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PONDEROSA PINE ROOT REGENERATION FROM TWO FOREST NURSERIES

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ABSTRACT

A study conducted in 1959 indicated that the root regenerating potential of 1-0 ponderosa pine stock from the Magalia nursery was less than half as vigorous as similar stock from Ben Lomond nursery. The following supplemental study attempted to determine if this was an inherent condition in the Magalia nursery or was a transitory condition peculiar to the year of the previous study. This article reports on the comparison of nurseries in root regenerating potential as related to time of lifting and to cold storage. Seedlings were lifted at four-week intervals from September through May. One-half of the seedlings were placed in 1°C. cold storage after each lifting. The other half were planted in soil trays which were immersed in a 20°C. temperature controlled water bath. After one month the seedlings were washed from the soil and the following data recorded for each live seedling: Activity of bud (dead - alive - growing); number of new roots 1/2" or over (elongation or initiation); total lengths of roots over 1". After three months of cold storage, the same data was recorded for stored stock. Results showed that the months of peak root production of this study exceeded the peak production of the previous study at both nurseries by a considerable margin, especially at Magalia. For the total test period, Magalia's root production (initiations and elongations over 0.5 inch) was higher than Ben Lomond's for both fresh and stored stock. The study indicated that stock lifted at the right time and properly stored for three months should not suffer any adverse effects from either nursery.

The root regenerating potential of ponderosa pine nursery stock from several California forest nurseries was compared in 1959 by Stone and Benseler (1962) at the University of California School of Forestry.

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The study reported that one year old ponderosa pine planting stock from the Magalia Forest nursery was less than half as vigorous in root regenerating potential as similar planting stock from the Ben Lomond Forest nursery.

The present study sought to determine if this was a condition inherent in the Magalia nursery, possibly due to soil management and cultural practices or was a transitory condition, perhaps peculiar to the particular year of the previous study.

The present supplemental study was a cooperative project with the University of California, School of Forestry, and the California Division of Forestry, with storage and water bath facilities provided at the University's Gill Tract greenhouse.

The following were the variables tested:

1. Stock from two forest nurseries (Magalia and Ben Lomond)
2. Fresh versus stored stock (3 months storage)
3. Ten lifting dates (September through May)

PROCEDURE

A 4 foot by 25 foot plot in a seed bed at each nursery was sown with Zone II ponderosa pine in May 1961. In August 1961 the plot was thinned to twenty seedlings per square foot. The plot was then divided into ten sub plots.

Beginning in September 1961, and every four weeks through May 1962, sixty seedlings were lifted from the pre-selected sub plots. Forty of the best seedlings were selected and root pruned to a length of eight inches. These in turn were divided into four lots of ten trees each.

Each lot was packed in a polyethelene bag with moist vermiculite as a packing medium around the roots. Two of the lots were planted immediately and two were placed for three months in cold storage at 10° Centigrade. The tops of the seedlings scheduled for cold storage were first dipped in a solution of "Captan" to reduce the chance of mold formation. Each package was then sealed in a larger polyethelene bag to reduce foliar moisture loss during shipping and storage.

The first two lots of ten trees each from each lifting date were planted the day after lifting and after all new white root tips had been removed. They were planted in metal trays filled with Sheridan sandy loam from the Ben Lomond Nursery. The soil was brought to field capacity and the trays were immersed in a 20° Centigrade temperature controlled water bath.

All plants were removed from the water bath after one month, and the seedling roots washed gently to prevent destruction of delicate new root growth.

Root development was evaluated according to the system used in the root regeneration study of 1959 (Stone and Benseler, 1962). The following data were recorded for each live tree:

- A. Activity of terminal bud
 - 1. Dead (D)
 - 2. Alive, but not growing (A)
 - 3. Growing (G)
- B. Production of new roots
 - 1. Number of new roots 1/2" or longer
 - 2. Elongation or initiation - used to denote specific growth
 - 3. Total accumulative length of roots over 1"

The same procedures were used for stored stock after three months storage at 1° Centigrade.

Significant differences at the 95 percent level of probability were determined by analysis of variance (Snedecor, 1955).

RESULTS

1. There was no significant difference between the survival of Magalia fresh lifted stock and Ben Lomond fresh lifted stock at the end of the one month period in the water bath (table 1).
2. Survival of Magalia stored stock was significantly greater than Ben Lomond stored stock overall, principally due to better survival in earlier and later lifting dates. Magalia survival was highest from November 1, 1961 ^{2/} through March 27, 1962, while Ben Lomond's highest period was from November 29, 1961, through March 27, 1962 (table 1).
3. In comparing Ben Lomond fresh stock to Ben Lomond stored stock, and Magalia fresh stock to Magalia stored stock, a significant difference in survival was noted, which indicated that fresh stock should be used when possible. However, if stored stock must be used, it should be lifted after November and before April at Magalia, and after December and before April at Ben Lomond (table 1).

^{2/} All dates refer to time seedlings were lifted from nursery seed beds.

Table 1. The number of live seedlings, one month after planting in soil trays, in controlled temperature water baths.

Lifting Date	Fresh Stock		Stored Stock	
	Ben Lomond	Magalia	Ben Lomond	Magalia
	(1)	(2)	(3)	(4)
9-6-61	1	9	0	0
10-5-61	20	18	2	0
11-1-61	20	20	6	20
11-29-61	20	20	20	19
1-3-62	20	20	20	20
2-1-62	20	20	20	20
3-1-62	20	20	20	20
3-27-62	20	20	20	19
4-29-62	20	19	0	10
5-27-62	19	20	0	5
Total	180	186	108	133

1. Twenty seedlings possible for any one entry.
2. A difference greater than 3.8 between any entry in column 3 and any entry in column 4 is significant.
3. A difference greater than 12.0 between column 3 total and column 4 total is significant.
4. A difference greater than 1.8 between any entry in column 1 and any entry in column 3 is significant.
5. A difference greater than 5.8 between column 1 total and column 3 total is significant.
6. A difference greater than 5.8 between any entry in column 2 and any entry in column 4 is significant.
7. A difference greater than 18.4 between column 2 total and column 4 total is significant.

4. The average number of new root initiations and elongations over 0.5 inch was highest for Magalia fresh stock from January through June, except for the month of May. Ben Lomond was highest from April through June (fig. 1).

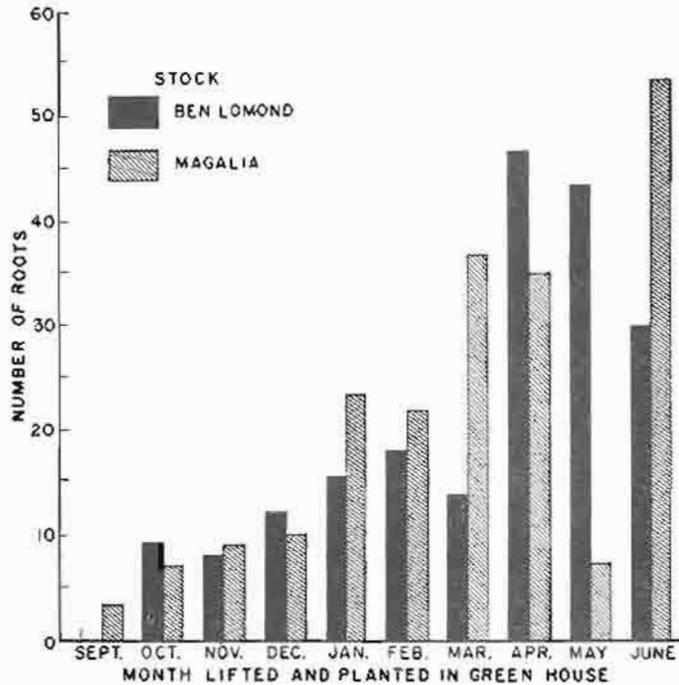


Fig. 1

AVERAGE NUMBER OF FRESH STOCK NEW ROOTS OVER 0.5" ELONGATED & INITIATED PER SEEDLING

5. The average number of new root initiations and elongations over 0.5 inch for Magalia stored stock was greatest from November through April, with a peak being reached in February. Initiations and elongations were greatest for Ben Lomond stock from December through April, with a peak also being reached in February. For the eight month period as a whole, Magalia root production was higher than Ben Lomond. However, the only significant difference noted in new root production was Ben Lomond fresh stock over Ben Lomond stored stock (table 2, fig. 2). The amount of new root growth from root elongation and from root initiation was fairly equal throughout the test period for both fresh and stored stock, with root initiation being slightly higher. New root development seems to depend on both elongation and initiation throughout the planting season.

Table 2. The number of new roots (elongations and initiations) over 0.5 inch, one month after planting in soil trays, in controlled temperature water baths.

Lifting Date	Fresh Stock		Stored Stock	
	Ben Lomond	Magalia	Ben Lomond	Magalia
	(1)	(2)	(3)	(4)
9-6-61	0	54	0	0
10-5-61	167	135	8	0
11-1-61	151	174	37	534
11-29-61	254	194	620	351
1-3-62	302	457	599	853
2-1-62	350	435	966	952
3-1-62	270	740	234	607
3-27-62	942	673	247	476
4-29-62	866	144	0	14
5-27-62	604	1073	0	2
Total	3906	4079	2711	3789

1. A difference greater than 206.4 between any entry in column 1 and any entry in column 3 is significant.
2. A difference greater than 652.0 between column 1 total and column 3 total is significant.

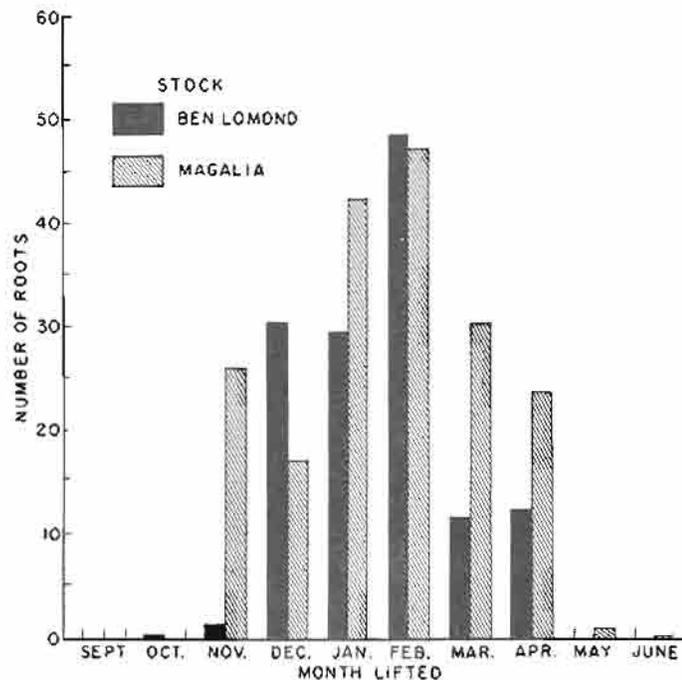


Fig. 2
AVERAGE NUMBER OF STORED STOCK NEW ROOTS
OVER 0.5" ELONGATED & INITIATED PER SEEDLING

6. Fresh stock - Average total root length development (elongation and initiation) for fresh stock at both nurseries was somewhat erratic. Magalia increased from December to a peak in March. In April there was a slight drop; and a considerable drop in May was followed by a large increase in June back almost to the April level.

Table 3. The length of new roots (either elongations or initiations) over 1 inch, measured in tenths of inches, one month after planting in soil trays in controlled temperature water baths.

Lifting Date	Fresh Stock		Stored Stock	
	Ben Lomond	Magalia	Ben Lomond	Magalia
	(1)	(2)	(3)	(4)
9-6-61	0	48.8	0	0
10-5-61	143.5	79.1	1.6	0
11-1-61	87.0	118.0	43.4	645.2
11-29-61	337.8	162.7	822.1	388.8
1-3-62	487.7	599.1	865.9	1185.6
2-1-62	562.6	619.6	1126.2	1032.3
3-1-62	212.7	1079.3	309.9	650.7
3-27-62	861.2	983.0	165.9	298.2
4-29-62	606.9	208.2	0	3.5
5-27-62	345.1	794.0	0	0
Total	3644.5	4691.8	3335.0	4204.3

1. A difference greater than 362.0 between any entry in column 2 and any entry in column 3 is significant.
2. A difference greater than 1148.0 between column 2 total and column 3 total is significant.

Ben Lomond increased from December through February. A considerable drop in March was followed by a peak in April with a gradual tapering off through June (fig. 3).

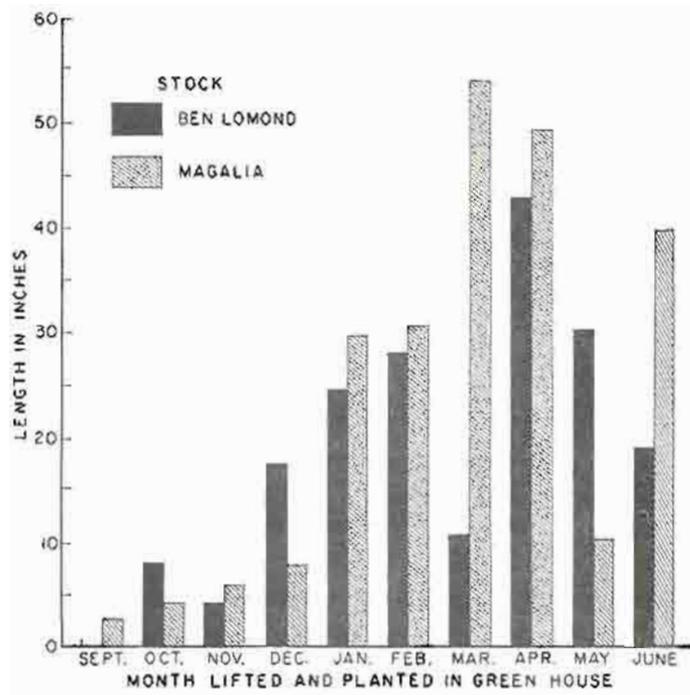


Fig. 3
 AVERAGE TOTAL LENGTH OF FRESH STOCK NEW ROOTS
 OVER 1.0" ELONGATED & INITIATED PER SEEDLING

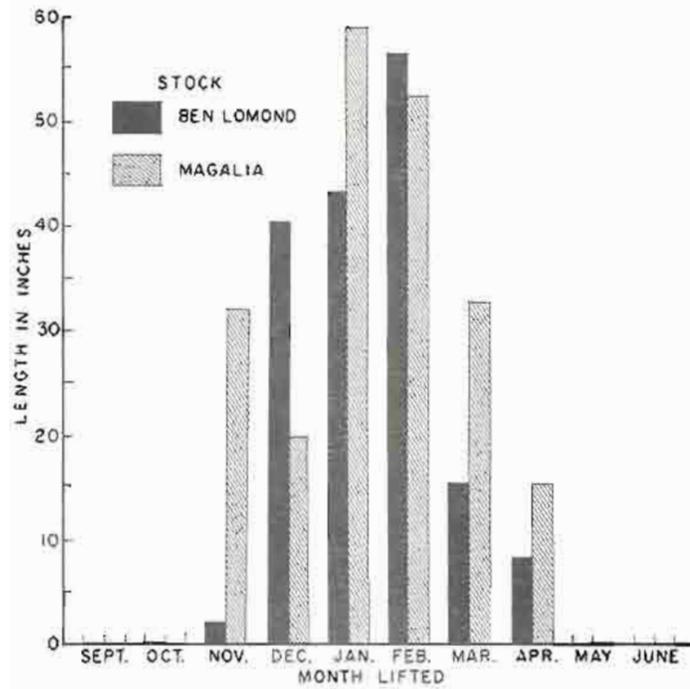


Fig. 4
 AVERAGE TOTAL LENGTH OF STORED STOCK NEW ROOT
 OVER 1.0" ELONGATED & INITIATED PER SEEDLING

7. Stored stock - Average total root length development for Magalia stored stock was greatest from November through March, with the peak being in January. Ben Lomond was greatest from December through February, with the peak coming in February (fig. 4). Magalia's growth was equal to, or greater than, Ben Lomond's through this period, except for December.

SUMMARY AND CONCLUSIONS

In 1959, Stone (1962) in a similar study found that new root production from Ben Lomond stock was twice as high as from Magalia stock for the month of peak production.

It appears that this difference in root production between the two nurseries in 1959 may have been a transitory condition existing at Magalia. Intensive soil management practices instituted at Magalia since 1959 may have been an influencing factor in the more favorable comparison of the 1962 study. It is also possible unknown variables could have existed in either study which could influence the final results.

The months of peak root production of fresh stock for the 1962 study exceeded the peaks of the 1959 study at both nurseries. Magalia's peak production of average number of new roots per seedling over 0.5 inch was approximately 13 in 1959 and 57 in 1962, an increase of over 400 percent. Ben Lomond's peak in 1959 was 33 and in 1962 was 47, an increase of over 40 percent.

The peak for stored stock was approximately 48 average number of new roots per seedling for both nurseries in the 1962 study occurring in February. The highest production in the 1959 study was 26 new roots per seedling for Ben Lomond, again a considerable increase for both nurseries.

The 1959 study indicated root regenerating potential of seedlings at Ben Lomond fell off considerably after the middle of March, whereas the 1962 study showed the highest production of new roots occurred for stock lifted during the months of March, April and May and planted immediately.

New root production for stored stock was highest for Ben Lomond for stock lifted during December through February, and highest for Magalia November through April. It appears that stock lifted at the proper time and stored properly for three months at either nursery should not suffer any detrimental effects.

It is difficult to correlate the various differences between the 1959 and 1962 studies. However, it does appear that it would be premature to state any conclusions which would be consistently accurate, based on either or both studies. Varying climatic conditions, at either nursery, unknown variables, differences in lifting, handling,

storage, planting and greenhouse maintenance of planted stock could influence the results of either study. Additional studies, similarly conducted, in all probability would assist in presenting a truer picture by which more accurate conclusions could be drawn.

REFERENCES

SNEDECOR, G. W. 1955. Statistical methods.

STONE, E. C., and R. W. BENSELER. 1962. Planting ponderosa pine in the California pine region. Journal of Forestry 60-462-466.