Growth Regulators and Irrigation Mitigate Competition Between Intercropped Grass and *Fraxinus nigra* 'Fallgold'[1]

Jeffrey H. Gillman[2] and Chad P. Giblin[2]
Department of Horticultural Science
University of Minnesota, St. Paul MN 55108

Abstract

Grass, intercropped with nursery stock, is beneficial to the long-term productivity of a field due to decreased erosion of topsoil and increased soil organic material. The primary disadvantage of using grass as an intercrop is supposedly due to a reduction in nutrients and water available to nursery stock. In the spring of 1999, *Fraxinus nigra* 'Fallgold' trees were planted in herbicide strips with no intercrop (cultivated soil), an intercrop of untreated ryegrass, an intercrop of mowed ryegrass or an intercrop of ryegrass treated with a growth regulator. Half of the trees in each treatment were irrigated and half were not. Growth measurements were taken over two growing seasons. There were no significant increases in growth with the addition of irrigation with the exception of trees grown with an intercrop of growth regulated ryegrass where the addition of irrigation resulted in greater tree height. Trees grown with no intercrop had the greatest increase in both caliper and height. Trees grown with grass treated with a growth regulator and irrigated did not show significantly different growth from non-irrigated trees grown without intercrops. Trees grown with untreated or mowed grass had the lowest increase in caliper and height.

Index words: intercrop, growth regulator, production nursery, woody ornamentals, ryegrass, cover crop.

Species used in this study: *Lolium perenne* L., *Fraxinus nigra* (Marsh.).

Chemicals used in this study: Trinexapac-ethyl (Primo) [4-(cyclopropyl-α-hydroxy-methylene)-3,5-dioxo-cyclo-hexanecarboxylic acid ethyl ester].

Significance to the Nursery Industry

Soils tend to decline in field nursery production settings due to erosion, compaction, and harvest. Grass intercrops have been shown to aid in reducing the erosion of topsoil and increasing organic matter. Grasses are known to affect the growth of plants intercropped with them because of competition for water and nutrients as well as possible allelopathic effects. By finding a way to mitigate the negative effects of intercropped grasses on field-grown nursery stock through some form of growth regulation, either mechanical or chemical, producers can realize the beneficial effects of intercropped grass without losing significant growth.

Introduction

The use of intercrops in the production of field grown landscape trees is controversial. Benefits of intercropping include reduced erosion, a more desirable soil structure, inhibition of weed species, and increased harvest accessability (4, 5). In addition, intercrops generally make P and K more available to cash crops (14). The primary drawback of intercropping is competition between crop plants and intercropped plants for nitrogen and water (5, 15) as well as possible allelopathic effects (6).

To reduce competition between crop plants and intercropped plants, many different methods have been employed, most of which involve inhibiting the growth of the intercrop. Inhibition of an intercrop may be attained through mechanical or chemical means. Mowed intercrops have been used in apple orchards but have generally resulted in decreased apple tree growth as compared to cultivation (8). Additions of water or fertilizer made directly to growing trees, however, bypasses the rootzone of the intercrop and, hence, help to mitigate the effect of the intercrop (9). Chemical growth regulators have been shown to mitigate the effect of grass intercrops in apple (1) and corn (7, 10).

Grasses in general, and ryegrass (*Lolium perenne* L.) in particular, are considered excellent intercrops for their ability to prevent erosion and build soil structure (3). The primary problem with using ryegrass as an intercrop is that it utilizes large amounts of water and nitrogen (3). In addition, ryegrass has been shown to have allelopathic effects on various other plants (8, 12) although, to our knowledge, it has not been shown to be allelopathic to plants in the genus *Fraxinus*. The following experiment was conducted to address the question of whether the negative effects of using ryegrass as an intercrop for *Fraxinus nigra* 'Fallgold' in a nursery setting could be reduced through either mechanical or chemical growth regulation of the intercropped ryegrass. Irrigation was also analyzed as a possible way to mitigate competition between intercrop and nursery crop.

Materials and Methods

One hundred and sixty *Fraxinus nigra* (Marsh.) 'Fallgold' whips 0.9–1.2 m long (3–4 ft), were planted bare-root on May 21, 1999, and arranged into four blocks with four treatment plots per block and ten trees per treatment plot. Individual trees were treated as experimental units. Treatment plots consisted of trees planted in 0.5 meter (1.5 ft) wide herbicide strips (maintained using glyphosate as needed) with a 0.6 m (2 ft) wide intercrop treatment area on both sides of the herbicide strips and 1.5 m (5 ft) between trees within herbicide strips. Treatment plots included trees that were intercropped with perennial ryegrass (*Lolium perenne*, Ph.D. blend) using one of four different treatments: (1) Ryegrass allowed to grow without growth control; (2) ryegrass mowed to a height of 7.6 cm (3 in) when it reached an average height

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[2]Assistant Professor and Assistant Scientist, respectively.

of 12.7 cm (5 in); (3) ryegrass whose growth was controlled with Trinexapac-ethyl (Primo) applied at a rate of 60 ml per 92 m² (2 oz per 1,000 ft²); and (4) a control consisting of clean cultivation [mechanical tilling to a depth of 10 cm (4 in) when tallest weeds grew to a height of 15 cm (6 in)]. Within each treatment plot five trees were selected randomly and irrigated with a drip irrigation system that released 3.8 liters (1 gal) of water between 07:00 and 07:30 am from May until October. A single drip emitter was placed within 0.3 m (1 ft) of each tree to be irrigated. Grass for all treatments was planted at a rate of 4 kg per 92 m² (9 lbs/1000 ft²)on May 15, 1999. Prior to treating intercrops in 2000 all plots were mowed. Plots treated with growth regulator were treated on July 19, 1999, and on May 26, 2000. 2,4-dichlorophenoxy-acetic acid was applied on May 8, 2000, to the intercrop area of all plots to control broadleaf weeds. All plots, with the exception of cultivated plots, were mowed to a height of 7.6 cm (3 in) on July 19, 2000, to prevent grass from seeding. Plots were fertilized with 22–2–3 on May 11, 2000, at a rate of 1.1 kg per 92 m² (2.4 lbs N per 1,000 ft²). Data on tree caliper and height was recorded in June and October of 1999 and 2000. Tree caliper was measured 7.6 cm (3 in) above the graft union and tree height was measured from the graft union to the tree's terminal growing point. Significant differences between treatments were determined by using the general linear model function of SPSS (13).

Results and Discussion

All trees survived for the duration of the experiment. Mowed plots required five cuttings in 1999 and six cuttings in 2000. Cultivated plots required tilling three times in both 1999 and 2000. Trees in cultivated plots showed the deepest green foliage color while trees in other plots were lighter green. Height increases were greatest between October and June for all treatments (Fig. 1), indicating that trees put on most of their shoot growth in the spring. Caliper increases were consistent between measurement dates (Fig. 2), indicating that caliper increased even after shoot growth had ceased.

Irrigation did not have a significant effect on final caliper within intercropping treatments (Fig.3a) although irrigated trees did tend to have a larger caliper than non-irrigated trees. Final tree height was not significantly increased by the pres-

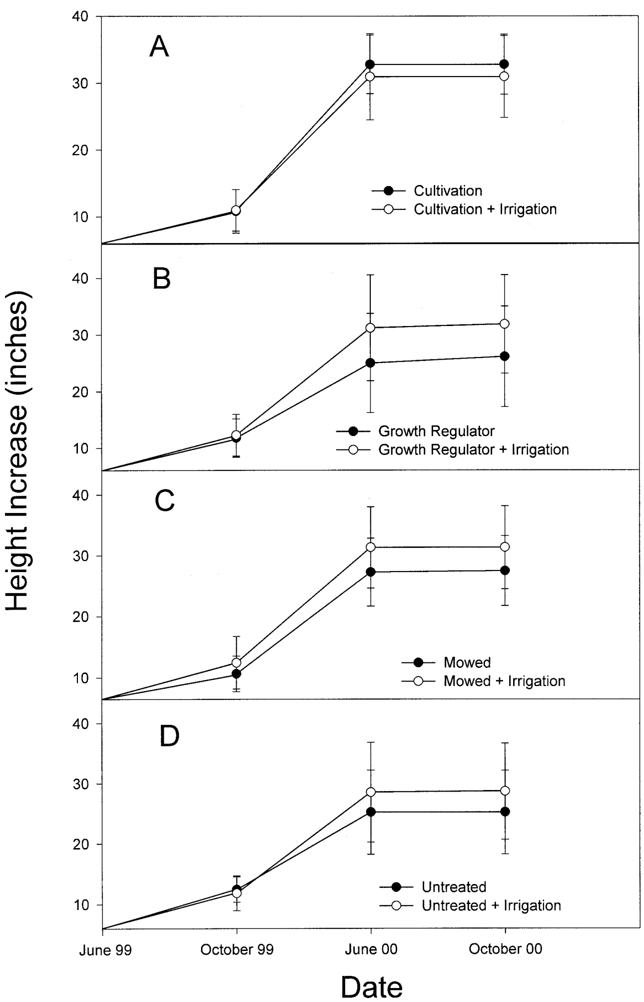

Fig. 1. **Height increase (± SD) of *Fraxinus nigra* 'Fallgold' over two growing seasons without an intercrop (A), or with an intercrop of growth regulated ryegrass (B), mowed ryegrass (C), or untreated ryegrass (D). U.S. measures are displayed as this is the current system used for grading nursery stock.**

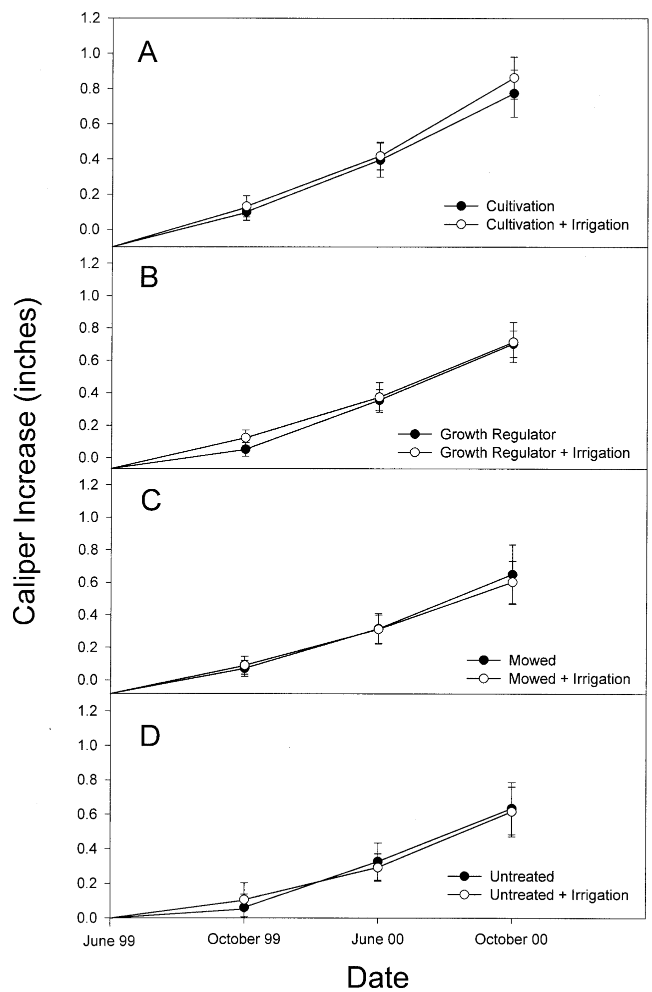

Fig. 2. **Caliper increase (± SD) of *Fraxinus nigra* 'Fallgold' over two growing seasons without an intercrop (A), or with an intercrop of growth regulated ryegrass (B), mowed ryegrass (C), or untreated ryegrass (D). U.S. measures are displayed as this is the current system used for grading nursery stock.**

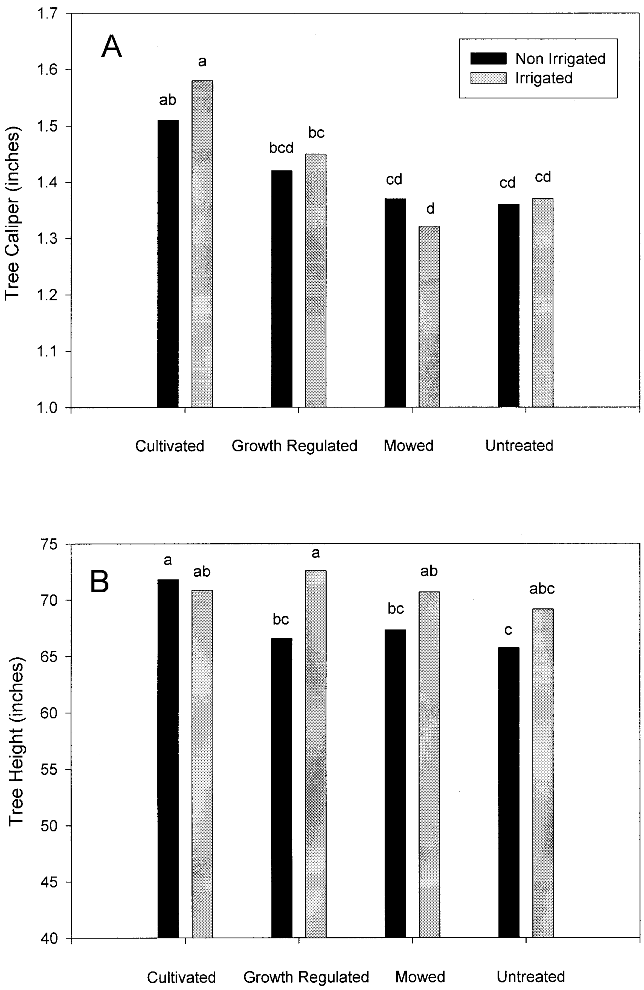

Fig. 3. Height (A) and Caliper (B) of *Fraxinus nigra* 'Fallgold' after two seasons of growth with intercrops. Mean separation between treatments by Duncans multiple range test ($P \leq 0.05$). U.S. measures are displayed as this is the current system used for grading nursery stock. Mean caliper of trees before treatment was 1.85 ± 0.17 cm (0.72 ± 0.07 in) and mean height before treatment was 102.12 ± 8.54 cm (39.58 ± 3.13 in). There were no significant differences in caliper or height among treatments prior to the initiation of this experiment.

ence of irrigation with the exception of trees planted with a growth regulated intercrop (Fig 3b). No significant interaction between irrigation and intercrop was found. Due to root growth and to the natural dispersal of irrigation water as it contacts the soil, it is possible that some roots from non-irrigated trees received irrigation intended for irrigated trees.

In general, the greatest differences between treatments was seen in final caliper rather than final height (Fig. 3). That tree caliper increased after shoot growth had ceased provides some explanation as to why there were greater differences between calipers than heights among treatments. Stress placed on trees through the spring months would have been seen in both height and caliper differences whereas stress in the summer months would have resulted in caliper rather than height differences. It is likely that ryegrass exerted its greatest effect on the trees during the summer as this is when it reached maturity and required the most nutrition and water.

Trees grown in cultivated plots achieved the greatest height and caliper (Fig. 3). Trees grown with growth regulated grass had heights and calipers that were not significantly different from those grown under cultivation without irrigation. This indicates that the practices of irrigation and growth regulation may help to minimize the detrimental effects of intercropping grass with trees.

Intercrops of untreated or mowed grass resulted in trees with the smallest average caliper (Fig. 3a). It has been noted previously (8) that mowed grass negatively affects tree growth. The finding that trees intercropped with chemically growth regulated grass (both irrigated and non-irrigated) did not have growth parameters significantly different from trees grown with cultivation and without irrigation implies that growth regulators and irrigation can reduce the stress that trees feel from intercrops. Likewise, the significant differences in caliper between trees intercropped with mowed ryegrass and irrigated and non-irrigated cultivated trees indicates that mowing cannot offer the same mitigation of intercrop effects that growth regulation can. It has been suggested that growth regulators may inhibit the root density of some species (2) and so grass treated with growth regulators may have a decreased root mass resulting in decreased uptake of water and nutrients. Mowing ryegrass at the height used in this study is unlikely to affect the roots of the grass (11).

Results from this experiment indicate that growth regulators applied to grass intercrops, especially in conjunction with irrigation, may have the ability to mitigate competition between trees and intercrops. Using a grass intercrop instead of cultivation results in decreased erosion as well as increased organic material. Further research needs to be conducted in order to determine the specific effects of growth regulators on intercropped grass and how these effects differ from the effects of mowing on intercropped grass.

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