

EFFECTS OF HEDGING ON MATURATION IN LOBLOLLY PINE: ROOTING  
CAPACITY AND ROOT FORMATION

By

Andreas Hamann

A thesis  
submitted in partial fulfillment  
of the requirements for the  
Master of Science Degree

State University of New York  
College of Environmental Science and Forestry  
Syracuse, New York


January 1995

Approved:  
Faculty of Forestry

  
\_\_\_\_\_  
Major Professor

  
\_\_\_\_\_  
Chair, Examining Committee

  
\_\_\_\_\_  
Faculty Chair

  
\_\_\_\_\_  
Dean, Instruction and  
Graduate Studies

HAMANN, ANDREAS. Effects of Hedging on Maturation in Loblolly Pine: Rooting Capacity and Root Formation. Typed and bound thesis, 90 pages, 8 tables, 20 figures. 1995

#### ABSTRACT

Maturation in woody plants refers to an age related process that results in changes which may be expressed in morphological characteristics, physiological properties and the ability to regenerate plant parts. Various aspects of maturation in conifers and its implications for vegetative propagation and clonal forestry systems are reviewed.

Three quantitative rooting experiments were conducted to investigate whether juvenility in loblolly pine can be maintained through hedging in up to 7-year-old donor plants of two superior full-sib families. Experiment 1 showed significant effects of hedge age on rooting percent. However, results did not clearly indicate a maturation effect since cuttings from 5-year-old donors rooted better than those from older or younger stock plants. Experiments 2 and 3 found no significant differences in rooting among cuttings from 3- to 7-year-old hedges. Significant family effects accounted for a large proportion of the total variance in all experiments.

The rooting process for cuttings from seedlings, from different aged hedges and from 3-year-old trees was investigated histologically. Anatomical changes associated with callus formation, root initiation and development of adventitious roots are described and illustrated with micro-photographs. These observations suggest that the formation of roots and the timing of root development is similar in cuttings of all donors except those from 3-year-old trees. The latter showed less callus development and little root initiation within a period of 12 weeks.

It is concluded that the use of hedged loblolly pine stock plants is a means to delay effects of maturation on rooting for at least 7 years.

## ACKNOWLEDGEMENTS

I would like to thank Dr. Farrell C. Wise at Westvaco Corporation for his support and expertise over the course of this study.

Acknowledgement is given to Dr. Bonnie Dumas for her assistance in statistical evaluation of the data.

Appreciation is also given to Rodney O. Jones and others working at Westvaco Forest Science Laboratory for their help and cooperation during this study.

Special appreciation is given to Dr. Miklòs A. Gràtzer, Dr. Charles A. Maynard and Dr. Allan P. Drew for their teaching, encouragement and guidance during my tenure at SUNY-ESF.

## TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	i
TABLE OF CONTENTS	ii
LIST OF TABLES	iv
LIST OF FIGURES	v
INTRODUCTION	1
LITERATURE REVIEW	6
Concepts of maturation and techniques to manipulate its level	6
Effects of maturation and its implication for vegetative propagation	10
Loblolly pine	10
Radiata pine	14
Douglas-fir	21
Norway spruce	24
Yellow cedar	27
Summary	29
OBJECTIVES	31
MATERIAL AND METHODS	32
Plant material, collection of cuttings and rooting environment	32
Quantitative rooting experiments	39
Histological methods	43

RESULTS	
Effects of age in hedged stock plants on rooting of cuttings	45
Effects of maturation on the course and timing of root development	55
Developmental sequence of adventitious root formation in loblolly pine cuttings	57
DISCUSSION	70
Rooting capacity	70
Root formation	75
CONCLUSIONS	77
LITERATURE CITED	78
APPENDICES	88
VITA	90

## LIST OF TABLES

1. Diameters and nitrogen concentration of cuttings used in the experiments (standard deviations are given within parentheses).	38
2. Analysis of variance for rooting percent.	42
3. Analysis of variance for total root length per cutting and number of roots per cutting.	42
4. Means of rooting percent, total root length per cutting and number of roots per cutting for families 9x49 and 3x7 in three experiments.	46
5. Analysis of variance and estimated variance components for rooting percent.	47
6. Analysis of variance and estimated variance components for number of roots per cutting.	48
7. Analysis of variance and estimated variance components for total root length per cutting.	49
8. Time course of callus and root formation in cuttings from seedlings (S), hedges 3, 5 and 7 years old (H3, H5, H7) and 3-year-old non-sheared trees (T3) from histological observations. trees.	56

## LIST OF FIGURES

1. Effects of maturation on rooting of loblolly pine air layers (from McAlpine and Jackson 1959).	11
2. Arrangement of hedged stock plants used for the rooting experiments (spacing 30 cm within horizontal rows, 60 cm within vertical rows).	34
3. Developmental stages of fascicular shoots of loblolly pine hedges (scale 1:2).	35
4. Rooting percent of cuttings in experiment 1.	52
5. Representative row plot of stage VI cuttings from experiment 1.	52
6. Rooting percent of cuttings in experiment 2.	53
7. Representative row plot of stage I cuttings from experiment 2.	53
8. Rooting percent of cuttings in experiment 3.	54
9. Representative row plot of stage IV cuttings from experiment 3.	54
10. Cross section of a fascicular shoot at the time of sectioning from the stock plant.	58
11. Cutting base after 10 days in the rooting environment.	59
12. Cross section 0.5 mm above the base of the cutting after 10 days in the rooting environment.	60
13. Cutting base after 20 days in the rooting environment.	62
14. Differentiation of callus tissue after 20 days in the rooting environment.	63

15. Root initiation after 30 days in the rooting environment. 64
16. Zone of dedifferentiation and active cell division leading to root development after 30 days in the rooting environment. 65
17. Root primordium after 40 days in the rooting environment. 67
18. Differentiation of vascular tissue near the origin of root development. 68
19. Vascular connection into a 1 cm long root. 68
20. Arrangement of wound tissues within the callus leading to root development or parenchymatic protuberances. 69