Competition Control for Establishment of Ash (*Fraxinus Excelsior L*) on Lowland Soil in Ireland

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Summary

The herbicide glyphosate was used to control competing vegetation in an ash plantation on a fertile agricultural site in Co. Wexford. Treatments consisted of complete weed control, and strip treatments of 0.5 and 1.0 m width and no treatment. The strip treatments were coupled with mowing or not mowing the untreated grass strips. The best result after three growing seasons was for the 1.0 m strip without mowing, with a cumulative height growth of approximately 134 cm. The poorest performance was for the untreated replicates which had a cumulative height growth of about 45 cm. We speculated that competition for water and/or nutrients was the cause for poor growth in the untreated plots. The reason for the beneficial effect of leaving an unmowed grass strip between the tree is unclear, but it would appear to be related to a combination of nutrient availability and protection, from wind of the young plants.

Introduction

Ireland has the lowest proportion of trees in the European Union (EU) with forests covering almost eight percent of the landscape. Forestry provides a means of diversifying the landscape and helps facilitate sustainable agriculture (Culleton and Lee 1993). Forest products can be a viable component of farm production (Richards et al. 1988) and forests can be useful in schemes designed to protect eroded land (Whitley 1991).

In Ireland, as in much of the EU, the majority of forest planting since the turn of the century has been with conifer species (Gillmor 1993). Recent interest in deciduous trees has sparked a number of studies on deciduous species and their suitability in Ireland (Fitzsimons 1987). Deciduous trees are being promoted because they can supply products that are in demand (Fitzsimons and Luddy 1986) and furthermore, they were components of the 'natural' landscape of Ireland before land clearing took place (Hickie 1990). Grants are available through the EU that cover the initial cost of establishment of trees and maintenance grants extend for 20 years beyond establishment. A premium is awarded for planting of broadleaves to encourage their use.

Farmers have been reluctant to plant deciduous tree, mostly because they were uninformed as to the potential of such species. The longer

rotation of many deciduous species has been a major disincentive to their culture, but species like ash (*Fraxinus excelsior*) and sycamore (*Acer pseudoplatanus*) are relatively fast growing and can produce a merchantable forest crop in a rotation length not unlike Sitka spruce (Culleton 1993). Ash is useful for a variety of products such as for furniture and hurleys (Culleton *et al.* 1993). Ash is also a fast growing species which requires a fertile growing site (Bulfin 1992) and it is particularly well suited to the productive lowland mineral soils (Culleton and Bulfin 1991). New EU granting scheme and CAP reforms provide incentive for converting such sites to forestry (Daly 1990).

Ash responds to high pH and to high levels of N and P (Gordon 1964), but on the fertile lowland soils, weed and grass competition is severe (Culleton *et al* 1993). On such sites, weed control is necessary in order to ensure establishment and rapid early growth of planted saplings (Culleton *et al* 1993; Culleton and Bulfin 1991, 1992). Herbicidal control of competing vegetation is well suited to plantation forestry, and the herbicide Glyphosate appears especially well suited since it is a broad spectrum chemical that is rapidly deactivated in the soil (Thomas and Burke 1972).

Thus, to provide information to Irish farmers who are considering tree planting on their agricultural sites, this study was designed to investigate the effect of herbicidal control of competing vegetation in ash plantations.

Methods

The competition control study was designed with six treatments, listed below:

1. Complete kill – All vegetation was sprayed 2-3 times per year with glyphosate which controlled virtually all competing vegetation.
2. Untreated – The competing vegetation was permitted to grow unaltered.
3. Narrow strip, mowed – a band 0.5 m wide, centred across the tree rows was sprayed with glyphosate and the remaining grass strips were kept mowed.
4. Narrow strip, unmowed – This treatment is similar to no. 3, above except the grass strips were left to grow.
5. Wide strip, mowed – This treatment is similar to no. 3, above except the sprayed band was increased to 1.0 m width.
6. Wide strip, unmowed – This treatment is similar to no. 5, above except the grass strips were left unmowed.

The planting site was a fertile lowland agricultural soil of the Crosstown Complex. The soil is a well-to moderately-drained brown earth with stratified loam over clay loam. The study site is part of a larger experimental block that had been fenced to exclude hares.

The statistical layout of the trial was a randomized complete-block design (Fig. 1) with 6 blocks, each containing all 6 treatments. Treatment plots consisted of 6 rows of 11 trees each, giving a total of 66 trees per plot. Thus, the 6 replications each contained 396 saplings and the entire study contained 2,376 saplings.

Bare-root nursery stock was obtained from Coillte, averaging 60 cm

Figure 1: *Layout for weed control trial.*

1.0m Cut	Kill	0.5m No Cut	1.0m No Cut	0.5m Cut	No Kill
0.5m Cut	0.5m No Cut	No Kill	0.5m Cut	Kill	0.5m No Cut
Kill	1.0m No Cut	0.5m No Cut	No Kill	1.0m No Cut	0.5m Cut
1.0m Cut	Kill	0.5m Cut	No Kill	1.0m No Cut	0.5m No Cut
Kill	No Kill	1.0m No Cut	0.5m Cut	1.0m Cut	0.5m No Cut
1.0m Cut	0.5m No Cut	0.5m Cut	1.0m No Cut	No Kill	No Kill

in height. Saplings were planting in the spring of 1991 by digging a hole in the soil of adequate size to accommodate the root mass, inserting the roots, backfilling and compacting the soil.

Height growth, total height and grade (good, medium and poor), using a subjective scale were 3 = good and 1 = poor, were measured in December 1991 and again after 1992 and 1993 growing seasons. In 1992 and 1993, sapling diameters at 1.3 m were measured. The data were analysed using analysis of variance to determine if treatments significantly affected height growth and grade.

Duncan's Multiple Range test was utilized to determine which means were significantly different.

Results

Analyses of variance were performed on plot-mean data to determine if the treatments were significantly different for incremental and total height and diameter. Table 1 indicates that annual height growth and total height growth at year three

Table 1: *Annual height increments and cumulative total height of trees, by treatments.*

Treatment	*Height increment (mm)*			*Total height (mm)*
	1991	*1992*	*1993*	*1993*
1.0 m, not cut	17.4 (1)*	6.53 (1)	56.6 (1) A**	192.6 (1) A
1.0 m, cut	5.6 (4)	47.2 (3)	52.3 (2) A	160.0 (3) C
Weed free	6.9 (3)	21.0 (5)	51.3 (3) A	156.9 (4) C
0.5 m, not cut	11.9 (2)	54.7 (2)	47.5 (4) B	173.3 (2) B
0.5 m, cut	4.5 (5)	40.2 (4)	46.8 (5) B	155.9 (5) C
Untreated	3.3 (6)	13.9 (6)	27.6 (6) C	100.0 (6) D

* Rank in descending order

** Duncan's Test - means with the same letter are not significantly different (Alpha = 0.05)

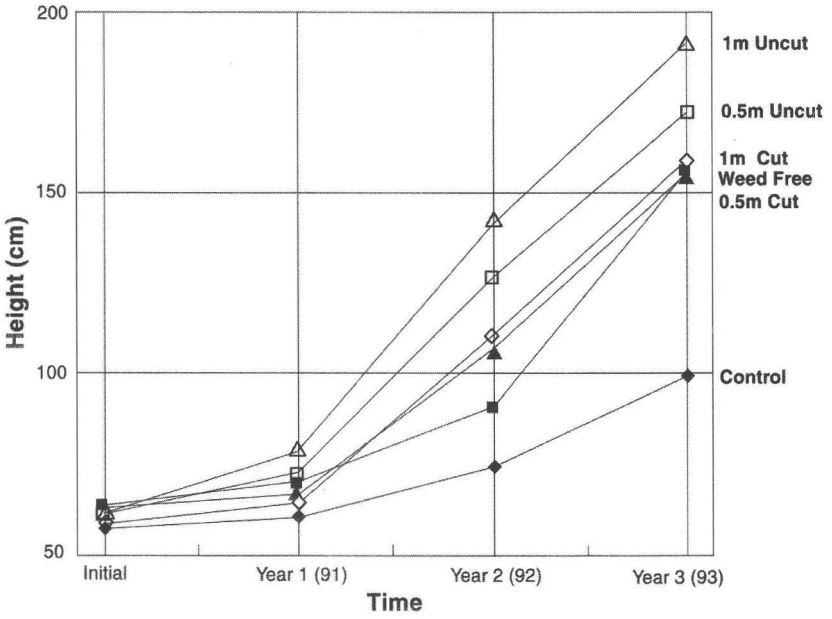

Figure 2:
Average height growth and time of treatments.

(1993) were significantly different by treatments. Diameters at 30 cm showed a similar trend (Table 2). The greatest height growth occurred for treatment 6 (1 m strip, unmowed) and the poorest for treatment 2, the untreated control. Duncan's Multiple Range treat indicated which means were significantly different. In general, the control was always significantly poorer than any of the treatments for both height and diameter and the 1 m, not cut treatment usually was the best, often significantly so.

In 1991, the first season after planting, height growth of the untreated

Treatment	*Diameter Increment (mm)*	*Total Diameter (mm)*
	1993	*1993*
1.0 m, cut	9.3 (1)* A**	23.3 (3) C
Weed free	8.2 (2) B	21.9 (5) D
1 m, not cut	8.0 (3) B	26.5 (1) A
0.5 m, cut	8.0 (4) B	22.3 (4) D
0.5 m, not cut	7.8 (5) B	24.4 (2) B
Untreated	4.5 (6) C	12.4 (6) E

* Rank in descending order

** Duncan's Test - means with the same letter are not significantly different (Alpha = 0.05)

Table 2:
Diameter increment and cumulative total diameter (at 30 cm), by treatment for 1993.

plots averaged only 3.3 cm while the best treatment (1 m, not cut) averaged 17.4 cm, a difference of 14.1 cm. In 1992, the corresponding figures were 13.9 and 63.5 cm with a difference of 49.6 cm. In 1993, the difference between the 1 m, uncut treatment and the control was 25 cm with treatment 2 averaging 27.6 cm and treatment 6 averaging 52.6 cm. Plotting the apparent growth curves of the various treatments over the three years of the study (Fig. 2) revealed that the best treatment (1.0 m, not cut) appears to be sustaining a rapid rate of growth while the control is still struggling to get started. Although all treatments started with seedlings of the same height, the 1 m, uncut treatment is currently almost twice as tall as the control.

Diameter at 30 cm height in 1993 gave results that were similar to those obtained for height growth (Table 2). The 1 m, not cut treatment had the largest average diameter in 1993 (26.5 mm and the control was the smallest at 12.4 mm. Duncan's test indicated that the 1 m, uncut treatment was significantly larger in total diameter than any of the others while the control was significantly smaller. There was a significant Pearson's correlation between sapling height and diameter ($r = 0.98$).

For sapling grade, there seemed to be little effect of treatment, although the average grade for the untreated plots was generally lower than the herbicide treatments.

Conclusions

A number of researchers have recommended planting of deciduous trees in Ireland (Fitzsimon 1987, Richards *et al.* 1988). Ash seems to be well suited to such plantings, especially on the more fertile agricultural sites (Daly 1990). Early results on such sites indicated that weed competition might be a problem in ash culture (Culleton and Bulfin 1992), and our results after three growing seasons seem to verify this.

Rapid early growth of planted saplings is desirable from several standpoints. First, saplings that get off to a good start generally maintain good growth, which accelerates the rate of maturity and shortens the rotation length. This has dramatic economic benefits, since the initial investment in planting becomes more difficult to justify as rotation length increases. Growing trees on a long rotation has not proven to be attractive to farmers, who are accustomed to a short interval between planting and harvest. In point of fact, ash has a rate of maturity that is comparable to that of Sitka spruce, but up until recently planting trees on high quality agricultural sites was not an attractive alternative (Culleton, 1993), and species like Sitka spruce were better suited to lower quality sites. There is also an increased awareness of the need to diversify Ireland's forests, particularly with deciduous trees. Ash seems to offer several advantages. It is fast growing and there is good market potential for ash as hurleys and for furniture (Culleton *et al.* 1993, Fitzsimons and Luddy 1986). But on the high quality sites that are required for ash, competition can be a problem for establishment and rapid early growth.

It is evident from the results of this study that controlling competition is essential to the early establishment of

ash on lowland agricultural sites. Height growth of ash with competition control in a 1.0 m wide band exceeded that of untreated plots by almost twofold after three growing seasons and the quality of stems seemed as good, or slightly better with competition control.

The surprising finding in this study was that leaving an unmowed strip of grass between the rows of saplings actually provided a significant benefit to height growth of the ash.

The exact reason for these results are not very clear. We speculate that one possible explanation is a two tiered argument:

a) The weed free zone in the immediate environs of the tree gave the trees unrestricted access to available soil nutrients without competition from grasses and weeds. There is little doubt the weed free zones do increase growth rates (Culleton and Bulfin, 1992).

b) There was a beneficial effect of leaving an unmowed grass strip between the ash rows in that this strip protected the young plants from the constant, often high winds normally experienced in Southeastern Ireland. The grasses and weeds which often reach a height of 50-60 cm probably act to deflect the wind over the ash saplings. The effect of wind may also be related to moisture stress since wind enhances the rate of evapotranspiration.

Another explanation maybe that competition control is making more water available to the tree saplings. Allelopathy and/or possible soil temperature effects cannot be ruled out completely.

We believe that herbicidal control of competition in 1 m wide bands is a means to help ensure establishment and rapid early growth of ash plantations on agricultural sites.

Now that the need for vegetation control has been established, we need to definitively establish how many years for which weed control is necessary and how many treatments per year are necessary to get the optimum results. Preliminary results in unpublished trials suggest that when trees reach 2.0 - 2.5 m tall, there is very little need for further weed control. Finally, we need to decide which herbicide is best to obtain the desired results. The ideal herbicide should be inexpensive, require only one application per year, selective for the target species and environmentally safe. We used glyphosate in our study, and certainly it meets many of these criteria, but other materials may be as good, or better. There may also be combinations of herbicides that will produce a better effect and these should also be investigated.

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