Forest Research Branch

ROOT DEVELOPMENT OF JACK PINE SEEDLINGS ON BURNED-OVER DRY SITES IN SOUTHEASTERN MANITOBA

by

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ABSTRACT

A study of root development of 1- to 8-year-old seedlings in southeastern Manitoba revealed a marked overall increase in rate of root growth beginning at age 4-5 years. Average length of vertical roots remained relatively constant after 4 years, while average length of laterals began a marked increase at the same age. Top:root ratios, by weight, ranged from 0.94:1 to 4.88:1, with highest ratios occurring in the older seedlings.

RÉSUMÉ

Une étude de la croissance des racines de semis de 1 à 8 ans dans le sud-est du Manitoba a révélé qu'une augmentation générale marquée de la rapidité de croissance des racines commence à l'âge de 4 ou 5 ans. La longueur moyenne des racines verticales est demeurée relativement constante après 4 ans, tandis que la longueur moyenne des racines latérales commençait à augmenter de façon marquée à cet âge. Le rapport de la partie aérienne de l'arbre et les racines, en poids, varie de 0.94:1 à 4.88:1, les plus forts rapports se trouvant chez les semis les plus vieux.

ROOT DEVELOPMENT OF JACK PINE SEEDLINGS ON BURNED-OVER DRY SITES IN SOUTHEASTERN MANITOBA[1]

by

H. P. Sims[2]

INTRODUCTION

During the summer of 1961 a limited study was made of the root development of jack pine (*Pinus banksiana*)[3] seedlings growing on burned-over dry sites in southeastern Manitoba. Areas that had been burned during the period 1953 to 1959 were chosen for the study. Soils were dry, medium textured sands; vegetation consisted primarily of bearberry (*Arctostaphylos uva-ursi*), low sweet blueberry (*Vaccinium angustifolium*), teaberry (*Gaultheria procumbens*), and rice grass (*Oryzposis pungens*). Thus soil and vegetation were similar to those of Site Group D—*Arctostaphylos—Vaccinium* vegetation type, as described by Jameson (1961), which is a widely distributed and important site in southeastern Manitoba.

METHODS

Selection of Seedlings

Seven seedlings, ranging in age from 1 to 8 years, were selected for study. Seedlings chosen were healthy, growing vigorously, and free from disease and damage caused by insects and mammals. Those 3 to 8 years of age were selected where seedling density averaged 5,300-6,000 stems per acre. Since the root systems of 1- and 2-year-old seedlings were not considered to have developed sufficiently to influence one another, no density control was imposed.

Excavation and Mapping of Roots

Root systems were excavated using a trowel, an ice pick, and a forest service pack pump. The use of water greatly facilitated excavation, particularly of the vertical root system, as the sandy soil was easily washed away. A great deal of digging was done with the hands as the smaller rootlets were easily damaged by instruments. Excavation time ranged from 2 man-hours for 1-year-old seedlings to 5 man-days for 5- to 8-year-old seedlings.

The vertical root system directly below the stem and along two main horizontal laterals, and the entire lateral (horizontal) root system, were mapped on cross sectional paper. A metre square grid of 10 x 10 centimetre squares was used in plotting the root systems of the larger seedlings (Figure 1), while a 40 x 40 centimetre grid of 5 x 5 centimetre squares was used for the smaller seedlings and as a supplement to the larger grid.

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[3] Nomenclature after Budd, A.C., 1957.

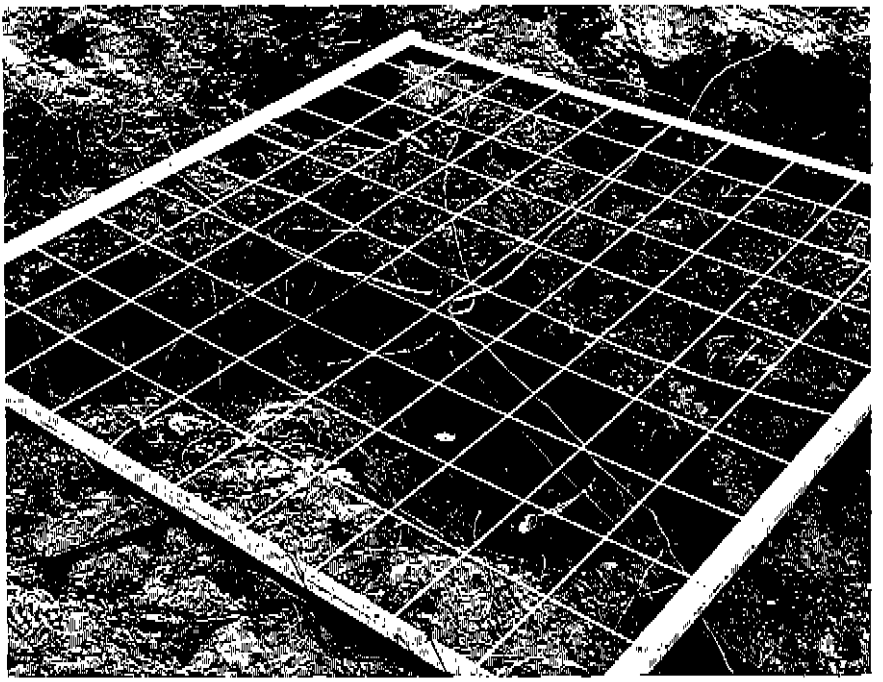

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FIGURE 1. The metre square grid in position for mapping.

Measurement of Seedlings

Total height of each seedling (aërial portion) was measured to the nearest 1.0 millimetre, and diameter at root collar to the nearest 0.1 millimetre; lengths of lateral and vertical roots were measured to the nearest 1.0 millimetre. Verticals and major branches of verticals directly below the stem were measured from the root collar, while verticals descending from two main laterals were measured from point of initiation on the lateral.

Tops and complete root systems were oven dried at 105°C until reduction in weight ceased and then weighed to the nearest 0.01 gram.

RESULTS

Seedling data are summarized in Table 1. Root development is illustrated by graphs in Figures 2, 3 and 4, and pictorially in Figures 1 to 13 of the Appendix.

TABLE 1. SUMMARY OF SEEDLING MEASUREMENTS

Age (years)	Height (mm)	Diameter at root collar (mm)	Weight (grams)		Top:Root ratio
			Top	Root	
1	22	0.4	0.01	0.005	2.0:1
2	38	0.9	no data	0.02	—
3	65	1.2	0.05	0.05	1.0:1
4	148	2.7	0.49	0.52	0.94:1
5	618	12.8	46.40	12.68	3.66:1
6	1,043	17.4	84.72	17.37	4.88:1
8	1,290	20.8	174.72	51.98	3.36:1

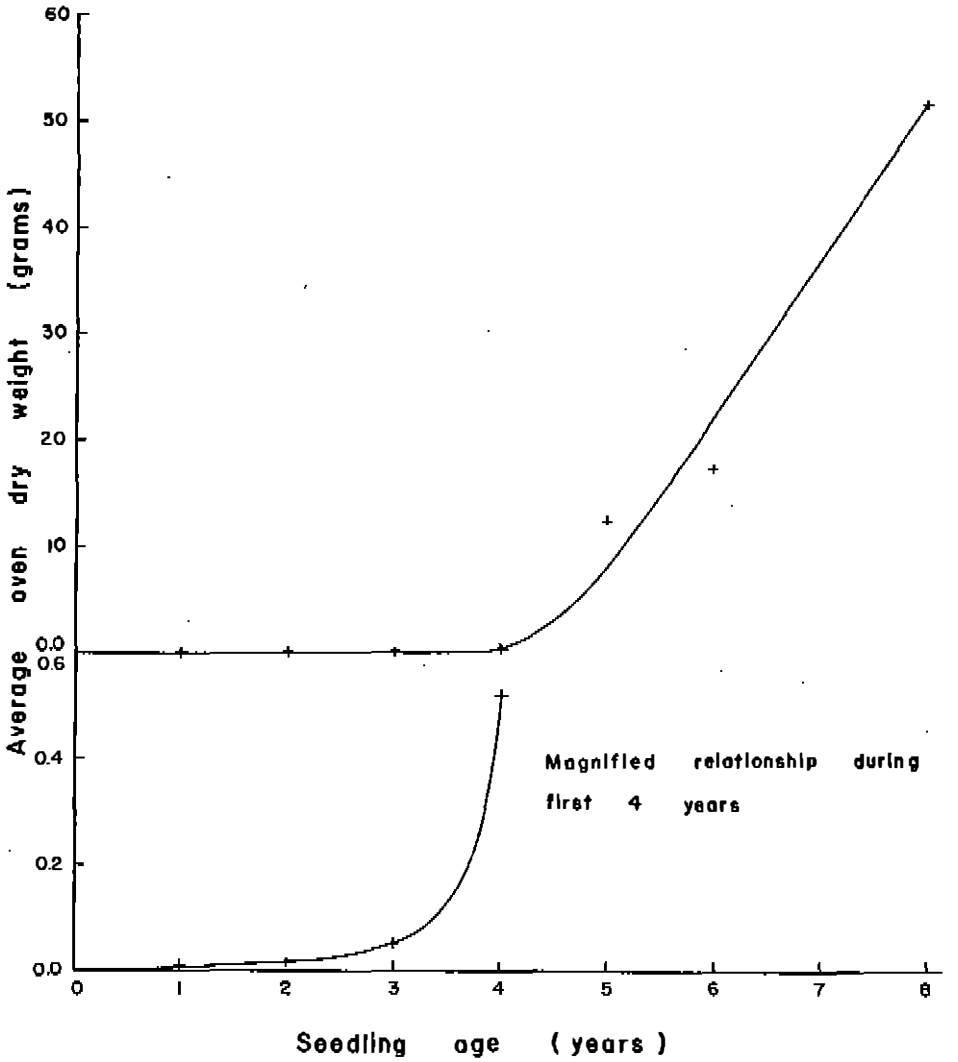


FIGURE 2. Relationship between root weight and seedling age.

Early root development was confined mainly to the tap-root, which by 4 years had descended almost 50 centimetres (19.7 inches) with no appreciable branching. Branching of the tap-root and descent of sinkers from lateral roots first appeared on 4-year seedlings and increasingly on older seedlings, but average length of vertical roots remained relatively constant beyond this time (Figure 3).[4]

There was little early development of a lateral root system but lateral growth increased markedly on 4- to 5-year seedlings (Figure 4), at which age the average length of roots in the lateral system also increased rapidly. Lateral root systems, disregarding sinkers, were quite shallow, the deepest root terminat-

[4] It should be noted that the Figures 3 and 4 are not meant to illustrate absolute values, but to describe the trend of root system development.

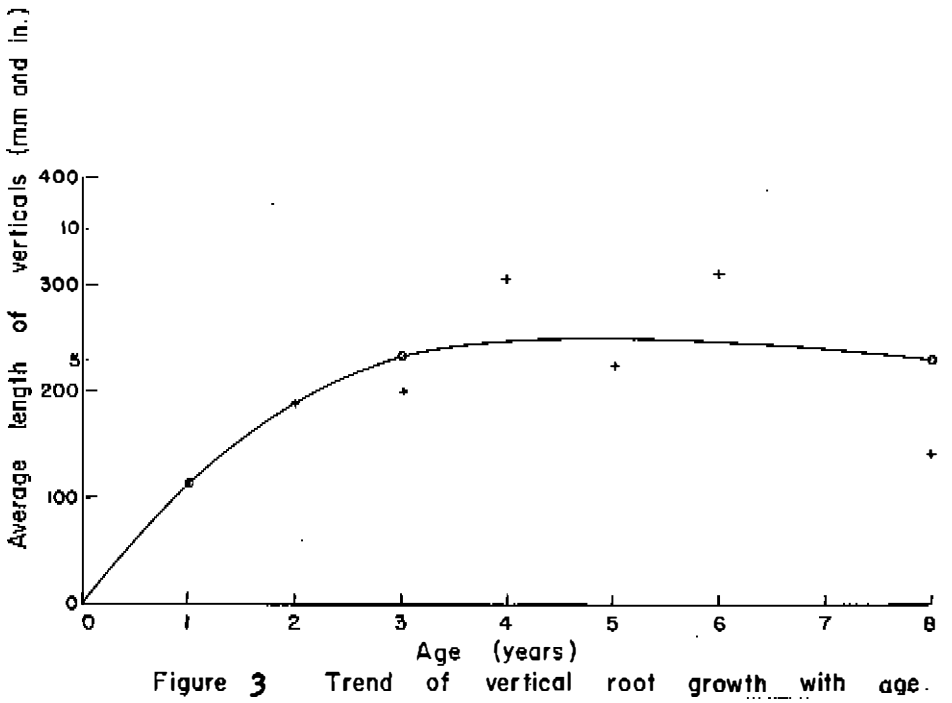


FIGURE 3. Trend of vertical root growth with age.

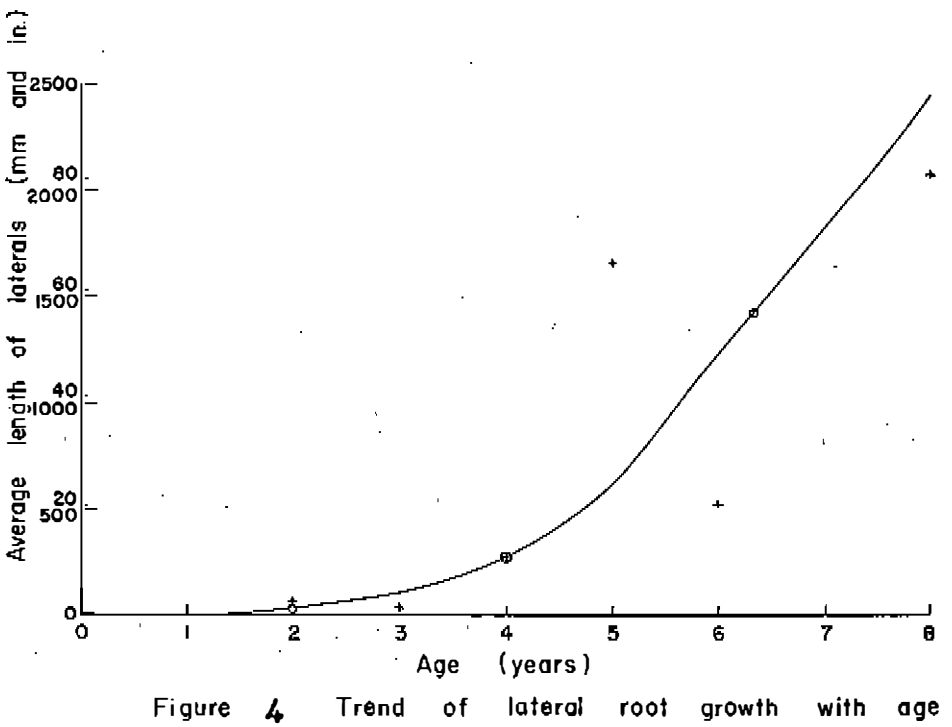


FIGURE 4. Trend of lateral root growth with age.

ing at a depth of 40 centimeters (15.8 inches). The majority of laterals terminated at depths of from 5-15 centimeters (2-6 inches).

A significant increase in root weight occurred in the fourth year after germination (Figure 2), the age at which lateral root development began to increase.

Sterrett (1920) stated that on dry sandy sites the jack pine tap-root descends 6-12 inches during the first year and develops very few laterals, and that on better soils a wide-branching lateral system develops early because of available soil nutrients. Ahlgren (1959) reported that areas of thick humus layer may have deeper roots due to the depth to mineral soil, but on burns the depth of the root system may be less. Results obtained in this study substantiate the above observations of behaviour on dry sites. Initial root development was confined to the tap-root which, however, grew to a depth of only 10 centimetres (4 inches) the first year. Four to five years after germination a shallow but extensive lateral root system began to develop.

The expansion of the root system coincided with the passage of the tap-root into the soil layer below the level of greatest grass- and herb-root concentration, suggesting that once competition to the vertical root system for moisture and soil nutrients was reduced the lateral system expanded, increasing the capacity and potential for stem growth. Root competition was intense in the upper 8 to 12 inches of soil. *Arctostaphylos uva-ursi* and *Oryzopsis pungens* produced the most dense and widespread root systems and probably exerted the greatest influence on root growth of the jack pine seedlings.

Top-root ratios of the Manitoba seedlings studied ranged from 0.94:1 to 4.88:1; highest ratios occurred in the oldest seedlings. Ratios for 1- to 4-year-old seedlings were 2.0:1 or less (Table 1). Considering the site upon which the seedlings became established, these ratios are probably more favourable than the ratio of 3:1 or less recommended for coniferous planting stock (Hawley and Smith 1954, Armson 1960) and more favourable than ratios of average jack pine stock grown in forest nurseries in the Lake States (Rudolph 1950 : 41). Previous studies (Anon. 1940) of planting on an open sand plain in Michigan showed survival of 1-0 and 2-0 seedlings to be highest for planting stock of lowest top-root ratio.

APPENDIX

FIGURE 1. Root development of a 1-year-old jack pine.

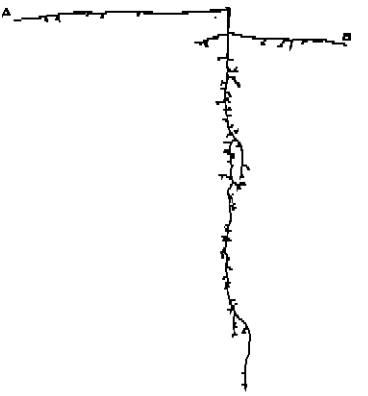


FIGURE 2. Vertical root development below the stem and along two main laterals of a 2-year-old jack pine.

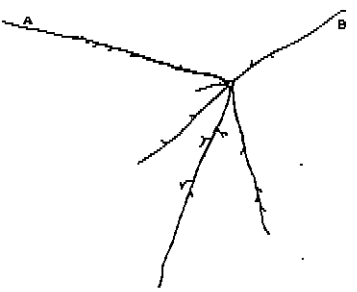


FIGURE 3. Lateral root development of a 2-year-old jack pine.

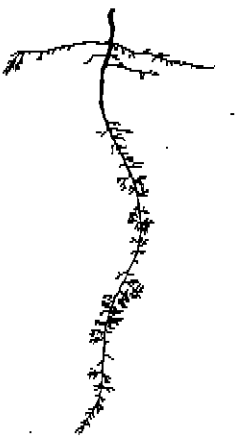
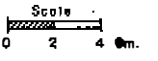


FIGURE 4. Vertical root development of a 3-year-old jack pine.

FIGURE 5. Lateral root development of a 3-year-old jack pine.



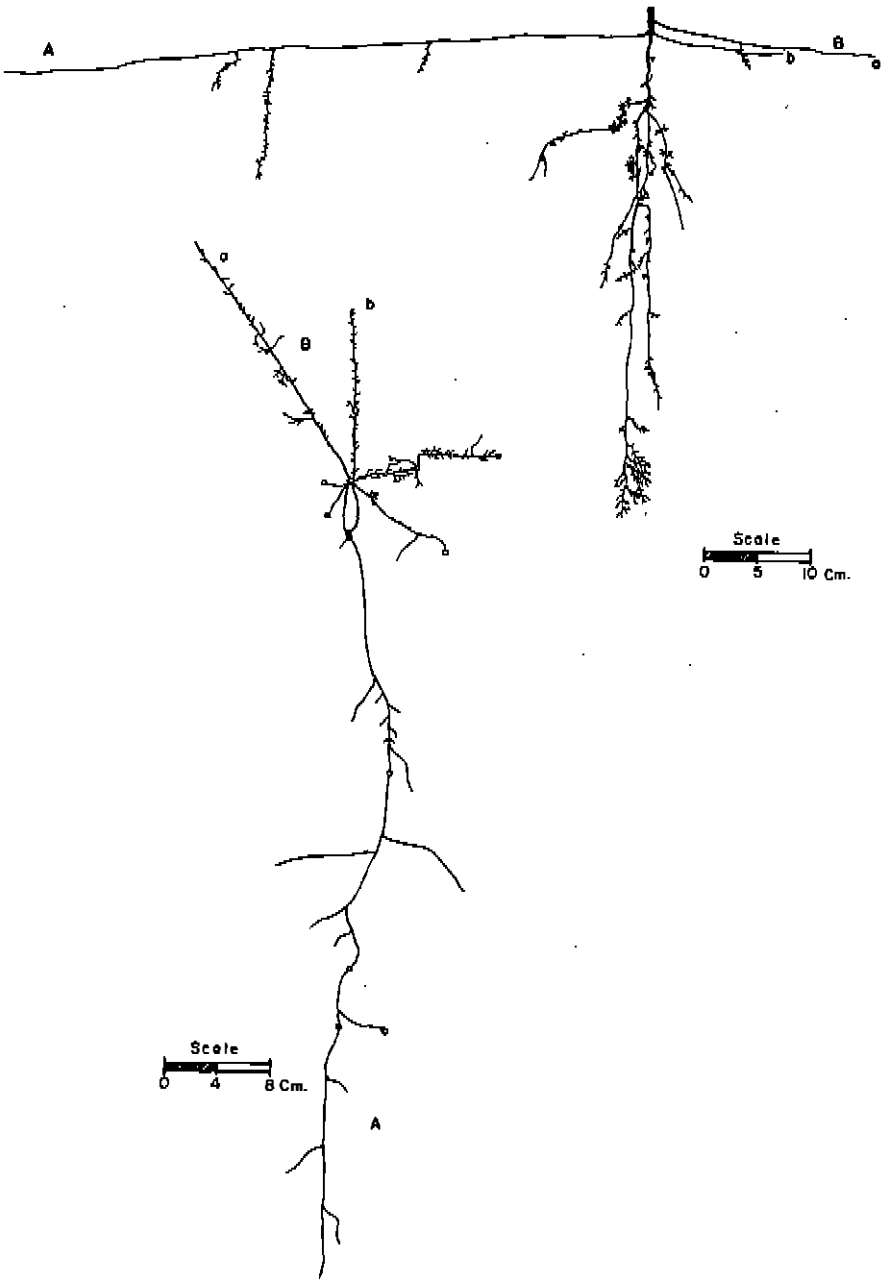


FIGURE 6. Vertical root development below the stem and along two main laterals of a 4-year-old jack pine.

FIGURE 7. Lateral root development of a 4-year-old jack pine. A circle (o) indicates the descent of a root at that point.

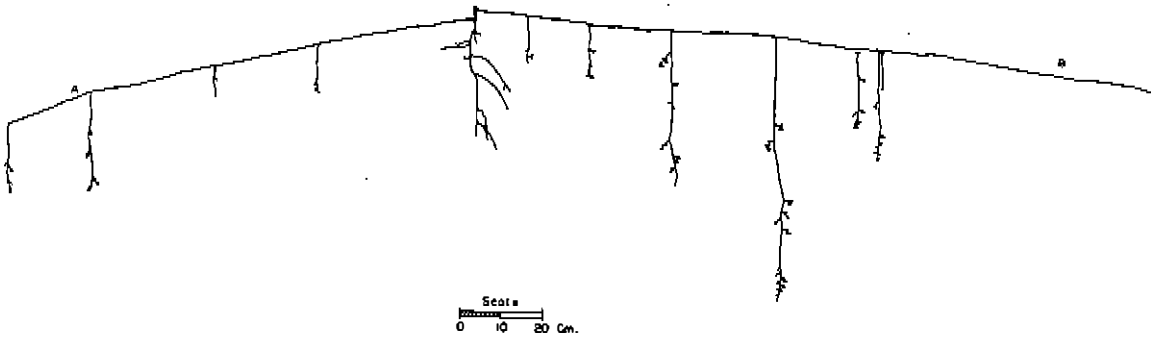


FIGURE 8. Vertical root development below the stem and along two main laterals of a 5-year-old jack pine.

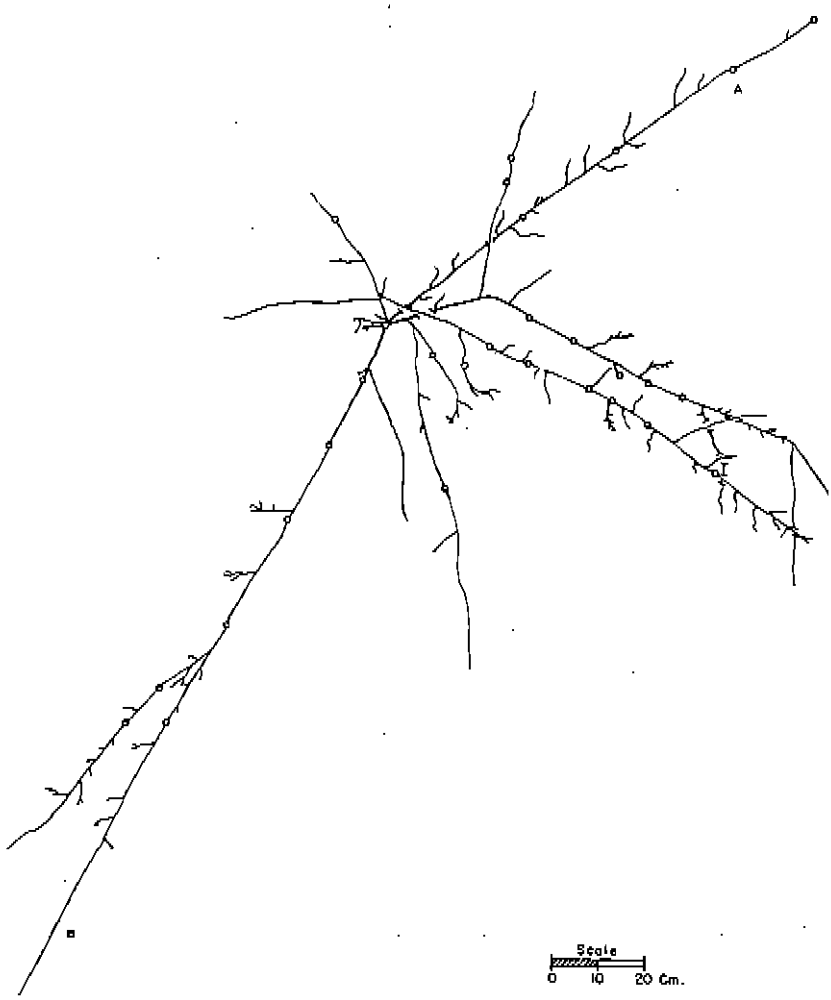


FIGURE 9. Lateral root development of a 5-year-old jack pine. A circle (o) indicates the descent of a root at that point.

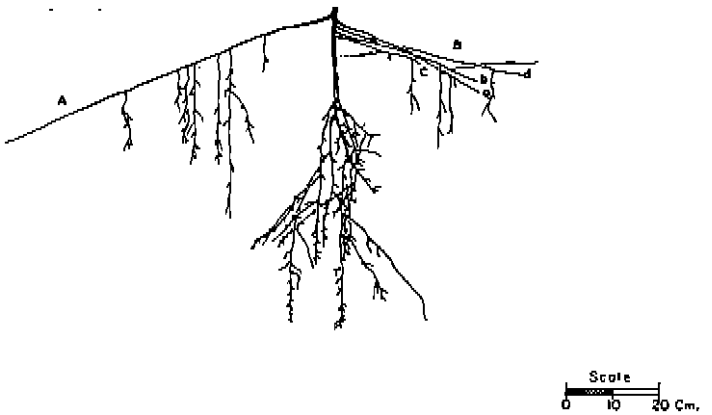


FIGURE 10. Vertical root development below the stem and along two main laterals of a 6-year-old jack pine.

FIGURE 11. Lateral root development of a 6-year-old jack pine. A circle (o) indicates the descent of a root at that point.

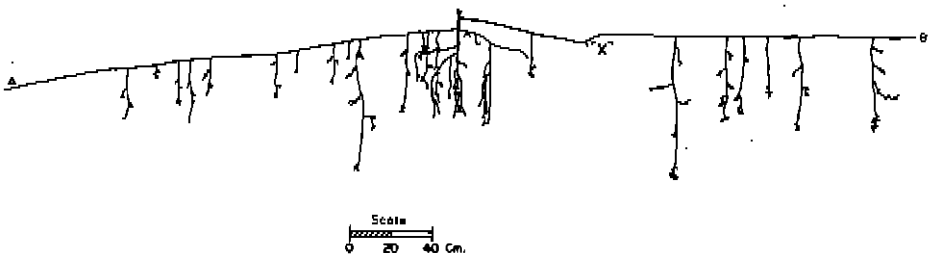


FIGURE 12. Vertical root development below the stem and along two main laterals of an 8-year-old jack pine.

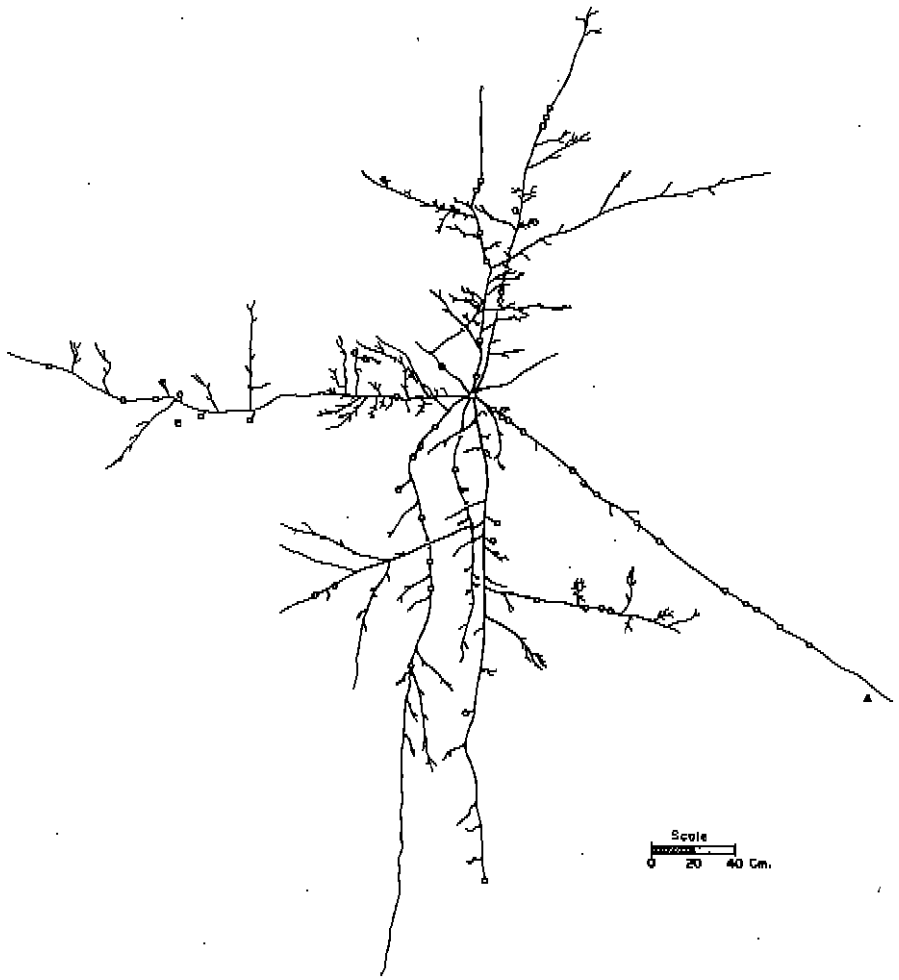


FIGURE 13. Lateral root development of an 8-year-old jack pine. A circle (o) indicates the descent of a root at that point.

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