soil showed that 7.8% of the roots were orientated above the horizontal angle compared to 38.7% for the trees grown on the 'wetter' soil. A comparison of taproot and lateral root scores between the 'dry' and 'wet' soils showed no differences.

TRIAL OBJECTIVES

1. The primary objective of the trial was to evaluate the growth, topple, and root morphology of container-grown cuttings, produced by Forenza Nursery, and compare them with bare-root cuttings and seedlings on an exposed ex-farm site.

2. To compare the root morphology of bare-root seedlings in the above trial with bare-root seedlings excavated from toppling trials established at Ngaruawahia, Waihi and Feilding.

3. To compare the root morphology of the container-grown cuttings and bare-root seedlings grown in the 'dry' soil of the Forenza trial with the same stock types grown outside the trial on a 'wetter' soil.

METHODS

Trial location & description

The Forenza trial was established by PF Olsen & Co Ltd staff in 1996 on an ex-farm site at Moonlight Forest, located adjacent to Mangatu Forest, Gisborne. The trial is situated on an exposed and steep hillside (see Figures 1 & 2) which face the prevailing westerly, northerly and north easterly winds.

Figure 1: Showing a general indication of the site type and terrain of the Forenza trial at Moonlight Forest. Trial boundaries are shown on the photograph

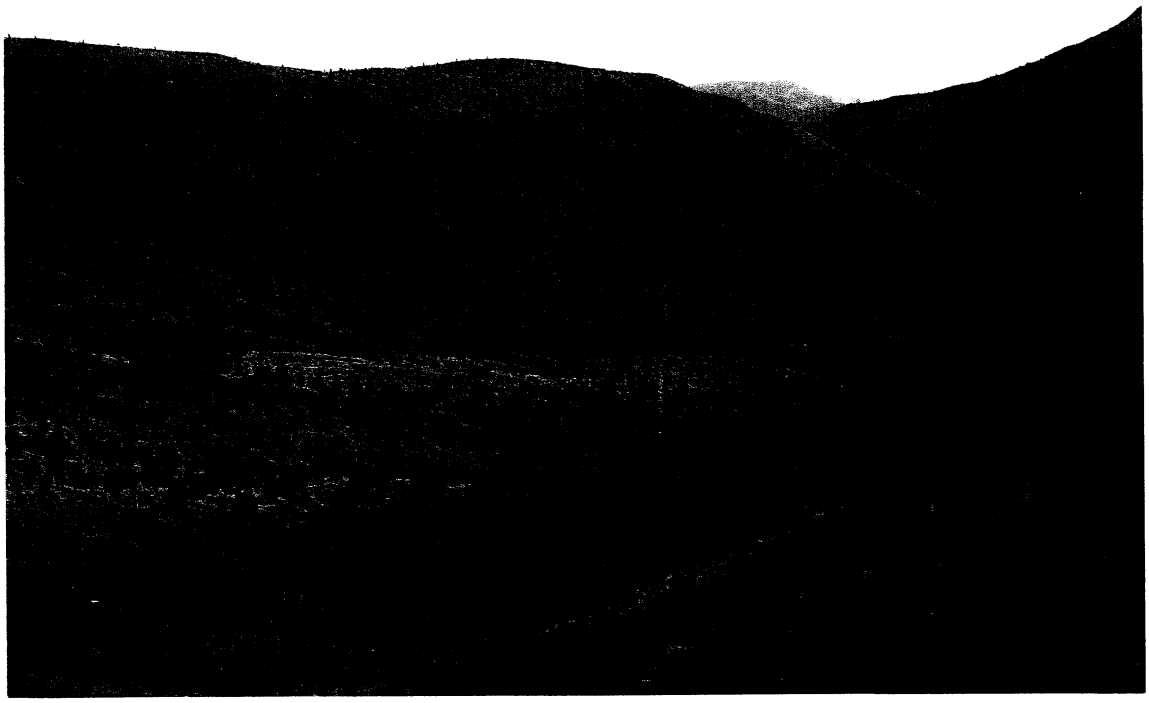
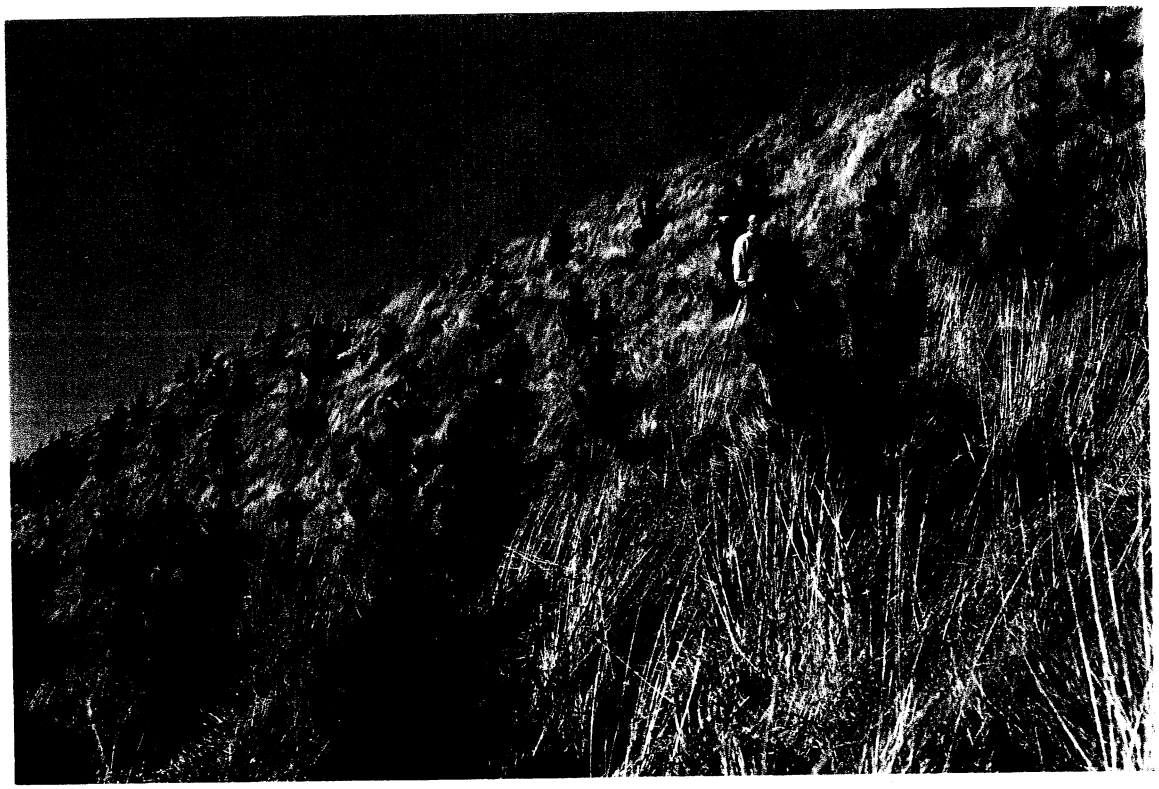


Figure 2: Showing a general indication of the steep and exposed slope of the Forenza trial located at Moonlight Forest.



Stock types

The following three stock types were evaluated:

1. Container-grown cuttings
2. Bare-root cuttings
3. Bare-root seedlings

The stock type used for the comparison with the toppling trials established at Ngaruawahia, Waihi and Feilding was conventionally nursery conditioned GF19 seedlings raised at the ***Forest Research*** Nursery.

The stock types used for comparison on the 'wet' soil outside of the Moonlight Forest trial were; container-grown cuttings (juvenile) GF28 and bare-root seedlings GF19 ex Puha Nursery.

Trial design

Each stock type was represented by a row plot of eight trees replicated 10 times. Trees were spaced 4 x 4m. Two of the replications were double planted at a spacing of 4 x 2 m (16 trees per row plot) to enable every alternate tree to be excavated.

Each of the Ngaruawahia, Waihi and Feilding toppling trials comprised 98 paired plots. Each plot comprised a conventionally root conditioned seedling and a severe lateral root trimmed seedling established at a spacing of 4 x 4 m. For comparative purposes in this study only the conventionally root trimmed seedlings were used. Details on the series of toppling trials used as a comparison in this study are contained in the Forest & Farm Plantation Management Cooperative Report Nos 44 and 53.

Rainfall Data

Total rainfall (mm) recorded at the closest meteorological station to each trial was obtained relating to the 25 month growing period (1 June 1996 to 30 June 1998) and presented in Table 1.

Table 1: Rainfall data for the 25 month growing period

Location	Total Rainfall (mm)
Gisborne	2 153[1]
Feilding	1 652[2]
Ngaruawahia	2 462[3]
Waihi	2 450[4]

[1] Records from Waipoa Station meteorological station, 5 km from trial location. No records were available from this station for June 1998, therefore the total rainfall for June 1998 recorded at Gisborne Aero meteorological station was used.
[2] Records from Palmerston North Aero meteorological station, 18 km from trial location.
[3] Records from Hamilton Aero meteorological station, 31 km from trial location.
[4] Records from Tauranga Aero meteorological station, 40 km from trial location. Rainfall records missing from 27/5/97 to 3/6/97 were filled using data from Oropi Water Treatment Meteorological Station which provided comparable records to Tauranga Aero.

Measurements

The Gisborne trial was measured in August 1998 when the trees were two years of age. Each tree (including those excavated) was measured for: total height, dbh, presence of socketing, and angle of lean.

The Ngaruawahia, Waihi and Feilding trials were also assessed at two years of age. Data are contained in the Forest & Farm Plantation Management Cooperative Report No 53.

Root Excavations

A sample of 15 trees was excavated from each of the three stock types. An additional sample of eight container-grown cuttings and eight bare-root seedlings located on a wetter soil type outside the trial area was also excavated. Trees were excavated using a sharp spade. The aim was to excavate to a minimum depth and width of 30 cm to provide sufficient root material to apply the necessary assessments. Following root excavation the stem of each tree was removed just above ground level. Root systems were placed in plastic bags for transport and assessment at ***Forest Research***, Rotorua.

A sample of 16 trees was excavated from each of the Ngaruawahia, Waihi and Feilding trials. Of the 16 tree sample, eight trees were conventionally nursery conditioned and the remaining eight had received a late deep undercut and lateral root trim. Trees were selected to cover the range of tree heights contained in each trial.

Root systems were assessed for the following:

Planting depth

Root collar diameter

Count of the sinkers and their diameter (Moonlight Forest trial only)

Menzies' Taproot Score (see Figure 3)

Menzies' Lateral Root Score (see Figure 4)

Menzies' Vertical Root Distribution Score (see Figure 5)

Figure 3: Menzies' Taproot Score. Source: Mason (1985).

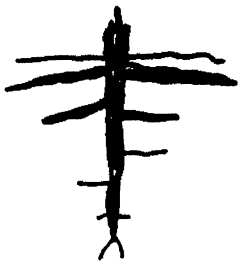
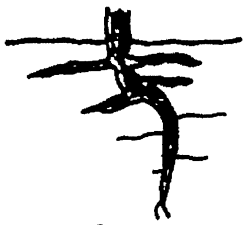
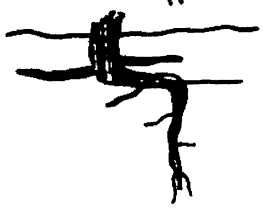
SCORE	DIAGRAM	DESCRIPTION
0		Strong, dominant, well developed taproot
2		Stunted, slightly malformed, but still a definite taproot
4		Taproot distinctly hooked
6		Taproot quite badly hooked, but downward development still present
8		Taproot severely deformed into two or more fracture zones, but growth still downward
10		Taproot does not come below a horizontal plane, or no taproot at all. Subtract one point for each strong sinker present.

Figure 4: Menzies' Lateral Root Score. Source: Mason (1985).

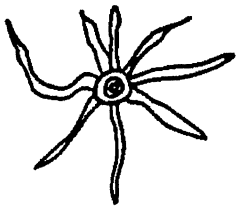
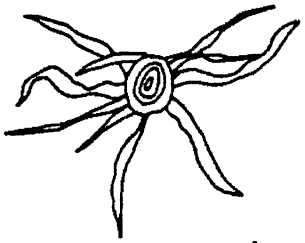
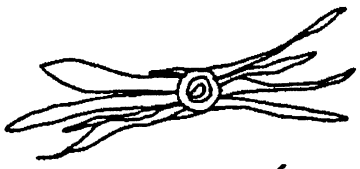
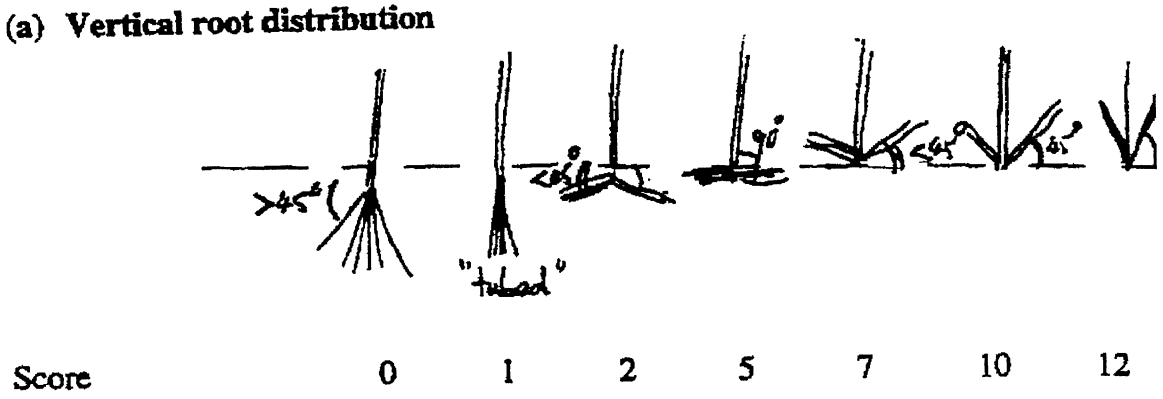
SCORE	DIAGRAM	DESCRIPTION
0		**Laterals on all four sides**
2		Laterals in three quadrants
4		Laterals in two adjacent quadrants
6		Laterals in two opposite quadrants
8		Laterals in one quadrant
10		No significant laterals in any quadrant

Figure 5: Menzies Vertical Root Distribution Score.



Analysis

Differences in percentage topple among stock types were analysed using a chi-squared test, at the 5% level. Differences in taproot, lateral and vertical root distribution scores between each of the stock types along with comparisons of the trees grown on the wetter soil type were analysed using an analysis of variance (ANOVA).

RESULTS

Tree Growth - Container-Grown Cuttings, Bare-Root Cutting & Bare-Root Seedlings

The bare-root cuttings are significantly ($p < 0.01$) larger in diameter (dbh) and height compared with the container-grown cuttings and bare-root seedlings (Table 2).

Table 2: Comparison of mean height and mean diameter (diameter over bark at 1.4m).

Stock Type	**Height** (m)		**Diameter** (mm)	
Container-grown cuttings	1.61	b[5]	13.4	b
Bare-root cuttings	1.90	a	19.5	a
Bare-root seedlings	1.70	b	15.2	b

Depth of Planting

A summary of depth of planting is shown in Table 3. On average planting depth ranged from 7.7cm (container-grown cuttings) to 11.6cm (bare-root cuttings) which is the apparent depth required to provide initial stability. Containerised cuttings were planted significantly shallower ($p < 0.01$) than the other two stock types.

Table 3: Depth of planting. Figure in brackets is the standard error of the mean.

Stock Type	Planting Depth (cm)	
Container-grown cuttings	7.7 (0.62)	a[5]
Bare-root cuttings	11.6 (0.60)	b
Bare-root seedlings	10.7 (0.62)	b

Topple

There was little topple in the trial. The bare-root seedlings however, had a higher incidence of topple than the other nursery stock (Table 4). All stock types had a similar degree of lean.

[5] Means with the same letter are not significantly different at the 5% level.

Table 4: Percent incidence, and average degree of topple among stock types.

Stock Type	Percent Toppled		Mean Degree of Lean (°)	
Container-grown cuttings	6.3	a[6]	10.2	a
Bare-root cuttings	8.8	a	10.4	a
Bare-root seedlings	17.5	b	9.4	a

Root Form

Taproot

The container-grown cuttings and bare-root seedlings had significantly ($p < 0.05$) better taproots than the bare-root cuttings (Table 5).

Lateral Root Distribution

The container-grown cuttings had similar lateral root distributions compared to the bare-root stock (Table 5).

Vertical Root Distribution

The container-grown cuttings had superior vertical root distribution scores compared to the bare-root stock. 26% of the container-grown cuttings stock had roots orientated at an angle equal to or above the horizontal compared to 45.3% and 45.7% for the bare-root cuttings and seedlings respectively (Table 6). There was no difference in the Menzies' Vertical Root Distribution score between the bare-root cuttings or seedlings (Tables 5 & 6).

[6] Differences in the incidence of topple were analysed using a chi-squared test. Differences are significant at the 5% level.

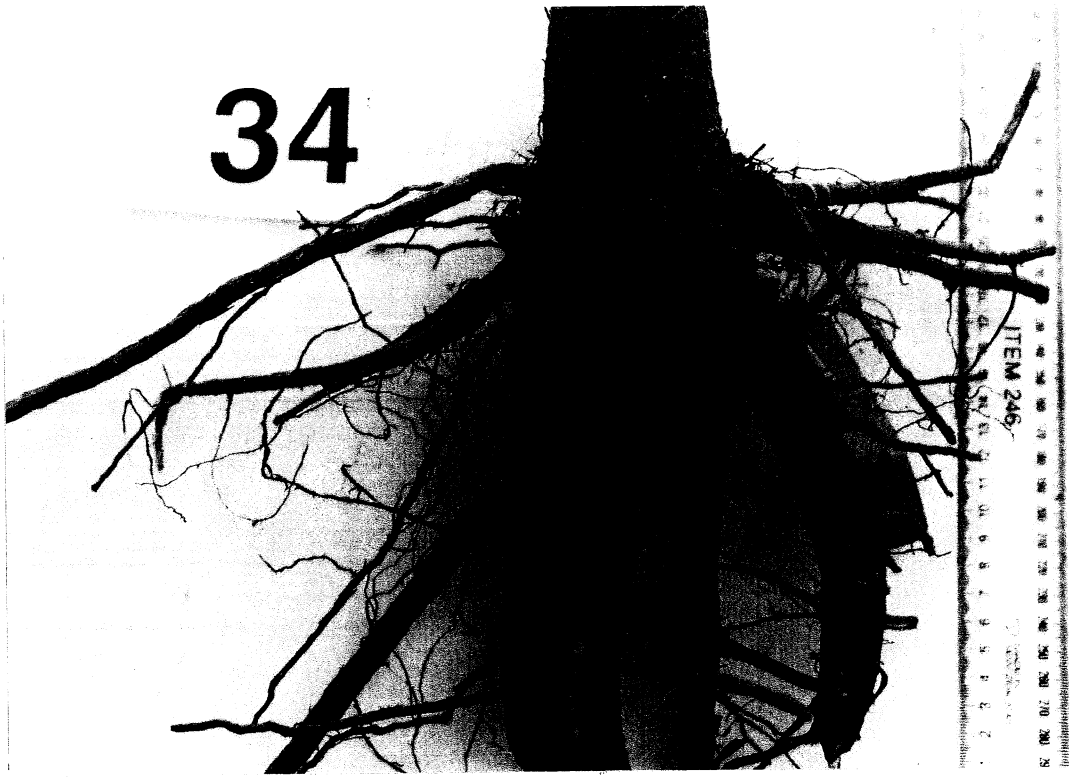
Table 5: Comparison of taproot, lateral, and vertical root distribution scores among stock types.

Stock Type	Taproot		Lateral		Vertical Root Distribution	
Container-grown cuttings	1.6 (0.62)	a[5]	3.7 (0.57)	a	1.8 (0.31)	a
Bare-root cuttings	4.0 (0.60)	b	5.0 (0.55)	a	2.7 (0.30)	b
Bare-root seedlings	1.9 (0.62)	a	4.1 (0.57)	a	2.7 (0.31)	b

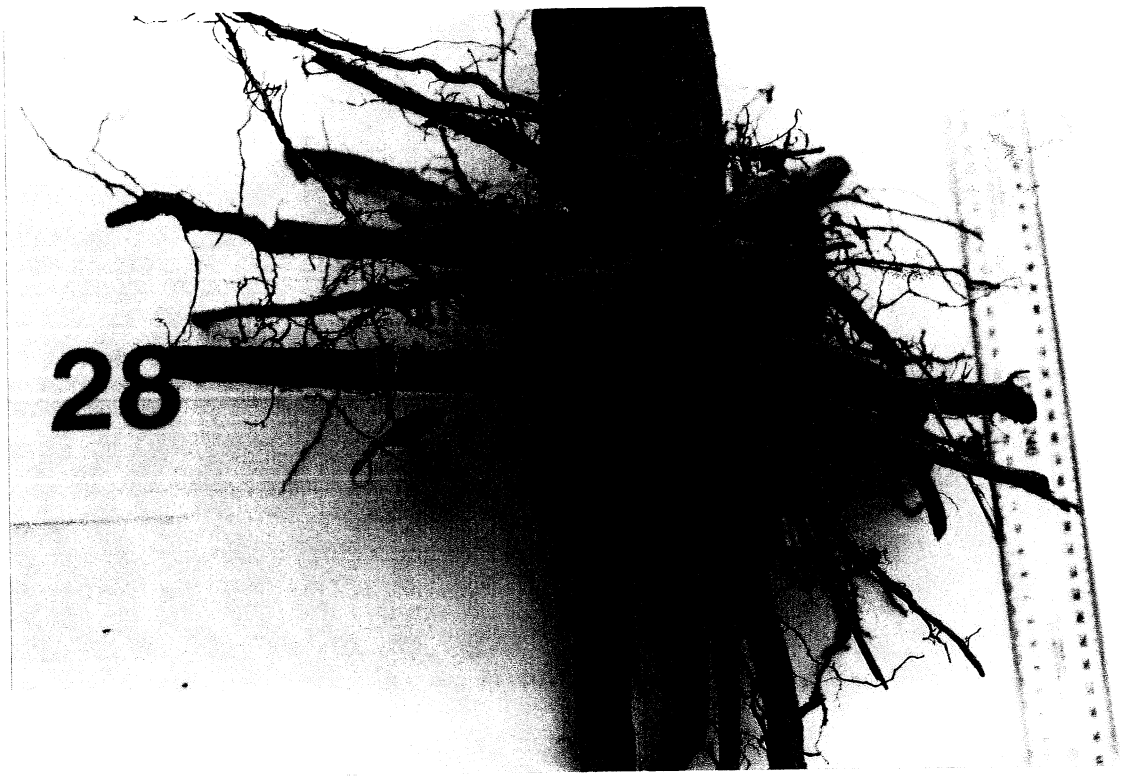
Table 6: Menzies' Vertical Root Distribution Score

Score	Description	Container-grown Cuttings (% Roots)	Bare-root Cuttings (% Roots)	Bare-root Seedlings (% Roots)
12	Roots at an angle greater than 45° above the horizontal	0	0	0
10	Roots at 45° above the horizontal	0	0	1.7
7	Roots at an angle less than 45° above the horizontal	6.7	4.4	7.3
5	Roots at the horizontal	20.0	40.9	36.7
2	Roots at an angle less than 45° below the horizontal	15.3	15.6	8.0
1	Roots tubed at an angle greater than 45° below the horizontal	0	0	0
0	Roots at an angle greater than 45° below the horizontal	58.0	39.1	46.3
	Weighted Average Score	**1.8 (0.31)**	**2.7 (0.30)**	**2.7 (0.31)**

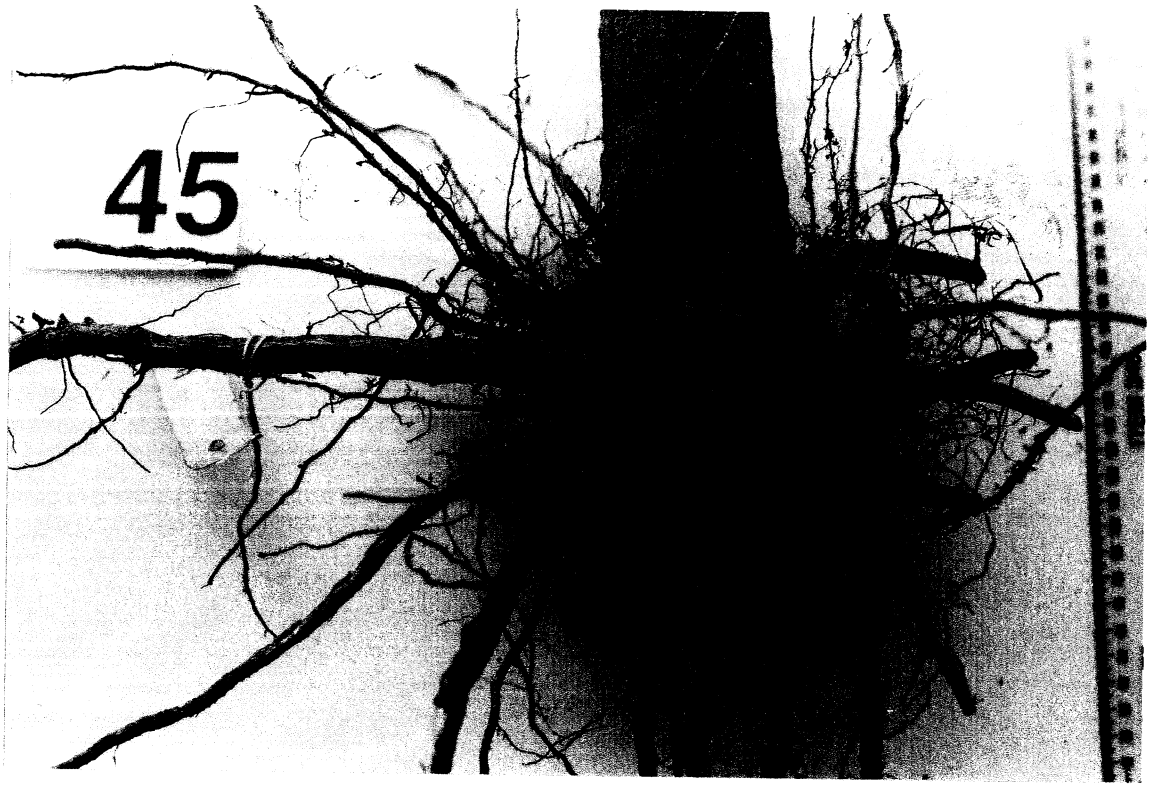
Figure 6: Photos illustrating the differences of root morphology for each of the three stock types.



Typical container-grown cutting



Typical bare-root cutting



Typical bare-root seedling

Sinkers

The containerised and bare-root cuttings had a significantly larger basal area of sinkers ($p < 0.05$) compared to the bare-root seedlings (Table 7). The container-grown cuttings had a significantly smaller root collar diameter basal area ($p < 0.05$) than the bare-root seedlings (Table 8). These differences result in the ratio of root collar basal area to sinker basal area being significantly lower ($p < 0.05$) for bare-root seedlings compared with container-grown cuttings and bare-root cuttings (Table 8).

Table 7: Comparison of the average number of sinkers and average basal area of sinkers (mm^2) between stock types.

Stock Type	No. of Sinkers		BA of Sinkers (mm^2)	
Container-grown cuttings	5.2 (0.56)	a[5]	915 (105)	a[5]
Bare-root cuttings	5.1 (0.54)	a	652 (101)	a
Bare-root seedlings	7.4 (0.56)	b	452 (105)	b

Table 8: Comparison of the mean root collar basal area (mm^2), and mean ratio of root collar basal area to sinker basal area among stock types.

Stock Type	Root Collar BA (mm^2)		Ratio of Sinker BA/ Root Collar BA	
Container-grown cuttings	1852 (260)	a[5]	0.48 (0.056)	a[5]
Bare-root cuttings	2298 (251)	ab	0.37 (0.054)	a
Bare-root seedlings	2664 (260)	b	0.19 (0.056)	b

Discussion

To the authors' knowledge this is the first time that root morphology of cuttings and seedlings have been compared. This study shows that cuttings have a larger total basal area of sinkers compared to seedlings. Of all the root characteristics, a well defined taproot is considered the most important characteristic affecting the incidence of topple (Mason 1985). It is generally accepted that cuttings, particularly physiologically-aged cuttings are more resistant to topple than seedlings (Holden *et al.* 1995). This stability has been linked to a greater crown permeability of cuttings

compared with seedlings. Less root distortion with cuttings at time of planting may also be a further contributing factor to greater stability of cuttings (Menzies *et al* 1991). The Moonlight Forest study suggests that the greater stability of cuttings may also be a result of a higher basal area of sinkers compared with seedlings. It is also noted that the container-grown cuttings in this trial clearly have superior root characteristics to the bare-root seedlings which will infer increased benefits of stability as confirmed by the lower incidence of topple of the container-grown cuttings compared with the bare-root seedlings in this study (Table 4). A comparison of the container-grown cuttings with the bare-root cuttings showed that container-grown cuttings had significantly better taproot and vertical root distribution scores.

Ideally this trial needs to be extended onto a range of other soil types, particularly the wetter soil types which may accentuate the advantages of container-grown cuttings.

Comparison of Wet and Dry Sites

The following photographs show the 'dry' and 'wet' characteristics of the Moonlight Forest site.

Figure 7: Forenza trial in foreground located on 'dry' soil characterised by presence of *Agrostis tenuis* (brown top). 'Wetter' soil is characterised by the presence of *Holcus lanatus* (Yorkshire fog) as shown by the dark green areas throughout the far side of the catchment and the area beyond the person standing in the photograph.

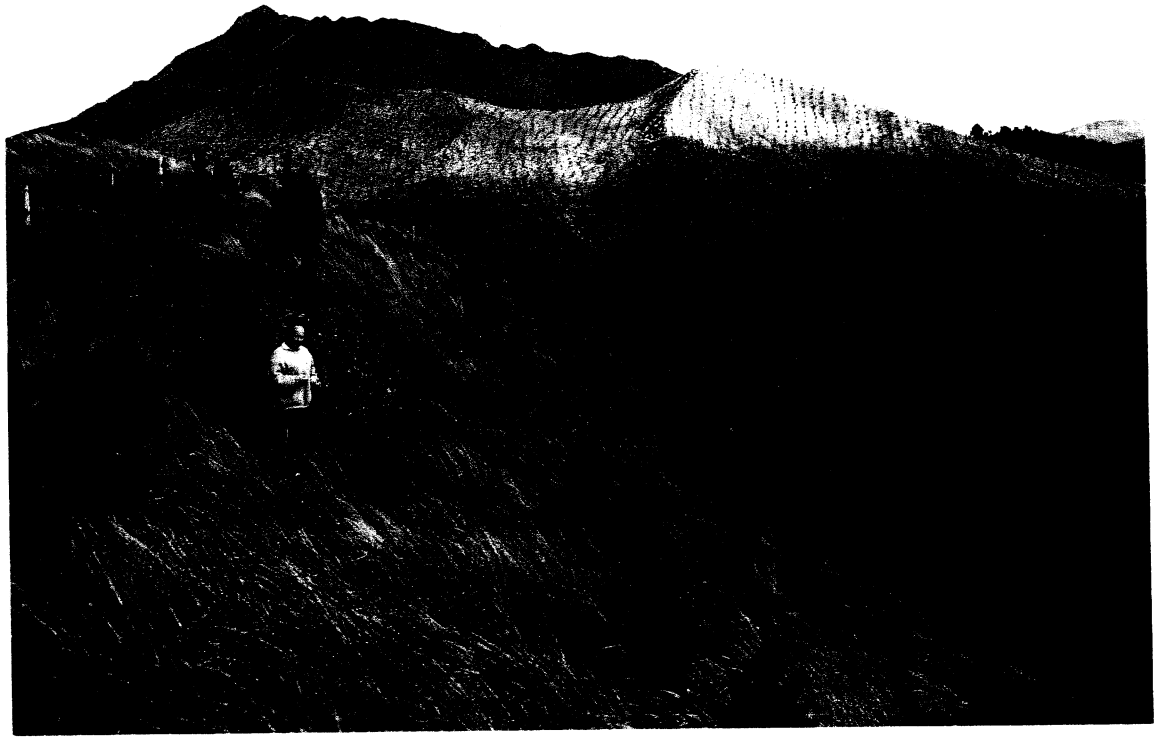


Figure 8: Showing hole following root excavation - note dry soil characteristics on hillside despite heavy rain in preceding days during month of August.

There was no significant difference ($p > 0.05$) between the container-grown cuttings and bare-root seedlings on the wet site as far as the considered features were concerned. There was a significant difference ($p=0.048$) in average vertical root distribution score between the container-grown cuttings and bare-root seedlings on the dry site. For simplicity of comparison between site types the data was combined by stock types on each site. This was possible due to the small differences between stock types on each site.

Trees on dry and wet soils had similar taproots and lateral root distributions on both the dry and wet soils (Table 9). Trees grown on the dry soil had superior Vertical Root Distribution scores ($p < 0.01$) compared to the wet soil (Table 9). Trees grown on the dry soil had 52.2% of their roots orientated at an angle greater than 45° below the horizontal compared to 23.4% for trees grown on the wet soil. Trees grown on the dry soil had only 7.8% of their roots orientated at an angle above the horizontal compared to 38.7% for the trees grown on the wet soil (Table 10).

Table 9: Comparison of taproot, lateral, and vertical root distribution (weighted average) scores between wet and dry sites.

Location	Taproot Score		Lateral Score		Vertical Root Distribution Score	
Dry	1.8 (0.45)	a[5]	3.9 (0.40)	a	2.2 (0.22)	a
Wet	2.8 (0.62)	a	2.8 (0.55)	a	4.7 (0.30)	b

Table 10: Menzies' Vertical Root Distribution Score

Score	Description	'Dry' Soil (% Roots)	'Wet' Soil (% Roots)
12	Roots at an angle greater than 45° above the horizontal	0.0	0.9
10	Roots at 45° above the horizontal	0.8	10.6
7	Roots at an angle less than 45° above the horizontal	7.0	27.2
5	Roots at the horizontal	28.3	29.1
2	Roots at an angle less than 45° below the horizontal	11.7	8.8
1	Roots tubed at an angle greater than 45° below the horizontal	0.0	0.0
0	Roots at an angle greater than 45° below the horizontal	52.2	23.4
	Weighted Average Score	**2.2**	**4.7**

Discussion

To the authors' knowledge this is the first time that root morphology has been studied on a wet and dry soil within the same location. The considerably greater percentage of roots orientated above the horizontal on the wet soil compared to the dry soil is most likely due to a higher soil moisture content and thus the roots are able to exploit soil nutrients closer to the surface.

Comparison of Bare Rooted Seedlings with Other Sites

There was no significant ($p < 0.05$) difference between sites for the Taproot Scores. The Moonlight Forest site had the poorest Lateral Root Distribution scores. The Moonlight Forest site along with Ngaruawahia had the best Vertical Root Distribution scores (Table 11).

Table 11: Comparison of taproot, lateral, and vertical root distribution (weighted average) scores for seedlings only between the four locations adjusted for trial treatment effects.

Location	Taproot Score		Lateral Root Distribution Score		Vertical Root Distribution Score	
Gisborne	1.9 (0.71)	a[5]	4.1 (0.58)	a[5]	2.7 (0.30)	a[5]
Ngaruawahia	1.9 (0.75)	a	2.2 (0.54)	b	3.7 (0.32)	ab
Waihi	1.2 (0.81)	a	2.5 (0.58)	b	3.7 (0.34)	b
Feilding	3.4 (0.75)	a	0.3 (0.54)	c	4.0 (0.32)	b

CONCLUSIONS

Container-grown cuttings compared to bare-root cuttings and seedlings grown at Moonlight Forest were shown to:

- have similar height and diameter to the bare-root seedlings
- be shorter in height and have smaller diameters than the bare-root cuttings
- be considerably more wind firm than the bare-root seedlings but have a similar level of resistance to topple as the bare-root cuttings
- have superior tap roots compared to the bare-root cuttings
- have less roots orientated above the horizontal compared to the bare-root stock
- have twice the basal area of sinkers compared to the bare-root seedlings
- have a greater ratio of basal area of sinkers to root collar basal area than the bare-root seedlings

A comparison of the root morphology of seedlings grown at Moonlight Forest with conventional root-conditioned seedlings grown in toppling trials established at Ngaruawahia, Waihi and Feilding showed that the seedlings grown at Moonlight Forest had similar taproot scores but poorer lateral root scores compared to the three other sites. The seedlings grown on the Moonlight Forest site also had similar vertical root distribution scores to Ngaruawahia but were superior to trees grown at the Waihi and Feilding sites.

A comparison of the root morphology of container-grown cuttings and bare-root seedlings grown within the 'dry' soil of the Moonlight Forest trial compared with the same plant types grown on 'wetter' soil outside the trial area showed the percentage of roots orientated above the horizontal angle was five times greater in the 'wet' soil compared to 'dryer' soil. The taproot and lateral root scores between the 'dry' and 'wet' soils were not different. These results need to be confirmed using controlled experiments.

Acknowledgments

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The authors are also grateful to Rex Barker and John Honey of PF Olsen and Co Ltd, Gisborne, who ably assisted with the trial assessment and root excavations.

The provision of rainfall data from the National Climate Database administered by NIWA is also acknowledged.

References

Holden D.G.; Klomp B.K.; Hong S.O.; Menzies M.I.. 1995. Growth and predicted timber value of *Pinus radiata* cuttings and seedlings on a fertile farm site. **New Zealand Journal of Forestry Science 25(3)**: 283-300.

Mason E.G. 1985. Causes of juvenile instability of *Pinus radiata* in New Zealand. **New Zealand Journal of Forestry Science 15(3)**: 263-280.

Menzies M.I., Klomp B.K.; Holden D.G.; 1991 Promising future for radiata pine cuttings. **What's New in Forest Research, No 212**

Turner JA, Tombleson JD, 1998 Toppling trial establishment report: Evaluation of severe lateral nursery root trimming and contrasting genetic improvement. Forest & Farm Plantation Management Cooperative Report 44.

Tombleson JD, Turner JA, 1998. Waihi toppling trial — assessment of roots following severe toppling. Forest & Farm Plantation Management Cooperative report 52.

Turner JA, Tombleson JD, 1998. Assessment of roots — Ngaruawahia, Waihi & Feilding toppling trials. Forest & Farm Plantation Management Cooperative report 53.

APPENDIX 1: Data summary — Moonlight Forest, Gisborne

Tree	Stock	Menzies' Scores		Modified Tap Root Score (%)							Planting	Sinkers										Root
No	Type	Taproot	Lateral	0	1	2	5	7	10	12	Depth	No.	Size									Collar
17	1	2	6	25			75				10	6	18	24	23	7	11	11				39
18	1	2	6	40		55		5			8	5	10	6	11	10	5					29
19	1	2	0	30			60	10			12	6	6	11	12	10	24	17				47
20	1	6	2	15		65	10	10			11	5	12	22	19	4	16					73
21	1	4	6	30		40	30				10	4	17	15	8	5						45
22	1	6	6	20		5	75				14	3	16	7	10							65
23	1	2	6	80		5	15				11	6	8	13	17	8	20	8				51
24	1	2	6	60		10	30				11	4	11	11	7	11						49
25	1	2	6	85		15					12	7	11	7	21	23	10	12	10			42
26	1	8	8	20		5	75				10	3	24	9	7							44
27	1	6	6	30			70				12	5	8	10	5	8	10					49
28	1	0	2	40		5	50	5			16	8	22	14	12	8	8	8	7	7		72
29	1	4	2	50		15	30	5			11	6	12	12	9	6	6	4				63
30	1	4	4	80		5	15				10	7	19	14	11	13	7	7	5			39
31	1	6	8	15		5	80				10	3	28	8	7							78
32	1	8	6	5		20	40	35			17	4	8	7	7	7						53
9	2	0	2	20		80					7	5	6	7	3	3	3					26
11	2	0	10	95		5					12	2	21	20								33
12	2	0	2	30		40	20	10			8	4	17	12	16	5						49
13	2	2	4	40			40	20			8	3	28	23	29							59
14	2	0	2	70		5	10	15			6	8	21	15	22	19	16	11	11	19		65
15	2	2	2	15		10	65	10			5	4	19	11	7	6						45
16	2	2	4	75			20	5			7	9	13	10	8	25	13	16	8	10	7	57
33	2	0	6	65			30	5			8	6	21	13	13	10	10	8				62
34	2	0	4	90		5	5				10	6	21	17	11	16	16	28				54
35	2	8	4	60		5	30	5			10	4	7	8	9	12						31
36	2	4	4	75		10	15				3	9	14	13	7	10	8	8	7	8	9	38
37	2	2	2	80		10		10			9	7	10	7	5	10	16	12	12			38
38	2	0	2	70		5	25				9	3	7	27	25							53
39	2	4	6	50		15	20	15			9	5	4	12	13	10	16					47
40	2	0	2	35		40	20	5			4	3	27	13	31							51

Stock type code

1 Bare root cuttings

2 Container-grown cuttings - Forenza

Continued ....

Tree	Stock	Menzies' Scores		Modified Tap Root Score (%)							Planting	Sinkers											Root
No	Type	Taproot	Lateral	0	1	2	5	7	10	12	Depth	No.	Size										Collar
2	3	0	2	25			70	5			10	4	15	12	7	5							51
3	3	0	6	95			5				11	12	8	11	8	12	12	10	10	8			51
4	3	0	6	30		10	60				13	9	11	7	7	7	9	5	5	7	7		72
5	3	5	4	70		5	10	15			11	8	8	7	7	6	6	5	5	5			39
6	3	2	6	70		5	10	10	5		12	12	16	13	8	8	12	7	8	8	7	7	61
7	3	5	2	50		15	20	15			12	6	8	9	7	10	9	8					44
8	3	0	2	75			15	10			7	7	12	14	19	8	7	7	8				49
41	3	0	2	25		5	65	5			10	5	11	9	6	5	5						62
42	3	0	2	40		25	30	5			10	5	6	5	8	7	14						56
43	3	0	8	35		25	40				12	4	19	13	13	10							54
44	3	0	6	60		10	25	5			10	10	17	16	7	7	8	8	10	6	7	5	60
45	3	7	6	35		10	40	15			17	9	4	4	3	4	4	4	4	3	3		64
46	3	2	6	45			15	20	20		8	7	8	8	7	7	15	11	12	12			57
47	3	0	2	20		5	70	5			10	5	7	6	6	12	11						71
48	3	8	2	20		5	75				8	8	7	6	5	4	5	6	7	6			71
1	4	6	6	10		15	25	50			9												
2	4	8	0	25			45	5	25		10												
3	4	4	6	10			20	30	40		8												
4	4	4	2	25		10	40	25			13												
5	4	2	0	30		10	10	40	10		10												
6	4	2	6	10		10	70	10			7												
7	4	0	2	50		5	30	15			13												
8	4	6	6	5		10	60	25			12												
9	5	2	2	20		30	25	25			13												
10	5	0	4	50			15	35			11												
11	5	0	2	15		5	30	35	10	5	10												
12	5	2	2	25		20	10	35	10		14												
13	5	2	0	50		10	5	15	20		10												
14	5	2	2	25		10	20	30	15		14												
15	5	2	2	10		5	40	30	15		11												
16	5	2	2	15			20	30	25	10	11												

Stock type code

3	Bare root seedlings
4	Container-grown cuttings - ex-Forenza excavated from damp soil adjacent to the trial
5	Bare root seedlings excavated from damp soil adjacent to the trial