- *This note presents results of a study of the growth and development of ash root systems and how poor planting practice affects the subsequent development of the plantation.*
- *The preference for using large ash plants at planting may lead to damage and distortion of root systems.*
- *Root deformities were caused in many cases by poor planting.*
- *Over 60% of root systems excavated after one year's growth were classified as having an abnormal configuration as a result of poor planting practice.*
- *Site cultivation had little effect on root development.*
- *The effects of poor planting practice on root architecture do not disappear, and future impacts such as toppling, windthrow and other possible negative effects cannot be ruled out.*
- *Care must be taken at planting time to avoid bundling the roots in the planting hole.*

Poor quality planting of ash – getting to the root of the problem

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Background

Most foresters and managers prefer to use large ash plants (*Fraxinus excelsior*) in the belief that they compete better with the lush vegetation characteristic of ash sites. However, big plants tend to have big root systems and there is a tendency to fold or roll the roots into the planting hole when slit or notch planting; especially where speed takes precedence over good planting (placing the roots evenly and without constriction in the planting hole).

Many foresters have been of the opinion that pit planting, or at least notch planting, was necessary for the successful establishment of large rooted broadleaved plants. Although pit planting is ideal for spreading roots evenly, it is not economically viable because pits take too much time to dig. More economical methods include notch planting, where a spade is used to raise a notch in the form of an L, T or H into which the tree roots are placed and the soil firmed, and slit

A well planted ash tree, where the roots have been arranged in a balanced fashion at planting.

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planting, where roots are placed in a single slit and then firmed in with the heel, but these methods provide less than ideal planting conditions for a large-rooted ash plant.

In all cases it is important not to plant the tree too deeply as this results in corrective growth of the root system to exploit the surface soil layers. Trees should be planted at the height of the original soil level on the tree when it was in the nursery. This is referred to as the root union or root collar. Furthermore all major roots should be firmed-in in without distortion, in the same direction at which they arise from the main root.

Methodology

In order to determine if poor planting results in long-term deformation of ash roots, intact systems were excavated from mounded (M), ripped (R), and ploughed (P) sites, at one, three, five and seven years after planting. Six root systems were excavated at each site. Each tree was coded for site cultivation, age, and location on the site.

The principal excavation tool was an air-knife. A stream of compressed air (piped from a mobile air compressor) was piped through a lance, removing the soil from around the tree roots within a radius of 60 cm. Root systems were then examined and classified according to their configuration. A classification of Normal was given to any root system that did not appear to have been unduly disfigured by the planting operation. Other categories included J-Rooted, L-Rooted and Twisted/Folded. (L-roots differed from the J-roots in that the angle they make with the main root is more acute, normally around 90^{o}.) Only one-year-old roots were ranked for lateral compression, as this did not feature in the roots of the older trees.

Results: Configuration of root systems

One-year-old root systems

Root system development one year after planting was not extensive. Roots of the trees planted at the mounded site had not reached the base of the mounds. The majority of trees appeared to have been planted too deeply, particularly at the ploughed site.

Root systems from the ripped site showed signs of lateral compression and were aligned along the sides of the planting slits. Compression was much less apparent at the mounded and ploughed sites. Examples of twisted and bent roots were found at all sites. It was interesting to note that almost 50% of all the one-year-old trees excavated had L-root formations. There were twice as many bi-laterally aligned root systems at the ripped site compared with the others. In many cases, a taproot wound (resulting from nursery undercutting) was easily discernible, with extensive secondary lateral roots developing above and around this point.

Three-year-old root systems

Long lateral horizontal roots were observed for the first time in three-year-old trees. Most of these were within 5 to 9 cm of the soil surface. Their spread was between 1.5 to 2 m radius around the tree. Development so close to the surface resulted in the roots being intricately interwoven with the grass root mat.

All the root systems on the mounded site had extended well beyond the confines of the mounds. In all cases, after a distance of 40 to 50 cm from the stem, the direction of extension of the shallow, long lateral roots was generally very straight and mostly horizontal. Slight directional deviations appeared to be caused mainly by stones, while the presence of roots of other species (grass or other tree roots) seemed to cause no directional changes in the spread of lateral roots.

A classic example of a J-root, where the taproot was bent upwards at the time of planting.

A typical example of an L-root formation.

Trees were planted relatively deep (root collar was 6 cm below the soil surface) at the mounded and ripped sites. Trees on the ploughed site were less deeply planted. Anomalies in root system shape and arrangement included J-roots, L-roots and a twisted root system. Less than 50% of three-year-old tree samples had L-root formations.

Five-year-old root systems

The growth patterns of long lateral roots observed in the three-year-old trees were also found in this case, though the extension from the root ball was much greater. In many cases, shallow lateral roots extended for more than 3 m from the main root.

At the ripped sites, sections of rip channel had remained open. Roots in a number of trees were seen to follow along the channels. Roots did not cross the open channels in some cases. However, where the channels had closed over, roots crossed the rip line. Although root development was generally in both directions along the rip line, root development in other directions also occurred. At the ploughed site long lateral roots followed the plough ribbon, sometimes staying within 1.5 to 2 cm of the soil surface. Root systems on the mounded site had a high proportion of roots twisted around the main root (e.g. most of the large structural roots on one tree were bent upwards from the base of the main root before leading off horizontally again).

Seven-year-old root systems

Root spread at the ripped site was extensive, with lateral roots remarkably close to the surface (frequently in the top 1 to 3 cm of soil, but most root systems were within the top 20 cm). Secondary roots arising from the long laterals were fibrous, and there was little pattern to the root system. Thirty-three percent of seven-year-old trees had normal root systems.

Conclusions

The method of site cultivation seemed to have very little effect on root system development. It was evident from all the excavated root systems that there had been no replacement of the taproot once it had been removed by the undercutting operation at nursery stage. Instead, a number of smaller sinkers had developed downwards, typically in the area immediately below the termination of the main root.

An undercut taproot showing new lateral roots directly above it. The root system was also compressed bi-laterally.

It was interesting to discover that over 60% of root systems excavated after one year's growth were classified as having an abnormal configuration that appeared to be the direct result of very poor planting practice. The bilateral compression, observed particularly in the one-year-old samples, was clearly caused by the roots being forced into small, narrow, slit-planting holes and from not being spread out before being firmed into the soil.

However, root systems generally appeared to recover rapidly. Three years after planting, the trees had developed long lateral root systems and the overall root system had begun to increase in depth and extent. Following seven year's growth, root systems were extensive and balanced. Thus it seems that root systems may recover from the effects of poor planting practice, at least in the short term. However, the concern remains of the possibility of some form of main root strangulation. Though not likely to be a significant cause of tree mortality, previous work (Stefansson 1978) has shown that such deformities can disrupt nutrient translocation (possibly affecting girth increment) and can lead to infection by decay fungi which could render affected trees susceptible to toppling, and possibly windthrow (Smith 1986), leading to a decline in plantation productivity.

In the long-term, the effects of poor planting practice on root architecture do not disappear and the future impact of effects such as root strangulation are unknown.

The results of this study have shown that large ash trees planted poorly (in most cases probably too quickly), suffer in terms of root balance and arrangement. Possible methods of remedying the situation include:

- increasing the amount of attention to the detail of planting, allowing more time to plant each tree, and training planting personnel in the correct methods of planting;
- reducing the size of plants – however, to prevent trees being swamped on fertile sites, this would require increased concentration on vegetation control and spraying.

The roots of this plant have clearly been folded back and forth underneath for ease of planting.

References

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