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Production of Dry Matter from Aspen Stands Harvested on Short Rotations

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by

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INTRODUCTION

Although the aspens (Populus tremuloides Michx. and P. grandidentata Michx.) are amongst the most widely distributed species in Canada and the United States, their utilisation has been disproportionally small; in fact aspen was considered a weed species for many years. Historically aspen was first used mainly for excelsior, splintwood and pulp, and since 1945 it has been used for hardboard, particle board, lumber and veneer.

In response to increasing interest in poplar, a symposium was held at Harrison Hot Springs, B.C., in 1967 to review and discuss the status of this genus in Canada. One of the points emerging at the symposium was that the trend toward greater utilization of hardwoods, together with reduced wood supplies in some areas, is focusing on those species which have the capacity for high yields on short rotations (Maini and Cayford, 1968).

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More poplar will be used and this will entail more intensive management. Perhaps new silvicultural systems as well as new methods of harvesting and processing will have to be developed. One approach is short rotations (McAlpine et al.1966 and Schreiner 1970) and utilization of a greater part of the tree (Young 1968 and Henry 1972).

This paper presents the results of the first four years of clear cutting aspen on short rotations. The major objectives of this experiment are to determine (a) the age which produces the greatest annual yield of wood fibre and (b) how the amount of fibre produced is influenced by repeated harvesting on short rotations.

METHODS

The experiment is being conducted at the Petawawa Forest Experiment Station, Chalk River, Ontario. An 18-acre area was clear-cut during the winter of 1968-69. The whole trees were skidded to landings where they were cut into logs and bolts and the slash burned.

The study area is on a north slope with soil of a moderately deep glacial till. The stand prior to harvesting was of mixed intolerant hardwoods, over 50 percent of which was aspen with an average diameter of 11 inches and a dominant height of 85 feet at 60 years. According to Plonski (1960) this is a Site Class 1 for this species.

Seven rotation ages were selected; 1, 2, 3, 5, 8, 13, and 20 years. The concentration in the early years was thought to be necessary to trace the rapid changes in stand development that occur early in the life of the stand. It is well known that after cutting, a new sucker stand

develops that has the ability to completely occupy a site within 2 to 3 years after harvesting (Einspahr 1972).

The seven treatment areas were laid out in a block on both sides of a baseline which was run parallel to the slope to minimise site differences. Rotation ages were assigned to the areas at random. Four replicates were established. Within each treatment area a 16.5 foot square sample plot was established.

In laying out the treatment areas and the sample plots within them care was taken to avoid competition between trees on different sample plots. The surround for each sample plot was made sufficiently large to prevent below ground competition from the roots of trees growing in the adjoining area. The distance required for this is dependent on the root spread of the species, which usually extends beyond the zone of influence of the aerial parts of the trees. A review of literature relating to root spread of aspen (Day 1944, Berndt and Gibbons 1958, Gifford 1966 and Tew et al.1969) shows that roots extend up to 50 feet by the time trees are 20 years of age. A graph showing root spread (Day 1944) was used to determine the width of surround required around each sample plot.

The size of each treatment area was determined by the width of surround required around the sample plot within it, this width being governed by the rotation age designated for the area itself and the rotation ages for adjoining areas. The sample plots are square, with sides 16.5 feet long (providing an area of 1/160 acre) and the minimum width of surround was 16.5 feet. This applied to rotation ages up to 5

years, and for older ages the width of surround was determined from Day's graph.

Each year after leaf fall, beginning in 1969, the numbers of stems on each sample plot were tallied by three size classes: those trees under 4 feet in height, those over 4 feet but with a diameter at breast height of less than 0.5 inches, and trees having a breast height diameter of 0.5 inches or larger. For trees in the last category the diameter and height of each tree were recorded. The designated sample plots and their surrounds were then clear cut, the trees being cut as close to the ground as possible. The cut trees from the sample plots were then oven-dried and weighed to obtain the weight of wood fibre plus bark.

Each year a sample of trees over 0.5 inches d.b.h. was harvested, covering the range in size, and the oven-dry weight obtained. A regression of tree dry weight on $d.b.h.^2$ and height was derived for the prediction of weights of individual trees.

To date the one-year rotation stands have been harvested four times, the two-year stands twice and the three-year rotation stands once.

RESULTS

The first year following the cutting of the mature overstorey the resulting aspen sucker stand varied considerably over the entire area. On the 28 sample plots the numbers ranged from a low of 2,000 to a high of about 67,500 with an overall average of about 25,000 stems per acre.

The regression equation for estimating dry weight for trees over 0.5 inches d.b.h. is:

$Y = 0.1632 + 0.1122X - 0.00047X^2$ $\quad R^2 = 0.963$

where Y = oven-dry weight in pounds

$X = (d.b.h.)^2H$ with d.b.h. in inches and H (height) in feet.

The results to date are presented in Tables 1 to 4 and will be discussed in terms of development of stands by rotation ages. The data presented in the tables are average numbers of stems and average dry weight produced.

The standard error, as a percentage of the mean, was calculated for each of the means shown in Tables 1 to 4. The average of these standard errors, amounted to 22 percent for number of trees and 28 percent for weight. Although the standard errors are relatively high, because of the wide range in numbers of trees on individual plots, the trends shown are indicative of the development of young aspen stands.

One-year rotation

Table 1 shows the average data for the four plots which have been harvested annually. Both numbers and weight increased following the first harvest but the third and fourth harvests have shown a marked decrease in the number of stems and the weight of material produced. In fact the fourth rotation consisted of about 60 percent of the number of stems in the first rotation, and 16 percent of the weight harvested at the end of the first year.

Two-year rotation

Table 2 shows the average development of the four stands that

were cut on a two-year rotation. The number of stems over a two year period from initiation to harvest followed the usual pattern of decrease in numbers. The initial number of stems starting the second rotation were slightly higher than that at the start of the first rotation but by the end of the second year the numbers had decreased and were practically the same as that harvested two years before. The weight of fibre produced in the second rotation was about 45 percent of that cut in the first harvest even though the numbers of stems were nearly the same.

Three-year rotation

Table 3 shows the average development of the four stands cut on a three-year rotation. During the three years of the first rotation the number of stems decreased as expected. But in the year following the harvest the new stand had fewer stems than there were immediately prior to the cut.

Stands not harvested to date

The data for all 16 stands that are scheduled for harvesting on rotations longer than three years were combined and the average presented in Table 4. The dry weights for trees larger than 0.5 inches dbh were derived from the regression equation based on $(dbh)^2H$. The oven dry weights for small stems were based on average weights of these size classes from the harvested plots. The numbers of stems per acre decreased with increasing age. The dry-weight shows that annual increment is still increasing.

DISCUSSION AND CONCLUSIONS

This paper has described the production from a natural aspen sucker stand which had originated following the clear-cutting of a mature stand. The data show that aspen stands clear cut on very short cycles decrease in vigor during the second and succeeding rotations in which fewer stems and less wood are produced. This lowered production is well illustrated when the data from the stands harvested on one, two and three year rotations are compared. The four one-year harvests amount to 2574 pounds per acre, the two two-year harvests amount to 4177 pounds per acre which are considerably less than the 5524 pounds harvested from the stands cut on one three-year rotation. This decrease in growth and vigor probably results from a decline in vigor of the root system since on short cycles the sucker stands have been drawing on the reserves without contributing much in return. As Zahner and DeByle (1965) pointed out the new roots produced by the suckers contribute little to the growth for the first six years and by age 25 years are contributing about 50 percent.

The decrease in numbers of stems on the non-harvested areas is consistent with all findings on aspen establishment and growth that the high initial number of stems rapidly decreases over the first few years in the life of the stand.

The current and mean annual increments of the non-harvested stands are still increasing, which is a clear indication that the rotation age for maximum production has not been reached. Further observations will be required to determine production on longer rotations. This concept of a longer rotation is borne out by Hughes and Brodie (1972) who claim that

annual volume increment increases for the first decade and that rotation age would probably fall between 12 and 25 years.

The harvesting and manufacturing methods required in short rotation management have not been covered in this paper. Studies have shown that bark can be separated from the wood and that satisfactory pulps and particle boards can be produced from young aspen but efficient harvesting methods would have to be developed if the system were to be economic.

Table 1. Average per acre development of stands cut on a one-year rotation

Year	Stems (no.)	Oven-dry weight (lb.)
1969 (cut)	19560	917
1970 (cut)	27040	990
1971 (cut)	22720	522
1972 (cut)	11560	145

Table 2. Average per acre development of stands cut on a two-year rotation

Year	Stems (no.)	Oven-dry weight (lb.)
1969	23920	
1970 (cut)	22200	2877
1971	26760	
1972 (cut)	22240	1300

Table 3. Average per acre development of stands cut on a three-year rotation

Year	Stems (no.)	Oven-dry weight (lb.)
1969	36400	
1970	29120	
1971 (cut)	18320	5524
1972	15440	

Table 4. Average per acre development of uncut stands

Year	Stems (no.)	Est. total oven-dry weight (lb.)	Current increment (lb. dry weight)
1969	23950	1125	1125
1970	20020	2814	1689
1971	11790	4670	1856
1972	9430	6790	2120

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