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THE EFFECTS OF PLANTING DENSITY AND WEED CONTROL ON THE PARTITIONING OF NITROGEN AND CARBON IN A HYBRID POPLAR PLANTATION

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THE EFFECTS OF PLANTING DENSITY AND WEED CONTROL ON THE PARTITIONING OF NITROGEN AND CARBON IN A HYBRID POPLAR PLANTATION

By

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ABSTRACT

THE EFFECTS OF PLANTING DENSITY AND WEED CONTROL ON THE PARTITIONING OF NITROGEN AND CARBON IN A HYBRID POPLAR PLANTATION

By

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A plantation of Populus x euramericana c.v. Eugenei clones was established in 1989 to determine the effects weed control and planting density have on community level C and N. A split plot design with random blocking was used. Three planting densities were split on the presence or absence of weeds. Aboveground biomass and N content of trees and weeds was determined by destructive sampling. Equations were developed to estimate tree stand biomass. At the end of the third growing season, cumulative aboveground biomass was equivalent in those communities that were fully occupying the site. Nitrogen content on the community level was not influenced by weed control. By the end of the third growing season weed competition did not significantly influence individual tree growth at the high planting density, but the presence of weeds had a significant negative impact on tree growth at the lower planting densities.

ACKNOWLEDGEMENTS

I'd like to express appreciation for my advisor, Dr. Kurt Pregitzer, who gave me independence in completing this program. My committee members Dr. Donald Dickmann and Dr. Katherine Gross whose additional assistance was most appreciated. And Dr. Carl Ramm whose help was invaluable.

A special thanks to Andrew Burton and Dr. Phu Ngyen whose assistance and encouragement helped to make this thesis a success. My parents who have always allowed me to be an equal. And the loggers and sawmill workers in the family who have, unknowingly, put what I'm doing into perspective.

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CHAPTER I

INTRODUCTION

Trees grown under short rotation intensive culture (SRIC) parallel agricultural systems where high productivity and harvestable yields are accomplished by the use of intensive management with a dependence on tillage and chemicals. A present trend in the United States and internationally is toward low-input, sustainable systems which will eventually mimic natural ecosystems where essential nutrients are more fully utilized and recycled.

Rotations of three to ten years under SRIC are achieved through breeding, intensive site preparation, weed control, and fertilizers (Ranney et al. 1987). Management practices to reduce or eliminate competition from weeds utilize herbicides and tillage. This reduction in standing biomass coupled with applied fertilizer increases the possibility of nitrate leaching. Nitrate levels are expected to change under management. Disturbance increases the level of nitrate in the soil solution and concentrations are kept at high levels by fertilization (Vituosek 1983). While present in the soil solution, nitrate is susceptible to leaching and leaching is most likely to occur when the site is not fully occupied (Shepherd 1986). Maximum nitrogen uptake by a community is dependent on the nature of the herbaceous vegetation (Baker et al. 1974). Annual crops are less efficient at nitrogen uptake than perennial plants (White, 1988). Weed control reduces the ability of an ecosystem to retain nitrogen, increasing the chance of nitrate leaching.

Most hardwoods grown in plantations are intolerant of weed competition (Kennedy 1984) necessitating weed control. Without good weed control SRIC with hardwoods is not feasible (Ranney et al. 1987). The competitive inabilities of plantation trees is in part due to breeding. Fast growth rates which require higher allocation of photosynthate to leaf tissue comes at the expense of the root system (Mooney and Gulman 1983). While the trees are partially limited in root growth, decreasing their ability to capture belowground resources, weeds are well adapted to disturbed sites where rapid growth is favored (Grime 1977) and exploitation of belowground resources is required. Resources captured by weeds may further limit the growth of trees in SRIC systems.

Previous studies on weed-crop competition have concentrated on the emergence pattern and spatial influence weeds have on agronomic crops (e.g. Beckett et al. 1988, and Monks and Oliver 1988). These studies have yielded a typical result, reduction in the weed population results in an increase in crop productivity as measured by biomass and harvestable yield. The main variables of competition examined are light interception and soil moisture (e.g.

Lemieux et al. 1987). Few studies have dealt with how plants sequester and allocate nitrogen under competition. This thesis examines the first three years of growth in a hybrid Populus plantation grown under a short rotation coppice system. The objectives of the study are to understand aboveground partitioning of nitrogen and carbon at the community level. Sub-plots have been established to examine the effect stand density has on community level N and C partitioning and to understand the role of plant competition in the partitioning process. The three null hypotheses of the study are: 1) competition from weeds does not decrease tree standing biomass, height, stem diameter, and tissue nitrogen concentration after three years of growth; 2) the total aboveground nitrogen content and biomass at the community level does not differ among plots where competition has been controlled versus those left untreated; and 3) nitrogen mineralization rates are the same regardless of weed control.

This thesis incorporates data from the first three years of the study. Only a fraction of the presented analysis is used to discuss the hypothesis the rest is included as reference for later use. Data from 1989 and 1990 was collected under the direction of Dr. Kurt Pregitzer and Dr. Katherine Gross. The author collected the data in 1991.

CHAPTER II

REVIEW OF LITERATURE

This review of literature includes studies on trees in SRIC systems as well as agricultural systems. Agricultural studies have generated the most relevant information on weed competition with crops. Topics of the review include short rotation intensive culture, the effect weeds and crops have on each other as seen in yield, nitrogen content, and in tissue nitrogen concentration.

Short rotation intensive culture (SRIC) of hardwoods is aimed at high production through coppice generations on marginal to good agricultural sites with rotations of three to ten years (Ranney et al. 1987). Anderson et al. (1983) has defined short rotation plantations as those that have less than 5,000 trees per hectare with harvesting cycles of six to ten years. In contrast, mini-rotation plantations were defined as having densities of 5,000 or more trees per hectare with harvesting cycles of five years or less. The primary products of SRIC plantations are wood fiber for direct combustion or subsequent conversion to methanol (Moran and Nautiyal 1985). Species used for SRIC in North America include _Populus_, _Salix_, _Betula_, _Platanus_, _Alnus_, _Liquidambar styraciflua_, _Robinia pseudoacacia_, and _Acer saccharinum_ (Anderson et al. 1983, Ranney et al. 1987).

Successful plantations are dependent on intensive management, which includes improved clones as stock, intensive site preparation, weed control, fertilizer (Ranney et al. 1987), and often irrigation (Anderson et al. 1983). Weed control is considered critical before canopy closure. Anderson and others (1983) have identified competition from grass as the most detrimental to plantation growth.

High yields are produced under SRIC management. Some yields produced under experimental trials have been compiled by Cannell and Smith (1980). *Platanus occidentalis* produced current annual increments (CAI) of 10-12 tons/ha/year and mean annual increments (MAI) of 14-16 tons/ha/year (Kormanik et al. 1973). Dutrow (1971) reported CAI values for *P. occidentalis* of 12-13 tons/ha/year and MAI values of 16-18 tons/ha/year. Reported yields for *Populus* have been lower. *Populus trichocarpa* produced CAI of 9-10 tons/ha/year and MAI of 12-14 tons/ha/year (Cannell 1980). *Populus* x *euramericana* produced CAI of 7-8 tons/ha/year and MAI of 9-10 tons/ha/year (Anderson and Zsuffa 1977, Zsuffa et al. 1977).

Benefits of weed control to plantation trees include increased survival (Kennedy 1984), increased height and diameter (Kennedy 1984, Nelson et al. 1981, and Fitzgerald et al. 1975), and early crown closure (Knowe et al. 1985). The limiting resource is often identified as soil moisture

(McLaughlin et al. 1987, Nelson et al. 1981). Although nitrogen has been identified as the most limiting resource in intensively managed forest systems (Shepherd 1986) and in other temperate forest production systems (Birk and Vituosek 1986) it is not often considered in SRIC research. This may be due to the ability to amend soil with fertilizer. Nitrogen is typically the most heavily applied fertilizer (Groffman et al. 1986). In agronomic crops it is suggested that if light and nutrients (through the application of fertilizer) are adequate then soil moisture is usually the limiting factor (Young et al. 1984).

The effect weeds have on crop production is often density dependent. In corn (Zea mays L.), a low density of quackgrass [Elytrigia repens (L.) Nevski] can reduce corn yields 12 to 16% and high densities can reduce yields 37% (Young et al. 1984). Similar reductions (13 to 39%) in sugar beets (Beta vulgaris L.) have been shown as well (Schweizer 1981).

For tree crops the first year has been identified as the most crucial year for weed control (Fitzgerald et al. 1975) and control is suggested until canopy closure (Dickmann and Stuart 1983). With weed control, survival in loblolly pine (Pinus taeda L.) was 89% by age four as compared to 61% without weed control (Tiarks and Haywood 1986). In the same study a 63% increase in volume was seen with weed control. Knowe et al. (1985) saw a seven fold increase in the first two years of growth in loblolly pine when weeds were controlled.

The extent to which the benefits of weed control carry through a rotation has been suggested by several authors. The first three years of tree growth is substantially reduced by weed competition (McLaughlin et al. 1987, Nelson et al. 1981). The fourth and fifth growing seasons, as well, show increased growth (Kennedy 1984). These early results may not be evident at the end of long rotations. McLauglin et al. (1987) did not see any growth advantage after four years in hybrid Populus receiving weed control. The early growth increase may result in shortening rotations (Knowe et al. 1985, Nelson et al. 1981), but documentation has not yet been published. SRIC may show the greatest benefit of weed control, as measured by merchantable volume, since it is based on rotations of 3-10 years.

The effect a crop has on the weed population has not been extensively studied. In one study, velvet leaf (Abutilon theophrasti Medik.) was shown to reduce soybean (Glycine max L.) yields to 41 and 46% in two consecutive years. At the same time the velvet leaf seed yields were reduced to 58 and 93% by the soybeans (Munger et al. 1987). Ghafar and Watson (1983) increased corn planting density from the normal practice of 66,700 plants/ha to 133,300 plants/ha and reduced the number of yellow nutsedge (Cyperus esculents L.) tubers by 71% In the same study reducing the planting density to 33,300 plants / ha increased tuber increased by 41%. The researchers also found that biomass of yellow nutsedge between corn rows was unaffected by planting density whereas at the higher planting density yellow nutsedge biomass was significantly reduced within the rows.

The effect of shading by soybeans on weeds was examined by Murphy and Gossett (1981). Soybeans were allowed to establish weed free for three weeks to allow for canopy development. Weed green biomass was reduced 85 to 97% when they emerged after the soybeans. At the peak of canopy development only 12% of radiant light reached the ground. In a study of cogongrass [Imperata cylindrica (L.) Beauv.] shading by trees reduced total plant dry weight, leaf area and the number of grass rhizomes and leaves (Patterson 1980). As full light was reduced to 56%, dry weight production of cogongrass decreased by 2 to 2.9-fold. A reduction of light to 11% resulted in a further 15 to 30-fold decrease in weed dry weight.

Nitrogen recovery from the soil is affected by the type of herbaceous cover. The stress induced by weed competition on trees is also influenced by the weed species. During the course of a rotation the species composition of the weeds present is expected to change. Where SRIC plantations have been established on agricultural land, herbaceous plants are the predominant weeds. Ruderals are well adapted to seasonal disturbances associated with cultivation. Many of these annual weeds utilize the C_4 photosynthetic pathway and are thought to have an advantage over C_3 annuals in environments where light and temperature levels are high and water is limited (Altieri 1988). Plants with C_4 photosynthesis tend to be drought resistant (Baker 1974). As conditions become more moderate under decreasing cultivation disturbance and as shade from trees increases, C_3 annuals have the advantage over C_4 annuals. The C_4 pathway consumes too much energy to be efficient under moderate conditions (Altieri 1988). The ruderals will be replaced by competitive perennial herbs which are adapted to relatively productive habitats (Grime 1977). A change in species composition should occur in plantations that do not use tillage as a means of weed control.

Nitrogen was found to be the limiting resource in short rotation hardwood stands (Wittwer et al. 1978). Studies examining nitrogen in intensively managed stands generally include fertilizer as part of the treatments, particularly in the planting year. When fertilizer was applied in the planting year of a loblolly pine stand (kept weed free) the trees recovered 46% of the applied nitrogen by the end of the third year. Whereas in a herbaceous plant stand 58% was recovered (Baker et al. 1974). Annual uptake of nitrogen in black cottonwood *Populus trichocarpa* Torr & Gray and *P. trichocarpa* x *P. deltoides* hybrids ranged from 95 kg N/ha for the former to 276 kg N/ha for the hybrids (Heilman and Stettler 1986).

Plant tissue nitrogen concentrations generally decrease under competition and over time. Total leaf nitrogen in Citrus trees was reduced (values not given) by annual weeds and Bermudagrass [Cynodon dactylon (L.) Person] (Jordan and Jordan 1981). Nitrogen concentration in loblolly pine foliage was found to be 12.5 g/kg in the first season and decreased to 5.2 g/kg in the sixth growing season (Tiarks and Haywood 1986). Kennedy (1984) also documented that the highest tissue concentration was seen in the first growing season and concentrations decreased with each consecutive year. Understory vegetation concentrations were at 1.07% Foliar nitrogen concentrations in hardwood trees averaged 1.63% in weedy plots, 1.78% in mowed plots and 1.94% in disked plots.

Heilman (1985) found a difference of nitrogen concentration in black cottonwood leaves depending on position in the crown. Leaves at the top of the leader averaged 2.16% nitrogen. Leaves on the youngest proleptic branches averaged 2.21% and leaves from mid crown averaged 2.14%. Nitrogen concentrations from these three positions were not significantly different. They were, however, significantly different from leaves in the lower half of the crown which averaged 1.75%. Date of sampling also exhibited significant differences in nitrogen concentration for leaves, decreasing from 2.28% on September 5 to 2.05% on September 25 to 1.77% on October 7.

McLaughlin et al. (1987) found no significant difference in stem and branch nitrogen concentrations the planting year of Populus hybrids in weed controlled plots that were fertilized or unfertilized. At the end of the second year fertilizer did significantly increase nitrogen concentrations in stem and branch components, 0.87% with fertilizer compared to 0.66% with no fertilizer. Total nitrogen content of leaf litter in fertilized plots was 59 to 103 kg N/ha and the nitrogen content of above and belowground portions ranged from 129 to 182 kg N/ha.

CHAPTER III

METHODS

Experimental Design

The study was conducted in southwestern Michigan at the Kellogg Biological Station's Long Term Ecological Research site. The soil type is Kalamazoo silt loam (fine-loamy, mixed, mesic Typic Hapludalf). The site has a history of agricultural cropping and tillage by moldboard plow.

The experimental design is a split plot with random blocking. Three planting densities are split on weed control. Low planting density is at a 2m x 3m spacing (0.17 trees/m^2; 1,667 trees/ha); medium planting density at 1m x 2m spacing (0.5 trees/m^2; 5,000 trees/ha); and high density is at 0.5m x 1m spacing (2.0 trees/m^2; 20,000 trees/ha). The treatments were replicated six times. The area of each density treatment is 50m x 23.2m and each subplot is 25m x 21.6m (Figures 1 and 2). Table 1 shows the treatment notations used in the study. The weed population is naturally occurring, not seeded.

Table 1

Labeling of subplots in the study

Block	System*	Planting Density	Weed Control
1-6	5	1 (Low)	1 (Control)
		2 (Medium)	0 (No Control)
		3 (High)	

* There are seven cropping systems in the study as a whole, treatment 5 denotes the poplar plantations.

Site Preparation and Planting

1989 The plots were plowed with a moldboard plow and disked in late April. Hardwood cuttings of the clone *Populus* x *euramericana* cv. Eugenei were planted in late April and in early May. Each subplot designated to be free of weeds received an application of herbicide shortly after planting. The tank mixture was: 1.0 qt/A of oxyfluorfen (Goal@); 1.5 qt/A of linuron (Lorox 4L@); and 1.5 qt/A of simazine (Princep 4L@). The mixture was sprayed at a rate of 20 gallons/A. All subplots were fertilized in early June with 110 kg N/ha as ammonium nitrate.

Weed Control

1989 Blanket herbicide was applied as part of the site preparation. Hand removal of weeds was used to keep subplots weed free during the growing season. Soil activity

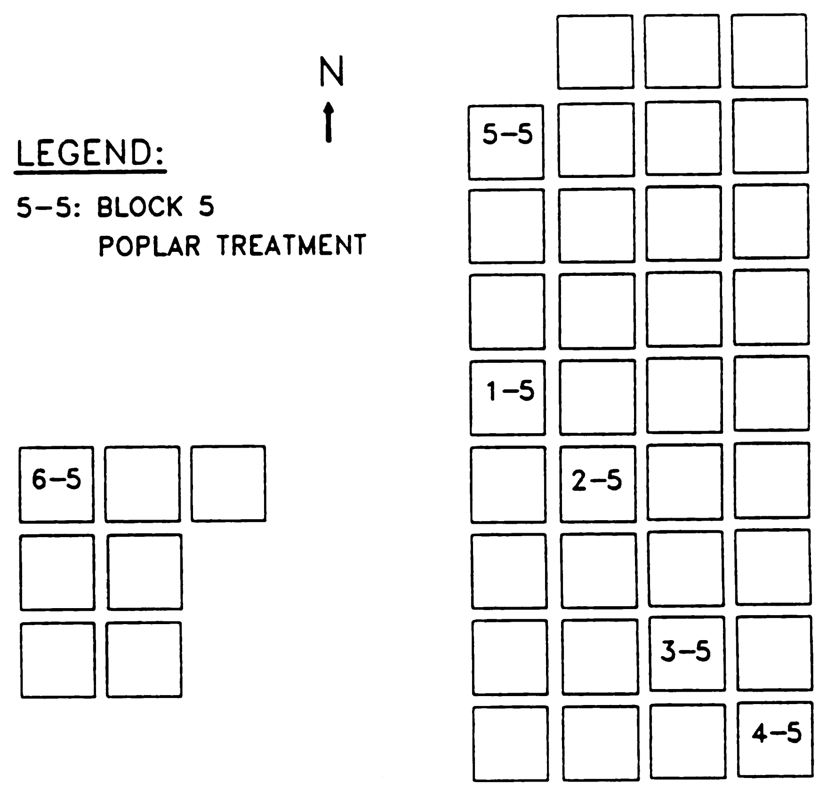

FIGURE 1

LTER site plan at Kellogg Biological Station

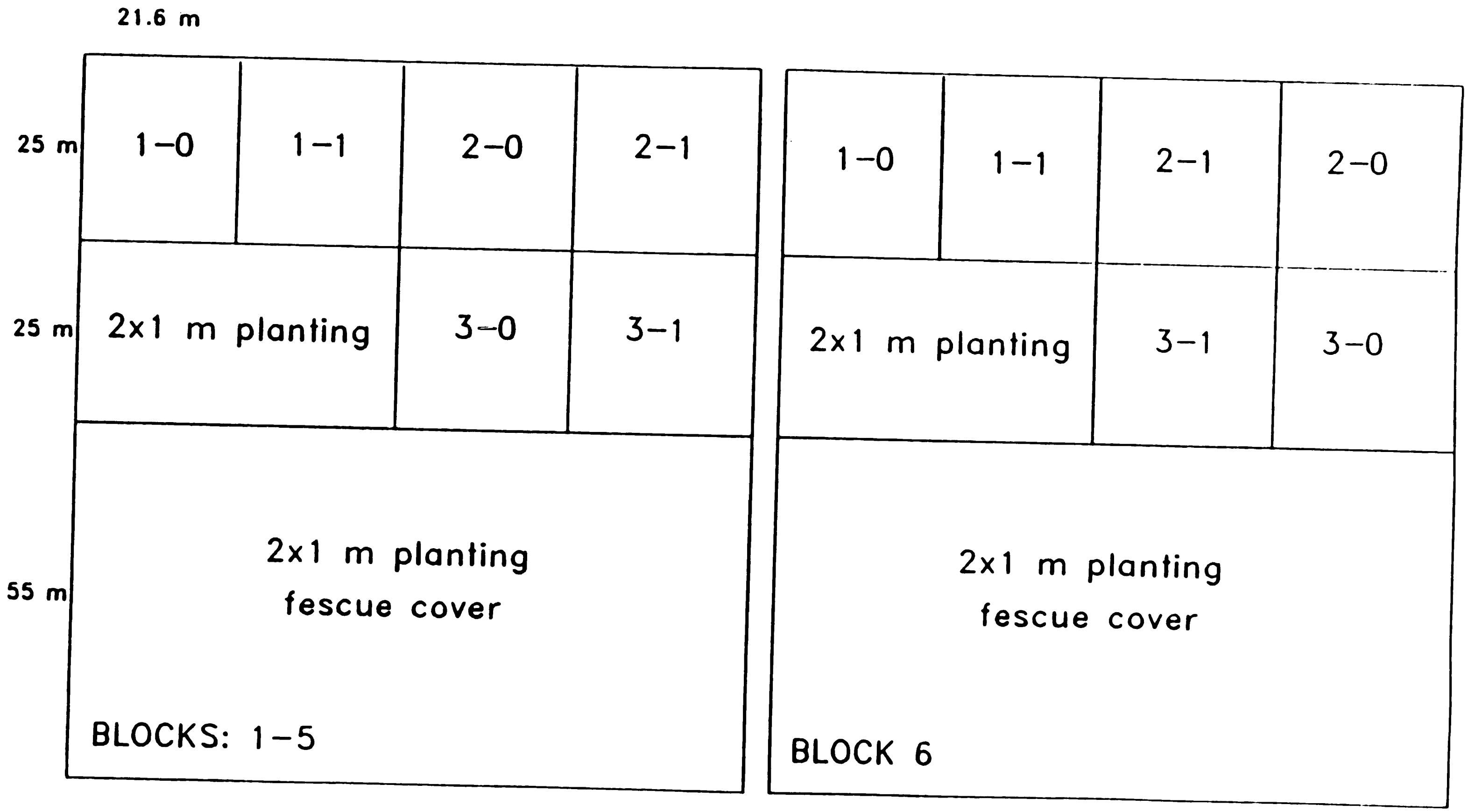

FIGURE 2

Diagram of Poplar research plots

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of simazine appeared to injure Eugenei in some blocks, most notably in block three which was partially replanted in 1990. The subplots in block three were partially replanted.

1990 Plots were mowed and weeds were hoed through the summer. Mowing is not a favorable method for weed control. In a study of hardwoods it was found that mowing as weed control showed no significant difference in tree yield over plots with no weed control (Kennedy 1984). Competition was seen whether the weeds were allowed to grow (3 to 4 weeks) and mowed or to grow continuously.

1991 Weed control was achieved through the use of herbicide and hand removal. The weed controlled subplots were mowed in mid-May. The weeds were allowed to recover and begin active growth before spraying. A 2% glyphosate (Roundup@) solution was applied using a backpack sprayer the first week of June in the low and medium planting densities. Eugenei sprouts emerging between the rows were avoided, but when accidentally sprayed, the leaves were removed to prevent translocation of glyphosate. Due to limited space between the rows at the high planting density these subplots were not sprayed (except for rhizomatous grass), the weeds were removed by hand. At the end of June the effectiveness of Roundup@ was evaluated and it was decided to respray the low and medium plots. Weed control was averaging 40-75% control as determined by remaining herbaceous cover. The low and r

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medium plots were then spot sprayed with 2% Roundup@ solution. Weed control from the second spraying appeared adequate. During the rest of the growing season weeds were periodically removed by hand.

Field Collection of Weeds

1989 Weeds were sampled on July 21 and September 15. One quadrat (0.1m x 2.0m) was harvested in each subplot without weed control. The quadrats were centered around trees across the rows. All weeds lying within the quadrat were clipped at the ground line, this included senescent plants (usually winter annuals). Plants were bagged and refrigerated until they could be sorted by species and dried at 60^{o}C for 72 hours. Plants that were not identified were listed as unknown dicots or monocots.

1990 Weeds were sampled on August 8 and 9 within wooden quadrats (0.5m x 2m). Quadrat size was increased from that of 1989 to 1.0m^2. One quadrat was randomly placed in each subplot. Plants were bagged and sorted as in 1989.

1991 Weeds were sampled July 30 through August 1. Two quadrats (0.5 X 2.0m) were randomly placed in each subplot. The placement of the quadrats avoided areas that were previously sampled. The quadrats were again centered around trees across rows to include the maximum number of trees possible. All plants within the quadrats were clipped at

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ground level, this included any Eugenei root suckers present. Weeds were then bagged and refrigerated until they could be sorted by species and dried as in the previous two years.

Destructive Tree Sampling

Aboveground portions of Eugenei trees were destructively sampled in 1989 and 1991. The trees were cut at 15cm above the ground and separated into components of stem, branches, and leaves.

1989 Two sets of trees were sampled, one on July 20 and one September 11-15. Trees in September were sampled shortly after the terminal bud on the leader had set, but before the majority of leaves began to abscise. Two adjacent trees in each subplot were sampled each time. Diameters were measured after the trees were cut and total height was measured. Individual leaf areas were measured with the Li-cor Li-3100 Area Meter before the leaves were dried. Components were dried at 60-65^{o}C for 72 hours.

1991 Two trees were sampled from each subplot September 3-5 after the terminal bud had set. The sampling was done over a three day period. The sampling was stratified and proportionally allocated. Sampling was based on diameters of permanently marked trees in the middle of each plot (Demaerschalk and Kozak 1974). Two trees per subplot were

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then randomly selected to fit the sampling scheme with a total of 12 trees per treatment. Edge trees were avoided. Diameters were measured before trees were cut. After felling, total height was measured along with the length of the leader from the previous years terminal bud scale scar to the current apical meristem. Height from the ground to the first live branch was also recorded. Leader leaves were removed and kept separate from lateral branch leaves. Branches were removed, counted, and bagged. The stem was cut and bundled. Individual leaf area was measured with the Li-cor Li-3100 Area Meter. Leaves were dried in a forced air oven at 60°C for 24-72 hours before weighing. Woody components were dried in a kiln at 65°C for one week before weighing.

Standing Tree Measurements

1989 and 1990 Trees in the center of each subplot were marked for annual monitoring of growth. In September the diameters of these trees were measured at 15cm above the ground with calipers. The number of trees in each subplot were: at the low planting density, 12 trees; at the medium and high planting densities 28 trees in each subplot.

1991 An area of 5m X 5m was set in the middle of each plot. All trees within this area were measured for total height (with telescoping pole) and diameter (with calipers) at 15cm above the ground. At the high planting density this area included 50 trees per subplot, at the medium planting density 15 trees per subplot, and at the low density 6 trees per subplot. These trees were measured shortly after the destructive sampling, starting in late September and ending in early November.

Canopy Transmittance

1991 Canopy transmittance was measured July 11, starting at 1200 hours and ending at 1415 hours. The Sunfleck Ceptometer (model SF-80, Decagon Devices, Inc.) used measured photosynthetically active radiation (PAR, 400-700nm). The measurements were taken at the height of the weed canopy, about one meter above the ground. Three points in each subplot were randomly chosen and three readings were taken at each point in a 360 degree circle at equal increments. The ceptometer was kept horizontal with the ground. Measurements of total incoming PAR were taken in the open field before and after measuring each block. Leaf area index (LAI, ratio of leaf surface area to unit area of ground) was indirectly estimated by converting canopy transmittance to LAI by using the Beer-Lambert Law (Pierce and Running 1988). The Beer-Lambert Law states:

$$LAI = -\ln (Q_i/Q_o)/K,$$

where Q_i is canopy transmittance, Q_o is total incoming PAR, and K is a light extinction coefficient. The extinction coefficient used was 0.39 (Raunee 1976).

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Foiliar Nitrogen Concentration

1991 Four leaves from two trees in each subplot were collected to asses nitrogen status during the growing season. On July 10, 1991 the 4th, 5th, 6th, and 7th leaves down from the apical meristem on the leader were collected. Leaves were kept on ice in the field, oven dried at 60^{o}C for 24 hours and ground for analysis.

Soil Samples

1991 Soil samples were taken to asses available ammonium (NH_4^+) and nitrate (NO_3^-). Soil samples were taken on August 5. One soil core (10cm long X 5cm diameter) was taken randomly beneath the tree's canopy. A total of 12 cores were excavated from each treatment (two per subplot). Loose organic matter on the soil surface was removed prior to taking the cores. The cores were restricted to the Ap horizon. The samples were kept on ice in the field and then refrigerated until they could be processed. The samples were processed within 36 hours. The samples were passed through a 2mm sieve to remove rocks and roots. A subsample was taken to determine soil moisture content and dried in an oven at 95^{o}C until a constant mass was reached. Two 5g field moist subsamples were removed. One subsample was used to determine initial extractable levels of NH_4^+ and NO_3^-, and the second sample was incubated to determine mineralizable nitrogen. The method of sample treatment and t

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nitrogen analysis follow that of Vituosek et al. (1982) and Zak et al. (1989). Fifty milliliters (50ml) of 2M KCl (148g/l) was added to each subsample, mixed and the sample was allowed to sit for 24 hours. The extracts were then filtered (No. 42 Whatman ashless filters) and refrigerated until they could be analyzed with the Technicon II Analyzer (Technicon 1977b). The second 5g sample was placed in plastic cups with ventilated lids and aerobically incubated for 25 days. The samples were incubated in the dark at 30^{o}C with approximately 85% relative humidity. The samples were kept at field capacity by periodically adding water. At the end of the incubation period the samples were extracted with 2M KCl as outlined above.

Preparation of Dried Plant Material

1989 and 1990 Dried plant tissues was coarsely ground and then reground through a 20-mesh screen. The three weed species with the highest biomass values in each quadrat were ground separately. The remaining species were combined and ground as a group.

1991 Large samples were subsampled. Branches were subsampled to include a proportional amount (based on weight) of all ages of tissues. The stems were in bundle lengths of 2 to 3 feet long. A section of about an inch long was cut out of the middle of each bundle. These sections were then split into match stick size pieces for grinding. For large diameter stems only a quarter of the sections were kept. Weeds were subsampled when necessary and care was taken to include a proportional amount of all tissue types. Dried plant tissue was ground twice through a 20-mesh screen based on biomass values as in 1989 and 1991.

Nitrogen Analysis

1989 and 1990 Nitrogen in plant tissue was analyzed using a block digester and the Technicon AutoAnalyzer II. The Kjeldahl procedure to determine nitrogen is based on a colorimetric method (read at 660nm). Detailed information can be found in the Technicon Manual (1977). Samples of 0.25g were placed in 75ml digestion tubes with two or three boiling chips and one Kjeltab and the catalyst. Nine milliliters (9ml) of concentrated H_2SO_4 was added. The mixture was then heated at 380 degrees for 1 to 1-1/2 hours or until the digestion turned clear and the mixture was then allowed to cool for 15-20 minutes. Fifteen milliliters (15ml) of deionized water was added and the mixture allowed to cool for another 20 minutes. The tubes were then brought to volume with deionized water and thoroughly mixed, decanted, and the supernatant poured into sample cups for analysis with the Technicon Auto-Analyzer II. Concentrations were corrected for baseline drift and for tissue moisture content.

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1991 Ground plant samples were analyzed by combustion with the Nitrogen Analyzer 1500 (series 2, Carlo Erba Instruments). Acetanilide was the standard used to create nitrogen concentration curves. Weights of acetanilide ranging from 0.3mg to 4.0 mg were used in constructing the calibration curves. Samples of the ground plant tissue ranging from 9mg to 14mg were placed in tin cups and folded for analysis. Ground citrus leaves from the National Bureau of Standards were used to check the quality of the analysis. Twenty percent of the samples were replicated. Reproducibility between replications was good, less than 0.02% difference in N concentration between samples. Weed samples generally had higher variability between replicate samples because all tissue types were ground together. Final nitrogen concentrations were corrected for moisture content in the samples.

Data Analysis and Hypothesis Testing

Analysis of variance (ANOVA) was performed on the data using procedures for a split plot design using SAS (SAS Institute Inc. 1985). Tukey's studentized range test (HSD) was used to separate significant means. Before analysis of variance was done all data were checked for normality and for homogeneity of variances. The 1991 poplar data showed a significant block effect for most variables. Block three was usually significantly lower than block two. This may have been a result of simizine injury in the

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planting year and block three, possibly, being a poorer growing site than the others. Block three was removed from the 1991 data and community totals and analysis of variance was rerun. Herbicide injury was severe enough in that the mainsite was partially replanted in 1990 and replanting occurred in some of the subplots. The severe herbicide damage was the justification for omitting block three from the statistical analysis. It did not appear necessary to remove block three from the 1989 and 1990 data.

Leaf area index was determined by applying prediction equations created through linear regressions of the destructive samples taken in 1989 and 1991 (Tables C.1 and C.4, Appendix C). The leaf area of the permanently marked trees in 1989 and the trees within a 5m x 5m area in 1991 was calculated with the equations.

Community biomass was determined by adding weed biomass from all three years to the total tree biomass in 1991. Tree leaf biomass from 1989 and 1990 was added as well. No destructive sampling of trees was done in 1990 in each treatment. The leaf biomass was interpolated from the September 1989 and 1991 values on a subplot basis. Tree biomass was determined by applying the developed prediction equations to standing tree measurements 1991 (Table C.3, Appendix C). Values from 1989 weed data were multiplied by an expansion factor to bring them from $0.2m^2$ area to $1.0m^2$ area equivalent to the 1990 and 1991 weed data.

Community nitrogen contents for aboveground biomass were determined separately for September 1989 and 1991. Total tree nitrogen was combined with weed nitrogen contents. Weed nitrogen contents were presented on g/m^2 basis and individual tree values were converted to an area value. It was assumed that unlike tree biomass where carbon has accrued over time in woody tissue that nitrogen is recycled more frequently through litter fall and senescence of roots and ground flora. For this reason biomass was combined over three years, whereas nitrogen contents were analyzed on a year by year basis.

Linear Regression Analysis

Linear regression analysis was employed to develop prediction equations to predict total tree biomass and total leaf area in 1989. Analysis from 1989 was done on the July and September destructive harvests (Pregitzer and Gross unpublished). Analysis of variance (ANOVA) was conducted to determine whether or not density and weed control significantly affected tree biomass, leaf area or stem diameter. Diameter-squared was used in all stages of the analysis since scatter plots indicated a quadratic relationship between diameter and leaf area and tree biomass.

Planting density did not significantly effect tree biomass or leaf area. In September of 1989, tree density did effect stem diameter. Weeds influenced all three variables both months, except for total weight of trees harvested in July. From the significant effects seen in the ANOVAs it was determined that a single regression equation would be inadequate to predict leaf area or tree weight from stem diameter-squared.

A test of the homogeneity of regression coefficients was done. As a result it was deemed necessary to use separate models for July and September harvests. From the July harvest it was also necessary to have separate models to predict tree biomass based on the presence or absence of weeds.

In 1991, analysis of variance showed that density and weed control had significant effects on tree diameter, woody biomass, total biomass, and leaf area. Stem diameter still appeared as a quadratic relationship with biomass and leaf area. Accuracy of the prediction equation was improved by adding total tree height as a dependent variable along with diameter-squared. Separate models were developed for each planting density based on the presence or absence of weeds using the NCSS computer program (Hintze 1990).

In both years extreme outlying values were removed from the analysis. The outliers were assumed unrepresentative of the sample due to measurement error, incorrect application of treatment, or environmental damage. Removal of observations was avoided as much as possible in 1991 since the maximum number of observations each equation was based on was 12 trees.

Equations for predicting total tree biomass in July and September of 1989 are shown in Table C.1, Appendix C (Pregitzer and Gross unpublished). The coefficients of determination (R^2) were adjusted for degrees of freedom. The total number of observations (N) is also given. Predicted weight has the units of grams (g) and the predicted leaf area is in centimeters-squared (cm^2). Equations were developed for July 1989, but are not applied here since no standing tree measurements were taken. In September, trees in the center of each subplot were measured for diameter at 15cm and these trees were used to determine total tree biomass on an area basis and leaf area index.

In 1991 equations to predict woody biomass, total tree biomass, and leaf area are shown in Tables C.2, C.3, and C.4 (Appendix C). The predicted woody and total biomass has the units of kilogram (kg) and the leaf area is expressed in centimeter-squared (cm^2). These equations for 1991 include block three. Although there is a significant block effect when block three is present it did contain the lower diameter classes which were present in all blocks when the standing trees were measured. Block three helps to assure that all standing trees fall within the data the prediction equations were based on. Equations for both years should be viewed with caution if applied to other sites or growing conditions.

CHAPTER IV

RESULTS

Results are presented here as individual tree variables; plant biomass for individual trees, the stand of trees, weed populations, and the community; leaf area index; plant nitrogen content (follows the same format as biomass); and soil. Analysis of variance tables for some of the measured variables can be found in Appendix A (September 1989 tree harvest) and Appendix B (1991 tree harvest and community).

INDIVIDUAL TREE

Density and weed control had no significant influence on tree height or diameter in July 1989. Within a planting density weed control did not significantly increase diameter, height, or leaf area (Table 2). By September 1989, density and weed control appeared to have had a significant effect on tree diameter. Only weed control affected tree height and individual tree leaf area. Tree diameter was significantly lower at each density when weeds were not controlled (Table 3). The low planting density plots with weed control produced trees with the

Table 2

July 1989 Individual tree means (standard deviation)

Treatment[1]	Diameter (CM)	Height (M)	Leaf Area (M2)	Woody Biomass (G)	Total Biomass (G)
1-1	0.72(0.14)a[2]	1.03(0.72)a	0.16(0.93)ab	3.98(2.01)a	13.67(6.37)a
1-0	0.73(0.18)a	0.80(0.17)a	0.15(0.08)ab	5.59(3.60)a	16.42(9.30)a
2-1	0.72(0.14)a	0.66(0.13)a	0.14(0.05)ab	3.89(1.40)a	14.18(3.91)a
2-0	0.65(0.06)a	0.76(0.05)a	0.12(0.03)b	3.80(1.23)a	11.56(3.58)a
3-1	0.85(0.14)a	0.86(0.13)a	0.23(0.06)a	6.75(2.56)a	21.22(6.15)a
3-0	0.71(0.05)a	0.87(0.08)a	0.14(0.03)ab	4.96(1.17)a	14.58(3.91)a

Table 2 (cont'd)

Treatment	Woody N Content (G)	Leaf N Content (G)	Total N Content (G)
1-1	0.06(0.03)ab	0.37(0.16)ab	0.43(0.19)ab
1-0	0.06(0.04)ab	0.31(0.20)b	0.36(0.24)ab
2-1	0.06(0.03)ab	0.37(0.13)ab	0.43(0.15)ab
2-0	0.03(0.01)b	0.18(0.06)b	0.20(0.70)b
3-1	0.10(0.03)a	0.55(0.14)a	0.65(0.18)a
3-0	0.04(0.01)b	0.24(0.09)b	0.27(0.11)b

[1] First digit signifies planting density (1-low, 2-medium, 3-high) and the second digit is weed control (1) or no weed control (0).

[2] Means with the same letter are not significantly different, Tukey's HSD alpha=0.05. Number observations for each variable was 72.

Table 3

September 1989 individual tree means (standard deviation)

Treatment[1]	Diameter (CM)	Height (M)	Leaf Area (M2)	Woody Biomass (G)	Total Biomass (G)
1-1	1.92(0.39)a[2]	1.47(0.20)a	0.91(0.32)a	97.2(34.2)a	176.5(59.6)a
1-0	1.15(0.25)bc	1.16(0.39)a	0.28(0.16)b	31.9(24.1)b	57.0(38.5)b
2-1	1.48(0.39)ab	1.36(0.32)a	0.57(0.34)ab	50.7(28.6)b	103.2(57.5)b
2-0	0.92(0.22)c	1.12(0.27)a	0.19(0.11)b	19.0(11.4)b	36.6(20.9)b
3-1	1.47(0.25)ab	1.43(0.27)a	0.57(0.19)ab	58.8(19.1)ab	107.7(31.7)ab
3-0	0.94(0.16)c	1.18(0.29)a	0.19(0.06)b	19.4(10.0)b	40.6(11.35)b

Table 3 (cont'd)

Treatment	Woody N Content (G)	Leaf N Content (G)	Total N Content (G)
1-1	0.83(0.31)a	2.77(0.93)a	3.61(1.23)a
1-0	0.20(0.17)bc	0.61(0.51)cd	0.81(0.68)bc
2-1	0.41(0.21)bc	1.88(1.05)ab	2.29(1.26)a
2-0	0.13(0.08)c	0.36(0.24)d	0.49(0.31)c
3-1	0.53(0.22)ab	1.61(0.47)bc	2.14(0.65)ab
3-0	0.09(0.06)c	0.34(0.17)d	0.43(0.22)c

[1] First digit signifies planting density (1-low, 2-medium, 3-high) and the second digit is weed control (1) or no weed control (0).

[2] Means with the same letter are not significantly different, Tukey's HSD alpha=0.05. Number of observations for each variable was 71.

largest diameters (1.92cm), but these were not significantly different from the medium and high density trees. The same trend was seen with individual tree leaf area, with the highest leaf area (0.91m^2) found in the low density weed control plots. Mean heights were not significantly different between treatments.

At the end of the third growing season, 1991, interactions between density and weed control influenced tree diameter, height, leader length, and individual tree leaf area. Tree height and leader length appeared independent of planting density although a significant interaction with weed control occurred.

Tree diameter decreased with increased planting density when weeds were controlled. The low and medium density tree diameters were significantly higher than the high density trees (Table 4). When the weeds were not controlled tree diameter increased with increased planting density. These diameters were not significantly different from one another or from those at high density trees with weed control. Weed control resulted in a 2.2-fold diameter increase in the low density trees; a 1.7-fold increase in medium density trees; and a 1.2-fold increase in high density tree diameter.

Tree height decreased with increasing planting density in weed-free plots (Figure 3). Low density tree height was significantly greater than the high density tree mean (Table 4). Tree height, when weeds were present, increased as planting density increased. High density trees without weed

Table 4

1991 Individual tree means (standard deviation)

Treatment[1]	Diameter (cm)	Height (m)	Leader Length (m)	Leaf Area (m^2)	Woody Biomass (g)
1-1	7.23(0.52)a[2]	5.67(0.38)a	2.14(0.06)a	4.43(0.93)a	3915(929)a
1-0	3.29(1.09)b	2.94(0.74)d	1.14(0.19)d	0.96(0.59)bc	479(229)c
2-1	5.89(0.51)a	5.49(0.30)a	2.03(0.24)ab	2.58(1.67)b	2462(577)b
2-0	3.39(0.37)c	3.59(0.20)cd	1.46(0.15)cd	0.74(0.22)c	697(268)c
3-1	3.96(0.75)c	4.77(0.56)ab	1.36(0.29)cd	0.58(0.28)c	1107(423)c
3-0	3.21(0.65)c	4.22(0.61)bc	1.69(0.23)bc	0.52(0.30)c	607(258)c

Table 4 (cont'd)

Treatment	Total Biomass (g)	Woody N Content (g N)	Leaf N Content (g N)	Total N Content (G)
1-1	4410(1030)a	30.81(18.91)a	11.40(2.46)a	42.22(20.04)a
1-0	578(288)c	3.00(1.46)b	2.05(1.50)bc	6.28(5.08)b
2-1	2669(601)b	11.50(2.96)b	4.64(0.65)b	16.15(2.87)b
2-0	771(285)c	4.35(1.54)b	1.63(0.37)c	5.98(1.88)b
3-1	1166(454)c	7.80(6.08)b	1.44(0.96)c	9.24(6.21)b
3-0	660(287)c	3.32(1.23)b	1.28(0.66)c	4.60(1.88)b

[1] First digit signifies planting density (1-low, 2-medium, 3-high) and the second is weed control (1) or no weed control (0).

[2] Means with the same letter are not significantly different, Tukey's HSD alpha=0.05. Number of observations per variable was 60.

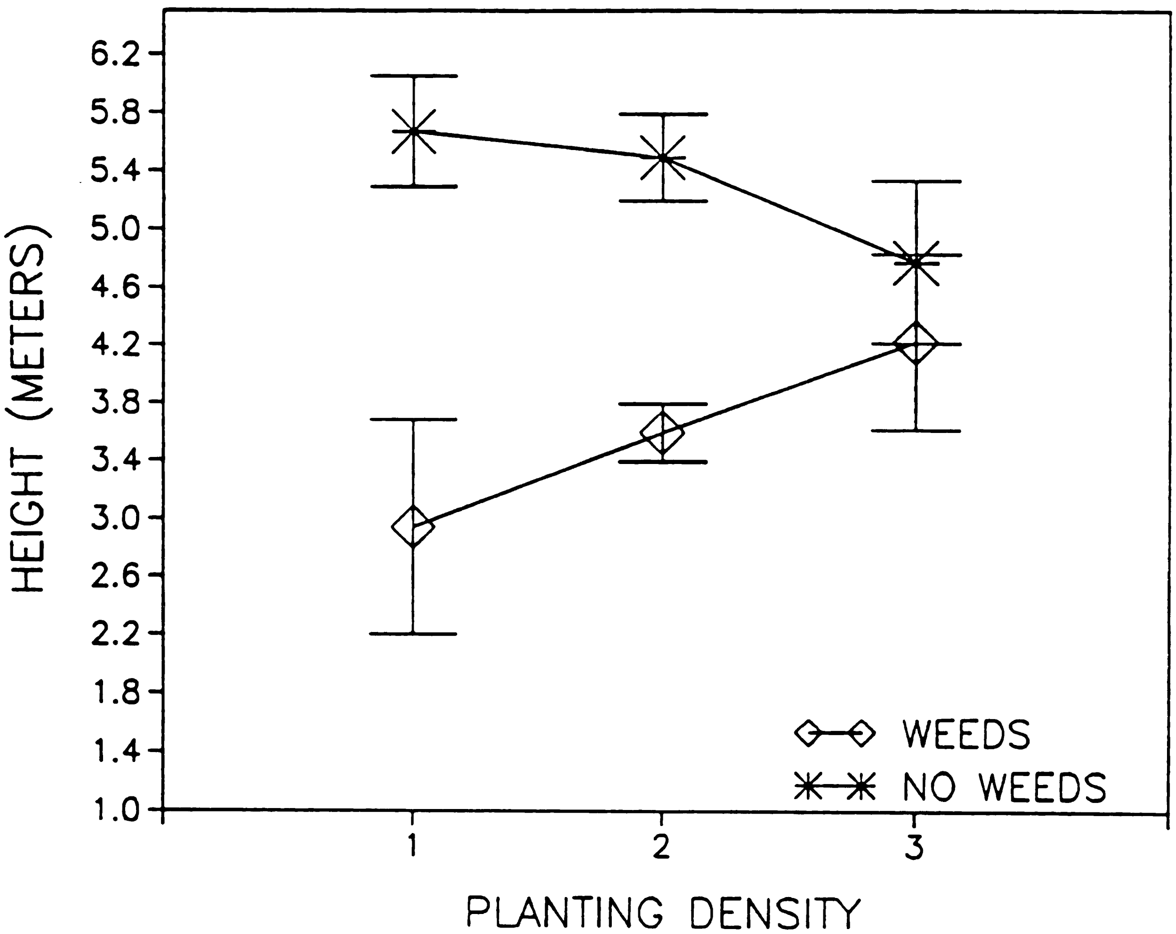

Figure 3

Poplar height in 1991

control had a mean height of 4.22m. This approached the height of high density trees with weed control (4.77m). High density mean heights were not significantly different from one another. At the low and medium densities the means of trees with weed control were significantly greater than those at the same density without weed control. A 1.9-fold increase was seen in height at the low density as a result of weed control. Medium density trees showed a 1.5-fold increase and high density trees gained only a 1.1-fold increase in height from weed control.

Leader length (1991) shows a similar pattern to tree height (Figure 4). When weeds were controlled leader length decreased as planting density increased. Trees at the low and medium densities had significantly more leader growth than the high density trees (Table 4). Trees with weed cover increased leader length as planting density increased. The high density trees without weed control surpassed the leader growth of the high density trees with weed control, although the difference was not a significant (Figure 4).

Individual tree leaf area showed a decreasing trend with increased planting density when weeds were controlled (Figure 5). This decrease was significantly different between planting densities. Leaf area at each density in plots without weed control were not significantly different from one another. The individual tree leaf area mean at the high density plots were equal, regardless of weed control.

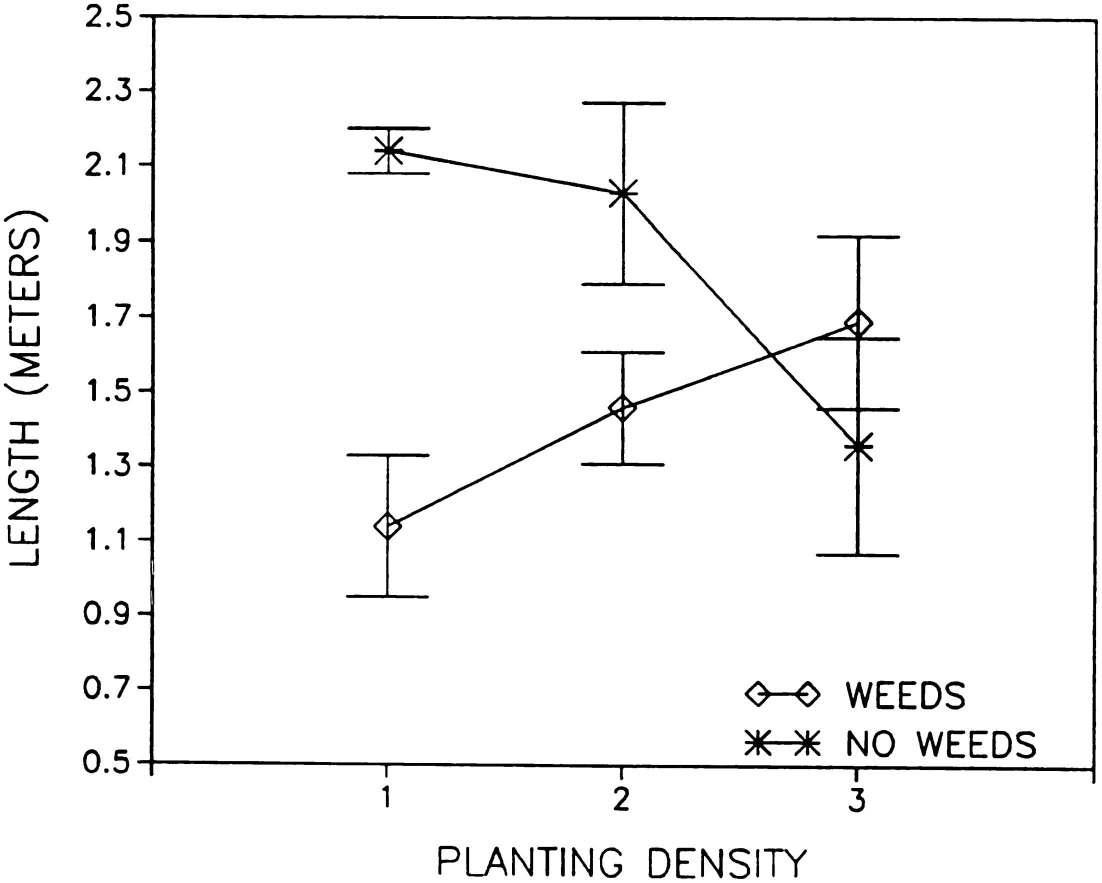

Figure 4

Poplar leader length in 1991

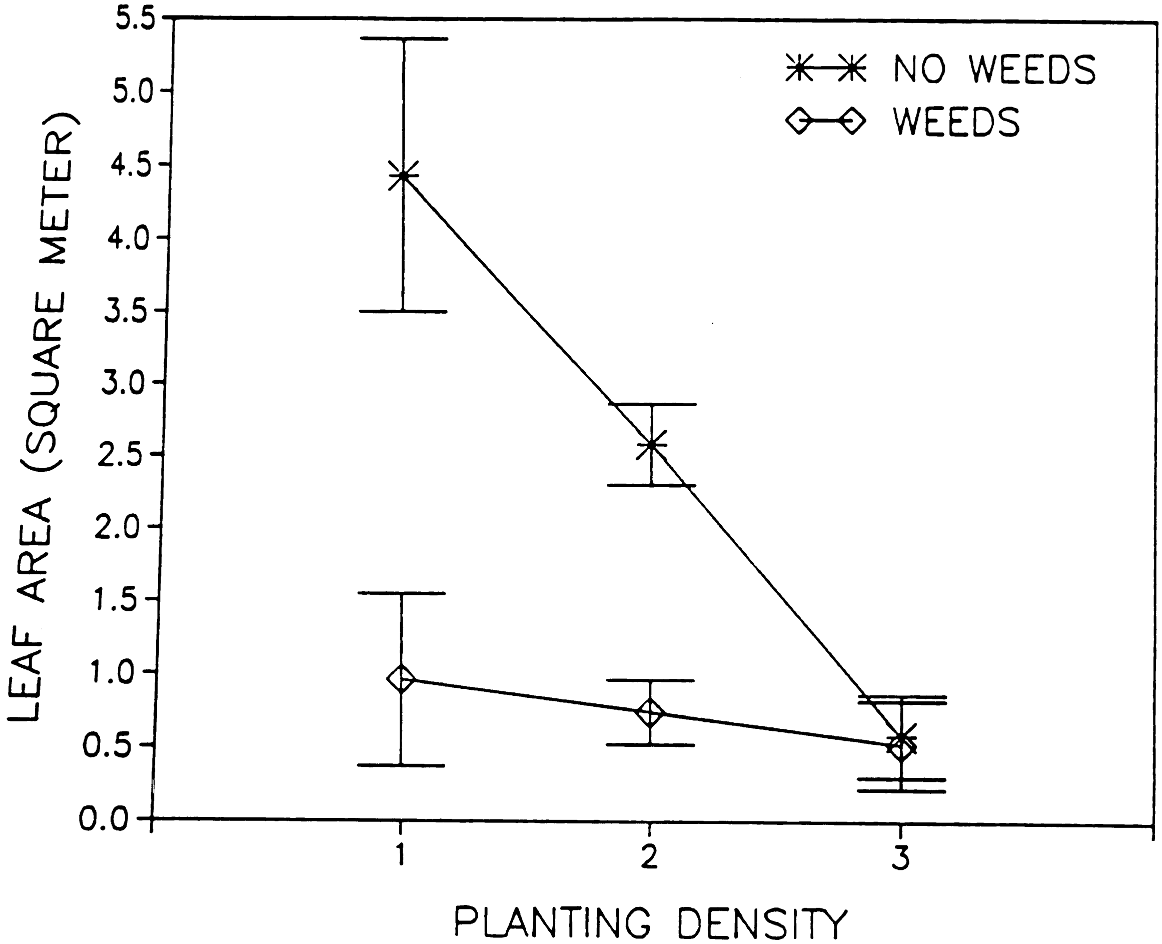

Figure 5

Individual tree leaf area in 1991

PLANT BIOMASS

Individual Tree Biomass

Aboveground individual tree biomass and woody biomass was influenced by planting density and weed control, but with no interaction occurring in September 1989. Tree biomass included green leaves and woody components. Woody biomass consisted of stem and branches. Total biomass and woody biomass showed similar patterns across treatments and these closely paralleled tree diameters. Individual trees with the highest total biomass were in the low density weed control plots (176.5g; 93.3g woody). Tree biomass in weed control plots decreased as planting density increased. In plots with no weed control, trees at medium and high density had equal biomass values (36.6g and 40.6g total biomass, respectively). Low density trees were slightly larger at 57.0g total tree biomass, but this value was not significantly different from the other two densities (Table 3).

At the end of the third growing season an interaction between planting density and weed control was influencing individual tree total biomass and woody biomass. In weed control plots, tree biomass decreased significantly with increased density (Figure 6). At low density, individual trees had a mean total biomass of 4410g (3915g woody). High density trees weighed only 1166g (1107g woody). Biomass in plots without weed control were not significantly different from one another (Table 4, Figure 6). Low and medium

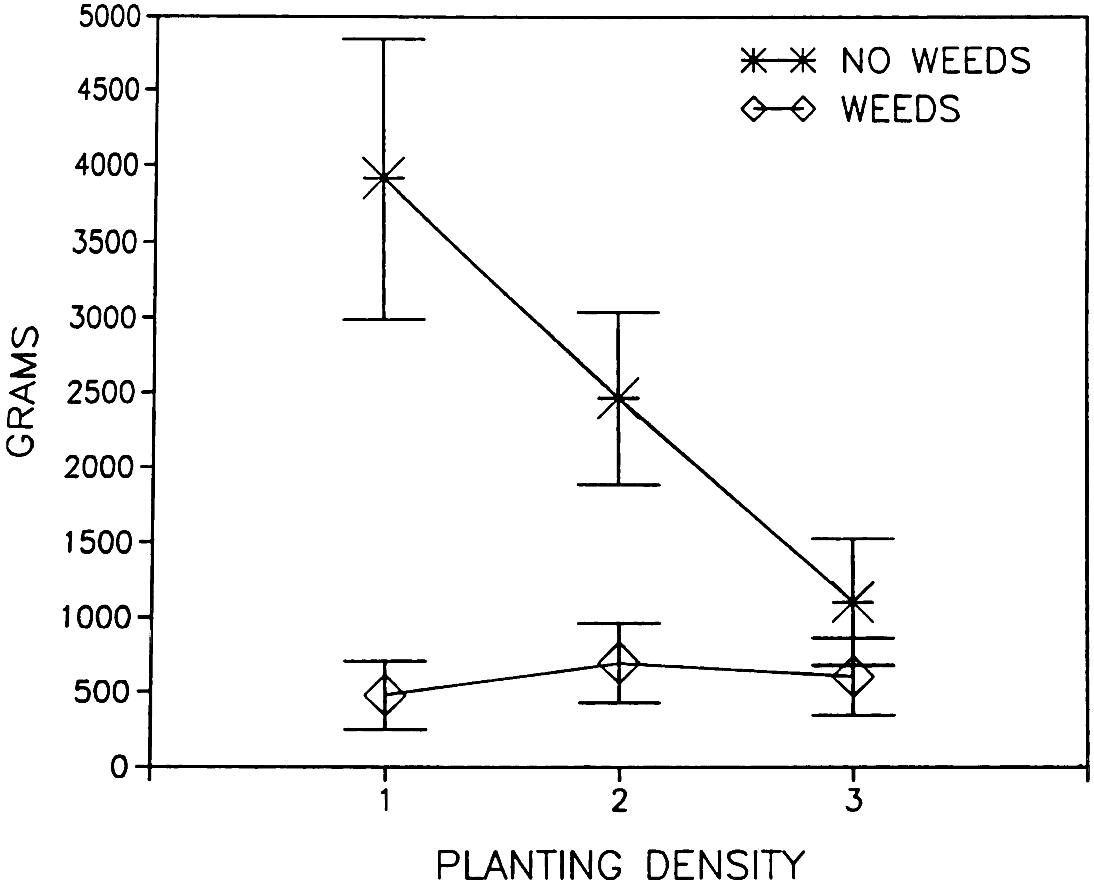

Figure 6

Individual tree woody biomass in 1991

density trees without weed control were significantly lower than those at the same density with weed control. Trees at the high planting density were not found to be significantly different across weed control treatments.

Tree Stand Biomass

Aboveground stand biomass at the end of the first growing season (1989) is shown in Table 5. At the end of the first year, biomass (g/m^2) decreased as the planting density decreased. The standing crop (woody biomass per unit area) at the end of the third growing (1991) season was greatest in the high density weed control plots ($1552 g/m^2$) and the medium density weed control plots had $1225 g/m^2$ in biomass (Table 6). Weed control resulted in a 5.8-fold woody biomass increase in the low planting density, a 4.8-fold increase at the medium planting density, and only a 1.6-fold increase at the high density. Without weed control, the high density trees ($940 g/m^2$) were able to produce more biomass than the low planting density ($611 g/m^2$) with weed control. In general, the standing crop biomass increased as density increased (Table 6) in 1991. In the weed control plots there was a 2.5-fold increase in biomass from the low to high density plots. With weeds present the increase was 9.0-fold. Total aboveground biomass was similar to the standing crop results.

Table 5

September 1989 aboveground tree stand means (standard deviation)

Trt[1]	Stand Biomass (g/m^2)	Stand Nitrogen Content (g/m^2)	Leaf Area Index
1-1	22.46 (5.24)c[2]	0.61 (0.20)bc	0.12 (0.03)c
1-0	8.49 (6.01)c	0.14 (0.11)c	0.04 (0.03)c
2-1	76.96 (19.34)bc	1.19 (0.61)b	0.40 (0.10)bc
2-0	24.44 (9.06)c	0.22 (0.17)c	0.13 (0.05)c
3-1	225.26 (101.3)a	4.29 (1.25)a	1.18 (0.53)a
3-0	139.33 (93.11)ab	0.99 (0.27)b	0.73 (0.49)ab

[1] First digit designates planting density (1-low, 2-medium, 3-high) second is 1-weed control or 0-no control.

[2] Means with the same letter are not significantly different, Tukey's HSD alpha=0.05.

Table 6

1991 Aboveground tree stand means (standard deviation)

Treatment[1]	Standing Crop (g/m^2)	Total Stand Biomass (g/m^2)	Stand N Content (g/m^2)	Leaf Area Index July	Leaf Area Index Sept.
1-1	611(93)cd[2]	718(104)c	7.18(3.41)b	0.35(0.16)b	0.70(0.09)ab
1-0	105(47)e	126(57)d	1.07(0.86)b	0.07(0.02)b	0.17(0.05)c
2-1	1225(181)ab	1339(196)ab	8.07(1.43)ab	1.45(0.18)a	0.88(0.12)a
2-0	256(85)de	290(95)d	2.99(0.94)b	0.42(0.17)b	0.34(0.09)c
3-1	1552(352)a	1646(382)a	18.48(12.4)a	1.67(0.24)a	0.61(0.14)b
3-0	940(109)bc	1028(120)c	9.21(3.76)ab	1.46(0.57)a	0.82(0.12)ab

1 First digit signifies planting density (1-low, 2-medium, 3-high) and the second is weed control (1) or no weed control (0).
2 Means with the same letter are not significantly different, Tukey's HSD alpha=0.05.

Weed Biomass

Aboveground weed biomass in July 1989 was not significantly different between planting densities. Weed biomass at the low planting density was 369g/m^2 (Table 7). At the medium planting density the biomass was 342g/m^2 and at the high planting density weeds were 363g/m^2.

Weed biomass in September 1989 at the three planting densities was not significantly different from one another. Biomass did decrease with increasing planting density. Weed biomass at the low planting density was 1194g/m^2 (Table 7). At the medium planting density weed biomass was 605g/m^2 and was 479g/m^2 at the high planting density.

By August 1990 planting density did have a significant effect on aboveground weed biomass. Weed biomass at the high planting density was significantly lower than the weeds at the medium density. Weed biomass from the low planting density was not significantly different from either the medium or the high densities. The mean biomass for low, medium, and high planting densities was; 268g/m^2, 301g/m^2, and 141g/m^2.

Planting density continued to effect weed biomass in 1991. Weed biomass was not significantly different at the high planting density (88g/m^2) and at the medium planting density (226g/m^2) (Table 7). Weed biomass at the high planting density was significantly lower than the weed biomass at the low planting density which had (435g/m^2).

Table 7

Aboveground weed biomass and N content means (standard deviation)

Month	Year	Density	Biomass (g/m^2)	N Content ($g\ N/m^2$)
July	1989	Low	369 (332)a[1]	8.67 (6.30)a
July	1989	Medium	342 (159)a	5.82 (2.72)a
July	1989	High	363 (110)a	6.40 (2.11)a
Sept	1989	Low	1194 (889)a	9.25 (7.99)a
Sept	1989	Medium	605 (397)a	7.23 (6.34)a
Sept	1989	High	479 (205)a	5.57 (2.68)a
August	1990	Low	268 (77)ab	2.79 (1.25)a
August	1990	Medium	301 (97)a	3.62 (1.17)a
August	1990	High	141 (52)b	1.92 (0.75)a
August	1991	Low	435 (273)a	6.18 (2.73)a
August	1991	Medium	226 (51)ab	3.80 (1.01)ab
August	1991	High	88 (48)b	1.49 (0.75)b

1 Means with the same letter are not significantly different, Tukey's HSD alpha=0.05. Sample size in each month of 1989 and 1990, N=18 in 1991 N=30.

Total Community Biomass

Total community biomass is presented here but should be viewed with caution. In 1989 weed biomass was sampled with quadrats of $0.20m^2$ with no repetitions within subplots. Only one quadrat per subplot was sampled. Heterogeneity of weed cover was not accounted for. In projecting the biomass to an area of $1.0m^2$ the sampling and measurement errors are magnified and these are additive to the errors from the 1990 and 1991 samples. In 1990 and 1991 quadrats of $1.0m^2$ were used. A quadrat size of $0.20m^2$ for vegetation sampling is viewed as inadequate by the author and is not recommended.

Total community biomass includes weed biomass from 1989, 1990, and 1991, poplar leaf biomass from 1989 and 1990, and 1991 total tree biomass (Table G.1, Appendix G). Planting density and weed control did not significantly influence total aboveground community biomass. A significant interaction between density and weed control was present. The only means significantly different from one another were the low density with weed control ($778g/m^2$) and the low density without weed control ($2150g/m^2$) communities. The other community values ranged from $1430g/m^2$ to $1852g/m^2$ (Table 8). Figure 7 shows that biomass increases in communities with weed control as planting density increases. The high standard deviation present for the low density community without weed control (1-0) appears to be reflect the high weed biomass values in 1989. These values are probably inflated due to the sampling technique and

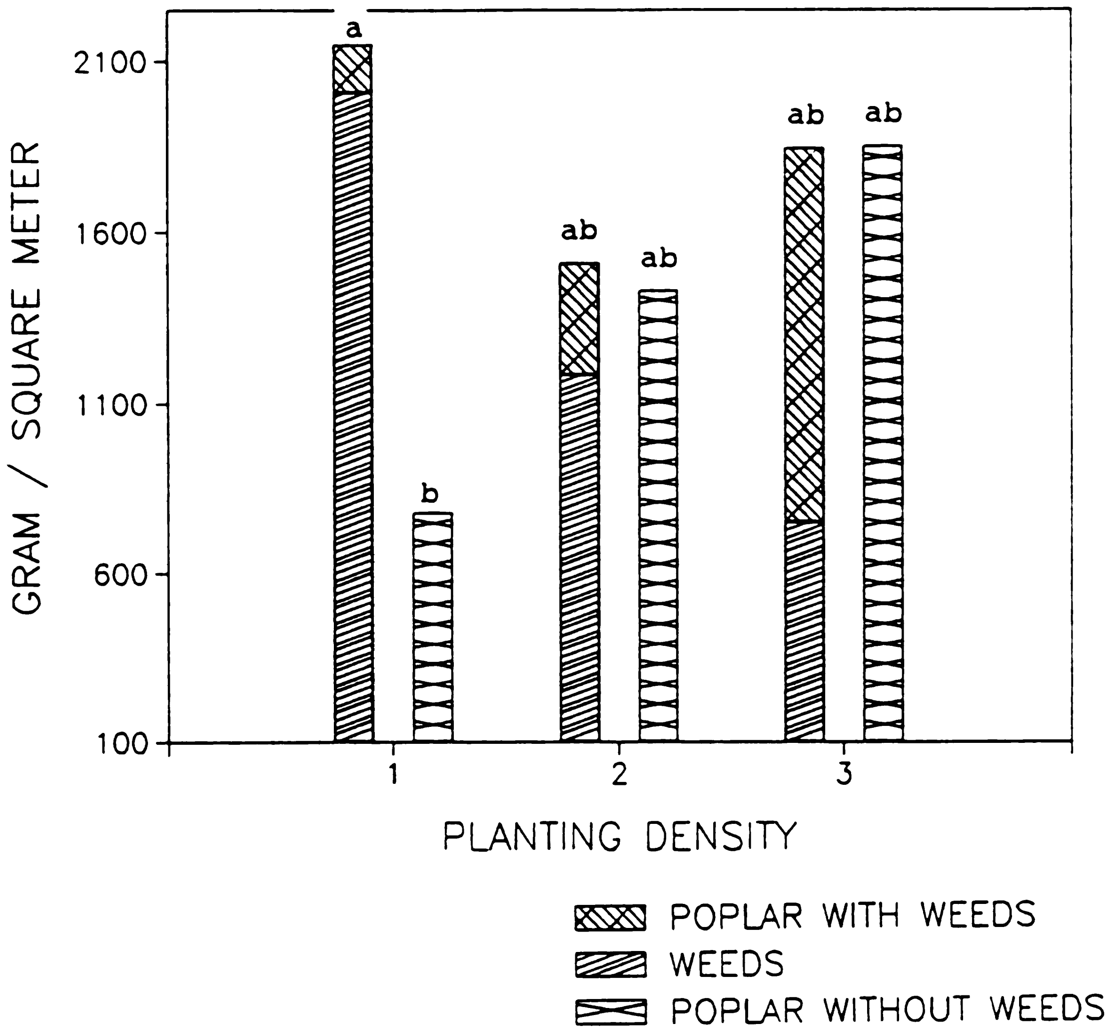

Figure 7

Aboveground cumulative community biomass at the end of year three (means with the same letter are not significantly different, Tukey's HSD alpha=0.5) expansion factor needed to bring the values to an equivalent basis with the other years.

Table 8

Cumulative community biomass at the end of year three, means (standard deviation)

Treatment[1]	Trees (g/m^2)	Weeds (g/m^2)	Total (g/m^2)
1-1	778(112)c[2]		778(112)b
1-0	142(62)d	2008(1089)a	2150(1097)a
2-1	1430(204)ab		1430(204)ab
2-0	327(98)d	1184(537)a	1511(598)ab
3-1	1852(413)a		1852(413)ab
3-0	1097(136)bc	749(289)a	1846(194)ab

[1] First digit signifies planting density (1-low, 2-medium, 3-high) second digit 1-weed control or 0-no weed control.
[2] Means with the same letter are not significantly different, Tukey's HSD alpha=0.05.
Sample size N=30

LEAF AREA INDEX

July 1991 leaf area index (LAI) was estimated by canopy transmittance and Beer-Lambert Law (Pierce and Running 1988). September LAI was estimated by prediction equations (Table C.4, Appendix C). LAI in both months were influenced by interactions between planting density and weed control. The highest LAI observed in July was 1.67 in the high density weed control plots (Table 4). The lowest values were present in the low density plots; 0.35 with weed control and 0.07 without weed control. By September LAI had dropped below 1.0 in the high and medium density plots due to partial leaf senescence. The LAI in the low density plots was actually higher in September than in July even though the trees were experiencing leaf loss. It is possible that the use of canopy transmittance to determine LAI at wide planting spacings (low density and possibly medium density) was inappropriate.

PLANT NITROGEN CONTENT

Individual Tree N Content

July 1989 nitrogen (N) content in individual poplar trees was influenced by weed control. Total tree N was also affected by planting density. High density trees with weed control contained 0.65g of N (Table 2), the highest total tree N content. Means across the three densities, within each weed control treatment, were not significantly different. By September the effect of weed control resulted in significant differences in total tree N content. All woody N content means were not significantly different (Table 3). There was more N present in the leaves than in the woody tissue. As in July, N content at each density with weed control (or without) was not significantly different. At each density, however, trees receiving weed control had significantly higher N contents than those trees not receiving weed control.

Trees in 1991 were influenced by interactions between planting density and weed control. The only significantly high total tree N and woody N contents were in the low density weed-free plots, reflecting their higher biomass values (Table 4).

Nitrogen concentrations in leader foliage in July 1991 ranged from 2.57% to 3.21%. Leaves collected were the 4th, 5th, 6th, and 7th mature leaves from the tip of the leader. The lowest two means (2.57% and 2.86%) were seen in the low and medium density plots without weed control. The highest two values (3.21% and 3.19%) were in the high density plots with and without weed control. The low and medium density plots with weed control had concentrations of 3.10% and 3.12% (Table F.13, Appendix F).

Tree Stand N content

Weed control influenced stand level N in trees by the end of the first year. Tree stands with weeds present consistently had lower N contents than the weed free stands (Table 5). Stand level N content (leaves and wood included) in 1991 was highest when the weeds were controlled at high density (18.48g N/m^2) (Table 6). The lowest values were seen in the low and medium density trees without weed control (1.06g N/m^2 and 2.99g N/m^2, respectively). At each planting density weed control resulted in a discernable increase in tree N content.

Weed N Content

Nitrogen content in the July 1989 weeds showed no significant differences due to planting density (Table 7). In September the amount of N in the weed biomass had increased over that in July but no significant differences occurred between densities. From 1989 to 1990 weed biomass at each planting density decreased, as did the N content. Weeds present in the medium density plots (3.62g N/m^2) did not have a significantly higher N content than the weeds at the high density (1.92g N/m^2).

In August 1991 weed N content exhibited a significant decrease as tree planting density increased. Although weed biomass decreased in the medium and high density plots in 1991 from that seen in 1990, the N contents varied little (Table 7). The static level of N, in spite of decreased weed biomass, may be attributable to the species composition of the weed populations. In the low planting density the weed N content (and biomass) nearly doubled from 1990 to 1991. The low values in 1990 are unaccounted for.

Total Community N Content

Aboveground community N in September 1989 did not exhibit effects from planting density. Weed control did influence N content. The majority of N (76-89%) present in the weedy plots was found in the weed biomass. The weeds at the low planting density contained the highest percentage of N. The only significant difference between communities was found at the low planting density (Table 9). With weed control the trees contained 0.55 g N/m^2 and in the weedy plots the community contained 10.38 g N/m^2. The difference in N content between weed control treatments at each density decreases as the planting density increased (Figure 8). Those communities without weed control are consistently higher in N than those with weed control.

Table 9

Total community nitrogen content for September 1989, aboveground biomass means (standard deviation)

Treatment[1]	Poplar ($g\ N/m^2$)	Weed ($g\ N/m^2$)	Community ($g\ N/m^2$)
1-1	0.55 (0.16)b		0.55 (0.16)b[2]
1-0	0.16 (0.12)b	10.22 (8.53)a	10.38 (8.48)a
2-1	1.14 (0.70)b		1.14 (0.70)ab
2-0	0.23 (0.17)b	7.99 (7.49)a	8.15 (7.42)ab
3-1	4.18 (1.43)a		4.18 (1.43)ab
3-0	1.02 (0.31)b	6.27 (2.68)a	7.28 (2.54)ab

[1] First digit signifies planting density (1-low, 2-medium, 3-high) and the second digit is weed control (1) or no weed control (0).

[2] Means with the same letter are not significantly different at the 0.05 alpha level by Tukey's HSD.
Sample size N=30, Block 3 was removed to allow comparison with the 1991 community N content.

In general, community N content increased in 1991. The low and medium planting densities without weed control communities experienced a decrease in N. The low planting density plots without weed control dropped from 10.38g N/m^2 in 1989 to 7.24g N/m^2 in 1991 (Table 10). The weed

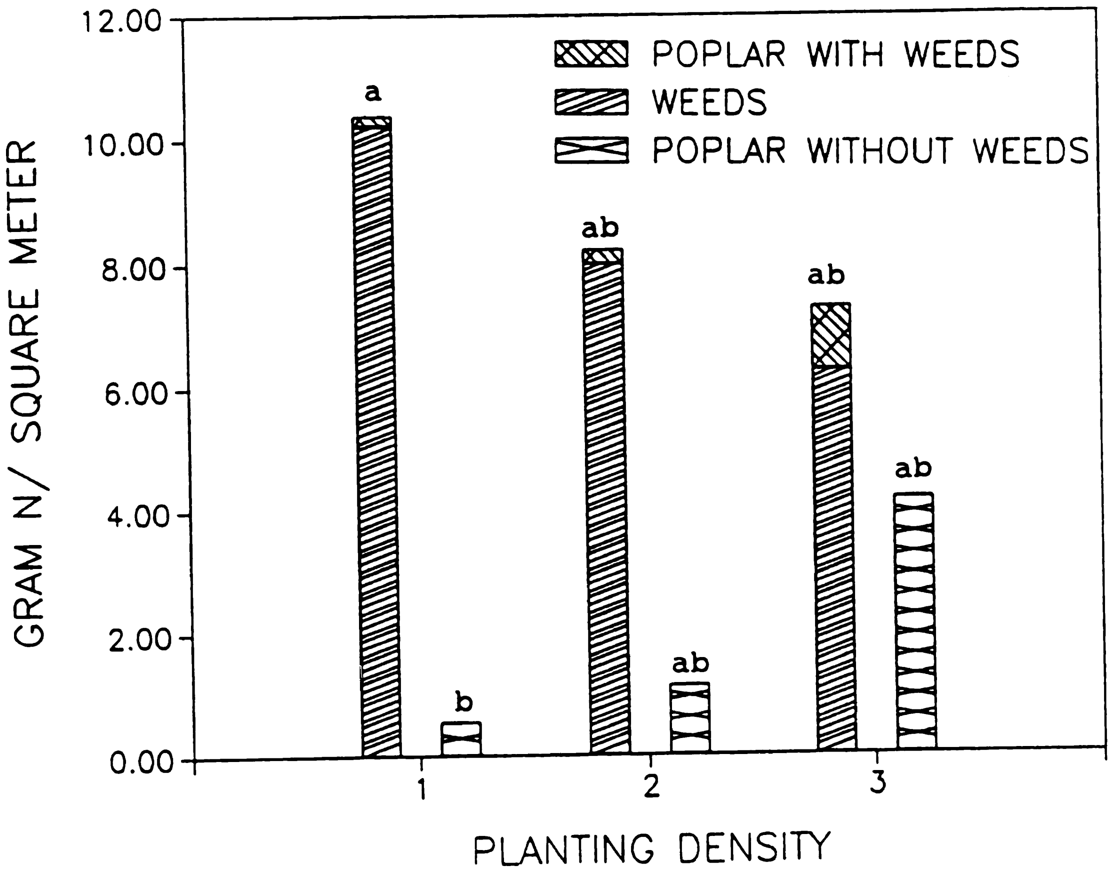

Figure 8

Aboveground nitrogen content in the 1989 plant community (means with the same letter are not significantly different, Tukey's HSD alpha=0.5) population lost 3.07g N/m^2 while the trees lost 0.07g N/m^2. In the medium density weedy plots, the weeds lost half of the N held in 1989 while the trees increased tissue N content by 325% This increase in tree N content was not equal to the loss of weed N content. The drop in N from 1989 to 1991 reflects the response of the annual weed population to the fertilizer applied the first year. This high level of applied N was not available for growth in 1991. By 1991 the high density plots with and without weed control contained the most N.

Table 10

Total aboveground community nitrogen content means (standard deviation) in 1991

Treatment[1]	Poplar (g/m^2)	Weed (g/m^2)	Community (g N/m^2)
1-1	7.18(3.41)b		7.18 (3.41)b[2]
1-0	1.07(0.86)b	6.18(1.02)a	7.24 (3.48)b
2-1	8.07(1.43)ab		8.07 (1.44)ab
2-0	2.99(0.94)b	3.80(0.47)b	6.79 (1.84)b
3-1	18.48(12.42)a		18.48 (12.42)a
3-0	9.21(3.76)ab	1.49(0.44)c	11.26 (3.28)ab

[1] First digit signifies planting density (1-low, 2-medium, 3-high) and the second digit is weed control (1) or no weed control (0).
[2] Means with the same letter are not significantly different at the 0.05 alpha level by Tukey's HSD.
Sample size N=30

Figure 9 shows that N content, regardless of weed control increases at the highest planting density. The differences between weed control treatment at each density is narrower than in 1989 (Figure 8). In 1989 the N content in the high planting density with weed control was approaching that of the high density without weed control. In 1991 the high density weed control community contained more N than when weeds were not controlled. There was a significant decrease in weed biomass from 1989 to 1991 at the high planting density.

When the community N contents of 1989 and 1991 were compared the ANOVA showed that the year had a significant effect on the communities and there was a weed control/year interaction (not shown). Weed control treatment by itself was not a significant factor, but planting density was.

SOIL

Soil moisture of samples taken August 5, 1991, were affected by weed control treatment but not by planting density. There was no significant differences between treatment means (Table 11). The soil moisture values ranged from 11.1% to 14.17% with the higher values for each planting density found in plots that had a weed cover. NH_4-N was also affected by weed control treatment but NO_3-N was not. Neither was affected by planting density. Both NH_4-N and NO_3-N showed no significant differences between treatment means. The mean NH_4-N values ranged from 2.22 μg

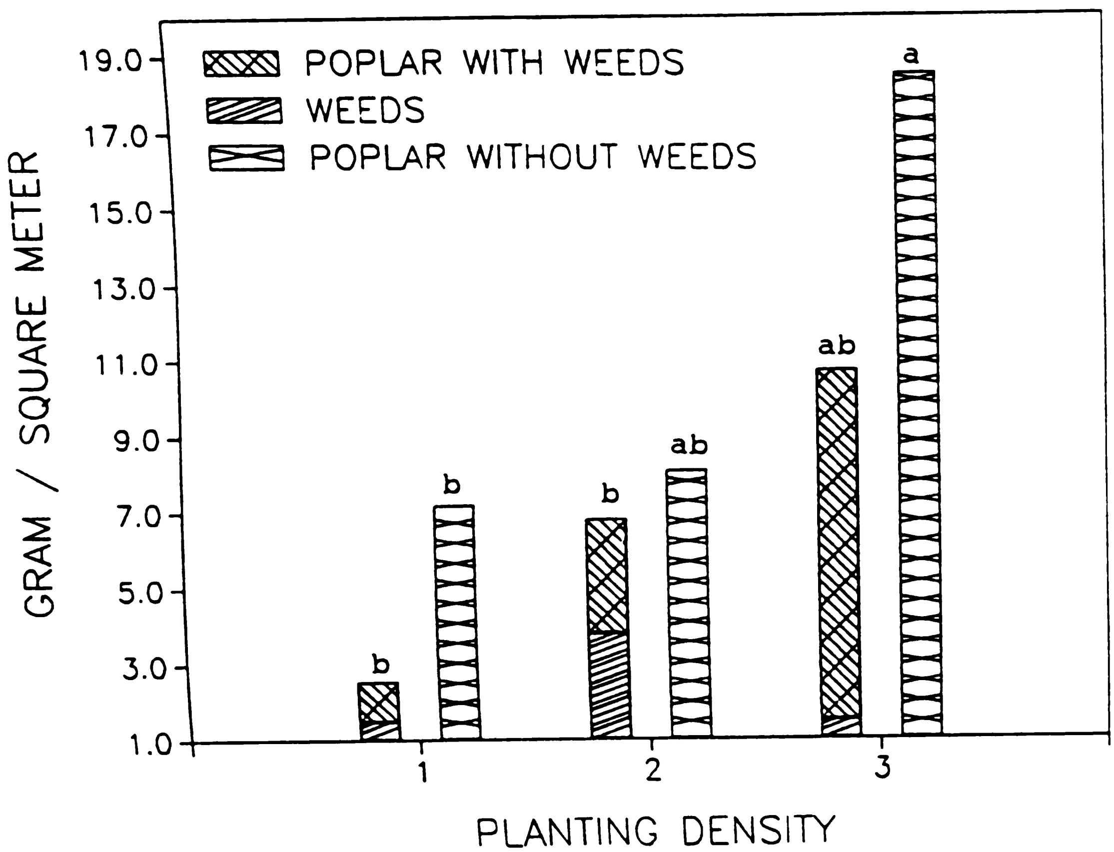

Figure 9

Aboveground nitrogen content in the 1991 plant community (means with the same letter are not significantly different, Tukey's HSD alpha=0.5)

N/g soil to 3.39 μg N/g soil. Within a planting density the higher values were in weedy plots and increased with planting density. Means for NO_3-N ranged from 0.98 μg N/g soil to 1.92 μg N/g soil. Mineralization of N was determined by summing the NH_4-N and NO_3-N content after incubation and subtracting the sum of the initial values. High density without weed control had the highest mineralization rate of 0.59 μg N/g soil per day

and was no significantly higher than any of the treatment means. The other treatments ranged from 0.22 to 0.53 μg N/g soil per day and were not significantly different from the highest and lowest rates. Figure 10 shows the mineralization rate for each treatment. It appears that the sampling was not rigorous enough to statistically indicate biologically significant differences in mineralization rates. A small sample size resulted in a high standard error in the analysis of variance.

Table 11

Soil extractable N and mineralization rates

Trt[1]	Soil Moisture (%)[2]	Extract. NH4-N[4] (μg N/g)[2]	Extract. NO3-N[4] (μg N/g)[2]	Mineral. Rate (μg N/g/day)
1-1	12.1(2.0)	2.22(0.34)b[3]	1.85(0.57)	0.23(0.19)a
1-0	13.2(1.3)	2.87(0.38)ab	1.67(0.99)	0.44(0.13)a
2-1	11.1(1.6)	1.90(0.75)b	1.05(0.21)	0.20(0.08)a
2-0	13.4(3.3)	3.30(0.80)a	1.92(1.56)	0.53(0.18)a
3-1	12.8(4.9)	2.17(0.90)b	0.98(0.53)	0.27(0.14)a
3-0	14.1(2.9)	3.39(0.83)a	1.38(0.70)	0.59(0.40)a

1 First digit designates density (1-low, 2-medium, 3-high) and second is 1-weed control, 0-no control
2 Values are not significantly different from one another
3 Means with the same letter are not significantly different, Tukey's HSD alpha=0.05
Number of observations for each variable was 60
4 Available N at the time of sample collection

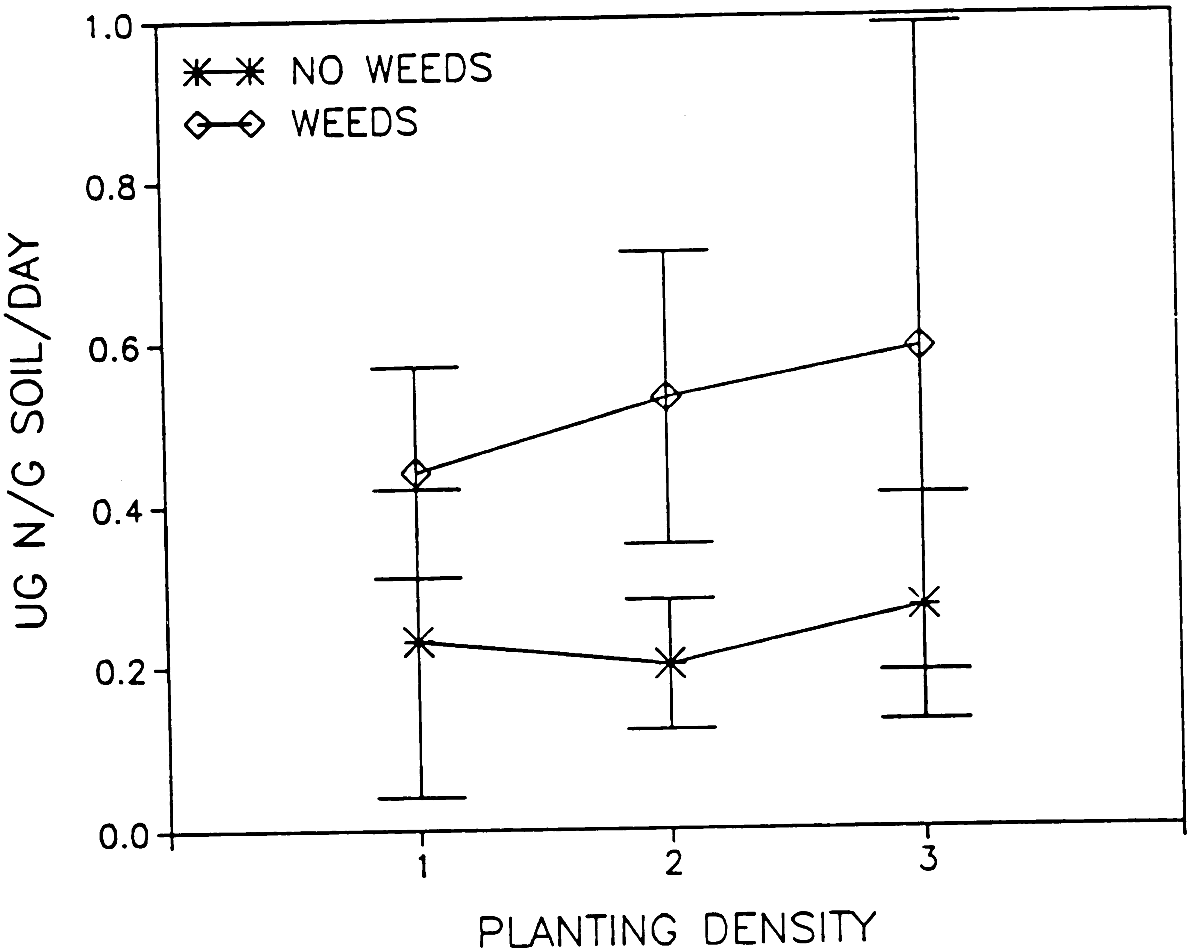

Figure 10

Soil mineralization rates in August 1991

CHAPTER V

DISCUSSION AND CONCLUSIONS

DISCUSSION

Tree diameter began to respond to treatment by September of 1989. Tree diameters in weed free plots decreased as the planting density increased. Trees in the weedy plots exhibited smaller diameters than those in the weed control plots. At each planting density weed control resulted in a significant increase in diameter.

In 1991 tree diameter responded to density in the weed control plots. In the weedy plots, tree diameter decreased in response to weed cover. The low density plots were carrying the greatest amount of weed biomass and the trees had the smaller diameters. As the weed biomass decreased with increased planting density, tree diameter increased, i.e. the effect of competition from the weeds diminished.

Tree height began to respond to treatments in 1989, although means was not significantly different. By 1991, height was independent of tree density but not of weed treatment. Trees established superior height over weeds in the first growing season, and light was not considered to be limiting. Other studies have shown that height is unaffected by stand density, unlike tree diameter and biomass (Whitehead 1978). Interspecific competition present in the weedy plots significantly decreased tree height in the low and medium planting densities but not in the high density. In both the low and medium density plots the weeds were the dominating portion of the community. Interior trees in the low density plots were not much taller than the weed population. The lowest weed biomass was seen in the high density plots and here the trees were equivalent in height to those high density trees that received weed control.

Leader growth (1991) response to treatment was similar to that of tree height. Growth in the high density plots suggests an explanation for the non significant height difference seen between weed treatments. Leader growth in the high density weed free plots was significantly lower than at the other two densities. This suggests that growth is inhibited by intraspecific competition. In the weedy plots leader length increased with increased tree density. As planting density increased the interspecific competition is reduced, as seen by a decrease in weed biomass. High density leader (1991) growth with weeds present surpassed the leader growth of high density trees with weed control. Trees in the high density weedy plots may be experiencing a lower level of neighbor interference than those with weed control because tree growth was reduced in the first two years. In the fourth growing season growth in the high density weedy plots is expected to be equivalent to that in weed control plots. The weeds no longer appear to be inhibiting growth.

Poplar leaf area index (LAI) estimated in July 1991 exhibited an increase as planting density increased. Presence of weeds decreased the LAI significantly only at the medium planting density. Because of tree spacing at the low and medium densities these estimates of LAI from canopy transmittance may not be accurate. The highest LAI was present at the high density weed control plots (1.67). LAI estimated for September reflects leaf loss as the trees began to enter dormancy. The highest September LAI was found in the medium density weed control plots (0.88). It is suspected that the high density trees experienced a proportionally higher amount of leaf loss by early September. Poplars, being very shade intolerant, drop lower branches and leaves when light is limited. Populus x euramericana hybrids do not tolerate lateral shade (Dickmann and Stuart 1983). The high density weed control plots may have actually reached maximum LAI in the first year. The September 1989 LAI of 1.18 also is likely to reflect the lack of neighbor interference which caused the lower leaves to drop early in 1991.

Tree stands are known to reach a maximum LAI which may decrease because of stand age or stress (Vose and Swank 1990). In the weedy plots the majority of the community LAI is held in the weed population (except high density). The trees may increase in LAI if the weeds decrease LAI. Community LAI was not measured. The low LAI in the weed control plots may be due to moisture and N availability (Jarvis and Leverenz 1983). American sycamore (Platanus occidentalis) and black locust (Robinia psuedoacacia) grown at 1.2 x 2.4m spacing were reported to have LAIs of 4.8 and 4.9, respectively, in July of the fourth growing season. The LAIs dropped to 4.7 and 1.7, respectively, in September (Dickmann, Steinbeck, and Skinner 1985).

Individual tree biomass decreased as planting density increased, when weeds were controlled. The opposite trend was seen in the weedy plots. The decrease in individual tree biomass in weedy plots is a result of intraspecific competition. In the weedy plots, trees at all planting densities experienced a decrease in biomass. High density trees without weed control were not significantly different from the high density trees with weed control. The visible difference may be due to interspecific competition the first two growing seasons. The greatest difference within a planting density was seen at the low density. It appears that the weed population dominated the site and that the trees were unable to exert a high level of suppression on the weeds as seen at the highest density. Trees in the low density plots with weed control did not experience much competition from neighboring poplars. This appears to be the case in the medium density plots where individual biomass has decreased over that of the low density. Medium density trees without weed control are responding to weed competition, not neighboring trees. Competition from the weeds is higher than the competition seen from neighboring trees in the weed control plots.

Nitrogen deficiency in poplar species has been identified as foliage concentrations of less than two percent (Dickmann and Stuart 1983). In July 1991, foliage collected had N concentrations higher than 2.50% in all treatments. The lowest two concentrations were in the weediest plots (low and medium density) with the highest level of interspecific competition. The trees in the two weediest plots did have sufficient N for growth, but possibly not enough to increase leaf area and photosynthesis rates to recover from the detrimental influence by the weeds during the first two growing seasons.

In the weed control plots, individual tree N content decreased with increasing planting density. Extractable soil N (at the time of sampling) and mineralization rates were equivalent at each density. That mineralization rates were not significantly different may be a reflection the small sample size. Although the rates were not statistically different they are probably significantly different, biologically. The decrease in individual tree N content reflects the division of available soil N among more trees at the higher planting densities. Among the weedy plots the mineralization rates were higher than those in the weed control plots, suggesting a higher turnover of fine roots and weed litter.

Standing tree crop biomass was significantly reduced due to weed competition at the end of 1991. The biomass difference between weed-free and weedy plots narrowed as the planting density increased. The low planting density weed-free plots had 5.8 times more biomass than the weedy plots. The high density weed-free plots only had 1.6 times more biomass than the weedy plots. The weeds had less influence on tree growth at the higher densities. By the end of the third growing season weed biomass also decreased in response to the higher planting density.

Nitrogen content in the tree crop was not significantly reduced by weed competition. Although the mean N content was higher in weed free plots, they were not found to be significantly higher, possibly due to high standard deviations within treatment samples.

Total community aboveground biomass was equivalent in each treatment when the site was fully occupied. The low planting density weed-free plots have not yet established complete site occupancy. Once the trees do establish a high level of occupancy the community biomass values are expected to be equivalent among the treatments. The weed population at the medium planting density was able to capture enough resources over the three years to achieve biomass values nearly equivalent to the biomass accrued by the medium density weed-free trees.

Total aboveground community N content was not significantly influenced by weed control at each planting density. Community N contents did not appear to be as dependent on site occupancy as biomass. The low density weed-free community which did not have equivalent community biomass values as the other treatments did have a N content equivalent to all treatments except the high density weed-free community. It appears that the trees in the high density weedy plots were able to capture enough resources in the first growing season to successfully out compete the weeds in the two following years. As the dominance of the trees continues to increase in the high density community the contribution of the weeds to the community N content will become negligible.

CONCLUSIONS

At the end of the third growing season I conclude the following:

1. Weed competition significantly decreased tree diameter, height, leader length, tree leaf area, and individual tree aboveground biomass at the low and medium planting densities.

2. At the high planting density weed competition did not result in a significant decrease in tree diameter, height, leader length, leaf area, individual aboveground biomass or N content.

3. As planting density increased in the weed-free plots tree diameter, leaf area, and individual tree aboveground biomass decreased significantly. High density trees consistently had shorter heights and leader lengths than either the low or medium density trees.

4. Standing crop biomass (trees) significantly decreased at each planting density due to weed competition. The difference between weed treatment at each density decreased as the planting density increased. As the planting density increased the biomass and N content increased. Biomass at the low planting density was significantly lower than the high planting density.

6. In the third growing season weed biomass decreased as tree planting density increased.

7. By the end of the third growing season total community aboveground biomass was equivalent in those treatments that fully occupied the site. Low planting density weed-free communities had not established complete site occupancy.

8. Total aboveground community N content was not significantly affected by weed control at each planting density, regardless of the level of site occupancy at the end of year three as suggested by biomass values. The high density weed controlled stands contained the highest amount of N. Nitrogen content in the low and medium planting densities were equivalent.

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APPENDICIES

APPENDIX A

APPENDIX A

1989 Analysis of Variance Tables

Table A.1

September 1989 tree height ANOVA

Source	df	Sums of Squares	F value[1]
Block	5	0.54171728	1.99 ns
Density	2	0.03618718	0.33 ns
Error (A)	10	1.27358332	
Weed	1	0.64547834	11.84 **
Dens*Weed	2	0.00716143	0.07 ns
Error (B)	15	0.81804935	

Table A.2

September 1989 tree diameter ANOVA

Source	df	Sums of Squares	F value[1]
Block	5	0.36070508	0.75 ns
Density	2	0.86559929	4.52 *
Error (A)	10	0.77497937	
Weed	1	3.46580278	36.16 **
Dens*Weed	2	0.10437918	0.54 ns
Error (B)	15	1.43764004	

Table A.3

September 1989 individual tree total biomass

Source	df	Sums of Squares	F value[1]
Block	5	7453.89306	0.80 ns
Density	2	16088.0006	4.52 *
Error (A)	10	15465.4128	
Weed	1	64177.7778	36.09 **
Dens*Weed	2	5535.72722	1.56 ns
Error (B)	12	26673.6325	

Table A.4

September 1989 individual tree N content

Source	df	Sums of Squares	F value[1]
Block	5	3.44759993	0.96 ns
Density	2	6.08070838	4.23 ns
Error (A)	10	6.41007595	
Weed	1	39.7735966	55.38 **
Dens*Weed	2	2.26695208	1.55 ns
Error (B)	15	10.7731596	

Table A.5

September 1989 community N content

Source	df	Sums of Squares	F value[1]
Block	4	71.47413778	0.79 ns
Density	2	6.15267129	0.14 ns
Error (A)	8	200.15761245	
Weed	1	332.22026408	14.64 **
Dens*Weed	2	57.04567636	1.26 ns
Error (B)	12	272.24289507	

[1] ns - not significant at 0.05, * - significant at 0.05, ** - significant at 0.01 alpha level

APPENDIX B

APPENDIX B

1991 and Community Analysis of Variance

Table B.1

1991 Poplar diameter

Source	df	Sums of Squares	F value[1]
Block	4	1.96796167	0.91 ns
Density	2	14.3224200	13.25 **
Error (A)	8	3.25263833	
Weed	1	42.9962408	79.53 **
Dens*Weed	2	12.8715466	11.90 **
Error (B)	12	6.48725000	

Table B.2

1991 Poplar total height

Source	df	Sums of Squares	F value[1]
Block	4	1.68733667	1.75 ns
Density	2	0.30832167	0.64 ns
Error (A)	8	1.43682833	
Weed	1	22.3430700	92.64 **
Dens*Weed	2	6.06234500	12.57 **
Error (B)	12	2.89423500	

Table B.3

1991 Poplar leader length

Source	df	Sums of Squares	F value[1]
Block	4	0.24401167	1.40 ns
Density	2	0.23668167	2.72 ns
Error (A)	8	0.25689333	
Weed	1	1.32720333	30.50 **
Dens*Weed	2	2.31276167	26.58 **
Error (B)	12	0.52213500	

Table B.4

1991 Poplar standing crop

Source	df	Sums of Squares	F value[1]
Block	4	54822.465	0.34 ns
Density	2	3970216.850	75.58 **
Error (A)	8	210112.827	
Weed	1	3633468.008	90.49 **
Dens*Weed	2	294629.545	3.67 ns
Error (B)	12	481858.672	

Table B.5

1991 Poplar standing crop N content

Source	df	Sums of Squares	F value[1]
Block	4	531.731058	1.26 ns
Density	2	1432.98631	5.34 *
Error (A)	8	1073.73683	
Weed	1	2593.11829	24.63 **
Dens*Weed	2	1631.85480	7.75 **
Error (B)	12	4421.62239	

Table B.6

Soil mineralization rate

Source	df	Sums of Squares	F value[1]
Block	4	0.06086606	0.46 ns
Density	2	0.04636591	0.71 ns
Error (A)	8	0.64578121	
Weed	1	0.58771304	17.95 **
Dens*Weed	2	0.02212044	0.34 ns
Error (B)	12	0.39280218	

Table B.7

1991 Community N content

Source	df	Sums of Squares	F value[1]
Block	4	146.506053220	2.30 ns
Density	2	379.94832470	11.90 ns
Error (A)	8	438.90041131	
Weed	1	59.33939136	3.72 ns
Dens*Weed	2	75.06818952	2.35 ns
Error (B)	12	191.57943465	

Table B.8

Cumulative community biomass at the end of year three

Source	df	Sums of Squares	F value[1]
Block	4	3101839.336161	1.87 ns
Density	2	6179524.76032	6.02 *
Error (A)	8	4108877.70129	
Weed	1	1848546.46930	4.46 ns
Dens*Weed	2	3511264.09330	4.24 *
Error (B)	12	469383.9250	

[1] ns - not significant at 0.05, * - significant at 0.05, ** - significant at 0.01 alpha level

APPENDIX C

APPENDIX C

Poplar Biomass Prediction Equations

Table C.1

1989 Prediction equations for poplars

Month	Variable	Equation[1]	R^2	N
July	Biomass (control)	-1.918 + 0.290(diam^2)	0.940	35
SE of coefficient[2]		[0.868] [0.013]		
July	Biomass (weeds)	-4.255 + 0.366(diam^2)	0.946	36
SE of coefficient		[0.793] [0.015]		
July	Leaf Area	-109.9 + 58.2(diam^2)	0.935	70
SE of coefficient		[29.8] [0.95]		
Sept	Biomass	-8.054 + 0.477(diam^2)	0.983	67
SE of coefficient		[1.913] [0.008]		
Sept	Leaf Area	-425.5 + 25.1(diam^2)	0.968	70
SE of coefficient		[128.3] [0.55]		

1 Predicted biomass (g), leaf area (cm^2)
diameter (mm) at 15cm above the ground
2 Standard error of the coefficient

Table C.2

1991 Prediction equations for poplar woody dry weight(kg).

Treatment[1]	Equation[3]	R^2	N
1-1	0.0174 + 0.0125 (diam^2 * ht)	0.977	11
SE[4]	[0.192] [0.0006]		
1-0	0.0230 + 0.0135 (diam^2 * ht)	0.988	11
SE	[0.015] [0.0005]		
2-1	0.1732 + 0.0144 (diam^2 * ht)	0.946	11
SE	[0.198] [0.0011]		
2-0	0.1083 + 0.0102 (diam^2 * ht)	0.956	11
SE	[0.034] [0.0007]		
3-1	0.1121 + 0.0101 (diam^2 * ht)	0.920	10
SE	[0.080] [0.0010]		
3-0	0.0589 + 0.0106 (diam^2 * ht)	0.985	12
SE	[0.022] [0.0004]		

199

Trea

1
S
1
S
2
S
2
S
3
S
3
S

Trea

1
S
1
S

1
3-
Con
3
4

Table C.3

1991 Prediction equations for poplar total dry weight(kg).

Treatment[1]	Equation[3]	R^2	N
1-1	0.2220 + 0.0140 (diam^2 * ht)	0.975	11
SE[4]	[0.224] [0.0007]		
1-0	0.0288 + 0.0164 (diam^2 * ht)	0.979	11
SE	[0.026] [0.0008]		
2-1	-0.1687 + 0.0155 (diam^2 * ht)	0.955	11
SE	[0.193] [0.0011]		
2-0	0.1253 + 0.0115 (diam^2 * ht)	0.948	11
SE	[0.043] [0.0009]		
3-1	0.0985 + 0.0110 (diam^2 * ht)	0.934	10
SE	[0.078] [0.0010]		
3-0	0.0603 + 0.0117 (diam^2 * ht)	0.988	10
SE	[0.025] [0.0005]		

Table C.4

1991 Prediction equations for poplar leaf area(cm^2).

Treatment[1]	Equation[3]	R^2	N
1-1	6056.841 + 122.339 (diam^2 * ht)	0.864	12
SE[4]	[4690.2] [15.35]		
1-0	3662.755 + 128.307 (diam^2 * ht)	0.671	11
SE	[1884.2] [29.98]		
2-1	514.468 + 93.001 (diam^2 * ht)	0.911	12
SE	[1687.1] [9.19]		
2-0	2597.551 + 107.713 (diam^2 * ht)	0.587	11
SE	[1447.3] [30.11]		
3-1	-1081.110 + 76.655 (diam^2 * ht)	0.898	9
SE	[783.4] [9.76]		
3-0	- 398.054 + 116.242 (diam^2 * ht)	0.860	11
SE	[850.4] [15.67]		

[1] First digit signifies planting density (1-low, 2-medium, 3-high) and the second digit is weed control (1) or no weed control (0).
[3] diameter(cm) at 15cm above the ground, total height(m)
[4] Standard error of the coefficient

APPENDIX D

B

Aver

Bloc

1

2

3

4

5

6

Avera

APPENDIX D

1989 Data

Table D.1

Poplar diameters (cm, at 15cm above the ground) in July 1989 from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.91	0.63	0.69	0.65	0.99	0.74
2	0.68	0.95	0.52	0.77	0.92	0.72
3	0.59	0.61	0.82	0.56	0.75	0.68
4	0.73	0.50	0.78	0.64	0.88	0.66
5	0.56	0.80	0.59	0.63	0.62	0.79
6	0.88	0.90	0.89	0.67	0.93	0.67
Average	0.72	0.73	0.72	0.65	0.85	0.71

Table D.2

Poplar diameters (cm, at 15cm above the ground) in September from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	1.28	1.12	1.16	1.35	1.74	1.12
2	1.65	0.94	1.02	0.92	1.20	0.92
3	2.37	0.88	1.65	0.90	1.56	0.83
4	2.08	1.08	2.08	0.86	1.26	0.73
5	2.00	1.58	1.32	0.86	1.31	1.14
6	2.14	1.29	1.69	0.67	1.77	0.92
Average	1.92	1.15	1.48	0.92	1.47	0.94

Block
1
2
3
4
5
6
Average

Block
1
2
3
4
5
6
Average

Table D.3

Total height (m) of poplars in July 1989 from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.85	0.69	0.70	0.73	1.01	0.99
2	0.68	0.96	0.52	0.83	0.89	0.90
3	0.71	0.68	0.73	0.72	0.77	0.82
4	2.50	0.57	0.74	0.81	0.89	0.80
5	0.60	0.91	0.49	0.79	0.63	0.91
6	0.86	0.98	0.81	0.71	0.94	0.81
Average	1.03	0.80	0.66	0.76	0.86	0.87

Table D.4

Total height (m) of poplars in September 1989 from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	1.08	1.00	1.10	1.40	1.82	1.60
2	1.40	1.15	1.02	1.06	1.10	1.04
3	1.54	1.00	1.82	1.52	1.47	0.94
4	1.54	0.64	1.49	0.92	1.20	0.84
5	1.59	1.79	1.18	0.93	1.36	1.38
6	1.64	1.38	1.58	0.88	1.64	1.28
Average	1.47	1.16	1.36	1.12	1.43	1.18

Block
1
2
3
4
5
6
Averag

Block
1
2
3
4
5
6
Avgerage

Table D.5

Individual tree leaf area (m^2) in July 1989
from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.225	0.099	0.134	0.092	0.307	0.135
2	0.121	0.242	0.094	0.169	0.239	0.146
3	0.089	0.086	0.181	0.076	0.172	0.130
4	0.128	0.063	0.170	0.112	0.260	0.103
5	0.097	0.212	0.080	0.113	0.128	0.192
6	0.328	0.227	0.210	0.134	0.260	0.118
Average	0.165	0.155	0.145	0.116	0.228	0.137

Table D.6

Individual tree leaf area (m^2) in September 1989
from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.723	0.153	0.651	0.198	0.893	0.109
2	0.841	0.076	0.645	0.092	0.710	0.100
3	1.194	0.063	0.805	0.088	0.789	0.068
4	0.958	0.125	1.099	0.067	0.732	0.054
5	1.018	0.287	0.714	0.075	0.675	0.144
6	1.003	0.146	0.792	0.049	0.907	0.108
Avgerage	0.912	0.283	0.568	0.190	0.569	0.194

Table D.7

Poplar woody biomass (g/tree) in July 1989
from destructive sampling

Block	Treatment 1-1	1-0	2-1	2-0	3-1	3-0
1	6.70	2.86	3.40	3.16	9.20	5.42
2	2.97	10.03	2.96	6.00	7.58	5.76
3	2.66	2.90	4.96	2.36	4.58	4.38
4	3.18	1.60	3.96	4.06	8.54	3.41
5	2.03	6.96	2.09	3.78	2.66	6.61
6	6.34	9.18	5.98	3.43	7.94	4.20
Average	3.98	5.59	3.89	3.80	6.75	4.96

Table D.8

Poplar woody biomass (g/tree) in September 1989
from destructive sampling

Block	Treatment 1-1	1-0	2-1	2-0	3-1	3-0
1	46.60	21.05	25.25	39.00	82.15	30.35
2	66.30	17.90	20.65	20.75	39.65	22.85
3	140.20	12.65	50.25	22.15	59.10	5.85
4	105.70	27.65	98.10	11.00	51.85	8.74
5	110.65	78.75	43.45	14.55	39.15	28.05
6	113.70	33.25	66.35	6.80	80.80	20.85
Average	97.19	31.88	50.68	19.04	58.78	19.45

To

Block
1
2
3
4
5
6
Average

Tot

Block
1
2
3
4
5
6
Average

Table D.9

Total poplar aboveground biomass (g/tree) in July 1989 from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	21.78	10.00	12.42	10.08	27.66	14.16
2	10.86	27.39	13.60	18.08	23.43	17.00
3	8.37	9.27	16.72	7.53	16.30	13.47
4	10.73	5.79	14.18	11.76	24.22	10.29
5	8.50	19.98	8.32	12.08	11.26	19.90
6	21.78	26.11	19.85	9.84	24.42	12.70
Average	13.67	16.42	14.18	11.56	21.22	14.58

Table D.10

Total poplar aboveground biomass (g/tree) in September 1989 from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	87.90	39.55	54.45	74.90	145.55	48.55
2	126.20	32.80	46.10	38.60	76.25	40.75
3	253.80	25.75	106.75	38.70	115.70	24.90
4	187.80	51.70	203.80	23.05	92.20	32.70
5	199.10	131.30	84.65	29.55	74.35	57.05
6	204.20	60.80	123.80	14.95	142.40	39.40
Average	176.50	56.98	103.26	36.63	107.74	40.56

Pcp

Block
1
2
3
4
5
6
Avera

Pop

Block
1
2
3
4
5
6
Averag

Table D.11

Poplar total aboveground N content (g N/tree) in July 1989 from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.65	0.19	0.40	0.17	0.76	0.20
2	0.36	0.54	0.28	0.34	0.72	0.28
3	0.27	0.14	0.55	0.12	0.52	0.23
4	0.33	0.12	0.46	0.21	0.74	0.17
5	0.28	0.52	0.27	0.21	0.36	0.48
6	0.70	0.67	0.65	0.18	0.81	0.28
Average	0.43	0.36	0.43	0.21	0.65	0.28

Table D.12

Poplar total aboveground N content (g N/tree) in September 1989 from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	1.80	0.55	1.30	1.05	2.62	0.61
2	2.74	0.38	1.12	0.38	1.51	0.45
3	5.44	0.24	2.29	0.66	2.41	0.43
4	3.84	0.67	4.55	0.33	1.82	0.28
5	4.02	2.11	1.78	0.31	1.44	0.68
6	3.82	0.88	2.70	0.23	3.06	0.52
Average	3.61	0.81	2.29	0.49	2.14	0.43

Block
1
2
3
4
5
6
Averag

Po

Block
1
2
3
4
5
6
Average

Table D.13

Poplar woody N content (g N/tree) in July 1989
from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.09	0.02	0.06	0.02	0.12	0.03
2	0.04	0.08	0.04	0.05	0.11	0.04
3	0.04	0.02	0.08	0.01	0.07	0.03
4	0.05	0.01	0.03	0.03	0.12	0.02
5	0.03	0.08	0.04	0.03	0.04	0.06
6	0.10	0.11	0.10	0.03	0.12	0.04
Average	0.06	0.06	0.06	0.03	0.10	0.04

Table D.14

Poplar woody N content (g N/tree) in September 1989
from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.34	0.12	0.22	0.21	0.85	0.19
2	0.59	0.08	0.18	0.09	0.28	0.10
3	1.22	0.10	0.44	0.26	0.54	0.09
4	0.98	0.16	0.76	0.06	0.44	0.05
5	0.97	0.53	0.36	0.10	0.34	0.11
6	0.91	0.20	0.48	0.05	0.72	0.09
Average	0.83	0.20	0.41	0.13	0.53	0.09

T

Block
1
2
3
4
5
6
Averag

Block
1
2
3
4
5
6
Average

Table D.15

Total standing tree biomass (g/m^2) in September 1989 from prediction equations

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	21.29	4.67	79.39	27.65	407.35	101.46
2	26.96	8.52	78.87	34.97	214.85	132.96
3		4.25	71.25	9.06	196.14	72.01
4	23.87	4.98	107.37	21.60	175.24	320.82
5	13.95	20.15	46.93	30.84	106.76	135.64
6	26.20	8.38	77.96	22.56	251.21	73.10
Average	22.46	8.49	76.96	24.44	225.26	139.33

Table D.16

Leaf Area Index in September 1989 from prediction equations

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.11	0.02	0.42	0.14	2.14	0.53
2	0.14	0.04	0.41	0.18	1.13	0.70
3		0.02	0.37	0.05	1.03	0.38
4	0.12	0.03	0.56	0.11	0.92	1.69
5	0.07	0.11	0.25	0.16	0.56	0.71
6	0.14	0.04	0.41	0.12	1.32	0.38
Average	0.12	0.04	0.40	0.13	1.18	0.73

Ab

Bloc
1
2
3
4
5
6
Avera

Abc

Block
1
2
3
4
5
6
Average

Table D.17

Aboveground weed biomass (g/m^2) in July and September 1989

	July			September		
	Planting Density					
Block	1	2	3	1	2	3
1	511.6	448.4	293.8	374.8	377.8	672.1
2	1023.2	74.9	540.0	3025.2	322.8	540.1
3	118.6	284.0	274.3	672.4	292.2	228.2
4	177.8		446.6	918.6	335.6	790.9
5	33.0	360.0	219.9	669.5	995.4	350.4
6	350.2	541.3	406.3	1503.4	1306.4	293.1
Average	369.1	341.7	363.5	1194.0	605.0	479.1

Table D.18

Aboveground weed N content ($g\ N/m^2$) in July and September 1989

	July			September		
	Planting Density					
Block	1	2	3	1	2	3
1	9.15	6.72	3.82	3.71	4.20	8.40
2	19.08	1.74	10.02	23.56	3.24	4.87
3	1.43	4.52	4.89	4.37	3.47	2.09
4	3.36		5.89	4.91	2.86	9.80
5	0.88	6.06	5.48	4.92	8.98	4.68
6	9.44	10.04	8.31	14.00	20.65	3.58
Average	8.67	5.82	6.40	9.25	7.23	5.57

Table D.19

Weed species (g/m^2) at the low planting density in July 1989

Table D.19

Weed species (g/m^2) at the low planting density in July 1989

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	121.90	0	17.90	32.95	0	0	28.79
Amaranthus albus	0	0	0	0	0	80.85	13.48
Amaranthus retroflexus	282.95	467.50	0	88.05	0	0	139.75
Ambrosia artemisiifolia	0	541.35	0	0	0	0	90.22
Apocynum cannabinum	10.45	0	0	0	0	0	1.74
Arabidopsis thaliana	0	0	0	0	0	0	0
Barbarea vulgaris	0	0	0	0	0	0	0
Chenopodium album	85.10	9.8	0	28.90	0	53.75	29.59
Conyza bonariensis[1]	0	0	0	0	0	0	0
Conyza canadensis	0	0	0	0	0	0	0
Cyperus esculentus	0	0	0	0	0	0	0
Digitaria sanguinalis	0	0	0	8.95	0	161.15	28.35
Echinochloa crusgali	0	0	0	6.95	0	0	1.16
Elytrigia repens[2]	0	0	0	0	0	0	0
Eragrostis cilianensis	0	0	0	0	0	0	0
Hypericum perforatum	0	0	0	0	0.16	0	0.03
Malva neglecta	0	0	0	0	0	0	0
Medicago sativa	0	0	0	0	0	0	0
Mirabilis nyctaginea	0	0	0	0.21	0	0	0.04
Mollugo verticillata	0	0	0	0	0	21.45	3.58
Oxalis stricta	0	0	0	0	0	0	0
Panicum capillare	0	0	0	0	0	0	0
Panicum dichotomiflorum	6.70	4.60	100.75	12.05	0	0	20.68
Phytolacca americana	0	0	0	0	0	0	0
Poa compressa	0	0	0	0	0	0	0
Portulaca oleracea	0	0	0	0	0	0	0

Table D.19 (cont'd)

Table D.19 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Potentilla argentea	0	0	0	0	0	0	0
Potentilla norvegica	0	0	0	0	0	0	0
Robinia pseudoacacia	0	0	0	0	18.25	0	3.04
Rumex aceta	0	0	0	0	0	0	0
Rumex acetosella	0.45	0	0	0	0	0	0.08
Setaria faberi	0	0	0	0	0	0	0
Setaria viridis	0	0	0	0	0	0	0
Solanum ptycanthum	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	14.35	33.05	7.90
Taraxacum officinale	4.10	0	0	0	0	0	0.68
Trifoilum repens	0	0	0	0	0	0	0
Trifolium hybridum	0	0	0	0	0	0	0
Unknown dicots	0	0	0	0	0	0	0
Veronica peregrina	0	0	0	0	0	0	0
Block Total	511.65	1023.25	118.65	178.06	32.76	350.25	

1 These plants were probably misidentified. The range of C. bonariensis is not known to extend north of Virginia.
2 Formerly in the genus Agropyron.

Table D.20

Weed *species* (g/m^2) at the medium planting density in July 1989

Table D.20

Weed species (g/m^2) at the medium planting density in July 1989

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	18.45	0	25.95	0	46.25	232.60	53.88
Amaranthus albus	0	0	0	0	1.00	0	0.17
Amaranthus retroflexus	219.30	0	33.55	0	184.90	58.60	82.72
Ambrosia artemisiifolia	0	0	0	0.60	0	0	0.10
Apocynum cannabinum	0	0.95	2420.00	0	0	0	403.49
Arabidopsis thaliana	0	0	0	0	0	0	0
Barbarea vulgaris	0	0	0	0	0	0	0
Chenopodium album	205.35	62.25	200.20	335.05	0	200.20	167.18
Conyza bonariensis[1]	0	0	0	0	0	0	0
Conyza canadensis	0	0	0	0	0	0	0
Cyperus esculentus	0	0	0	0	0.15	0	0.02
Digitaria sanguinalis	0	0	187.00	0	0	0	31.17
Echinochloa crusgali	0	0	0	14.85	0	33.75	8.10
Elytrigia repens[2]	0	0	0	0	0	0	0
Eragrostis cilianensis	0	0	0	0	0	0	0
Hypericum perforatum	0	0	0	0	0	0	0
Malva neglecta	0	0	0	0	0	0	0
Medicago sativa	0	0	0	0	0	0	0
Mirabilis nyctaginea	0	0	0	0	0.45	0	0.08
Mollugo verticillata	0	0	0	0	0	0	0
Oxalis stricta	0	2.80	0	0	0	0	0.47
Panicum capillare	0	0	0	0	1.30	0	0.22
Panicum dichotomiflorum	5.35	8.75	0.10	0.85	25.45	5.50	7.67
Phytolacca americana	0	0	0	0	16.00	9.65	4.28
Poa compressa	0	0	0	0	0.35	0	0.06
Portulaca oleracea	0	0	0	0	0	0.35	0.06

Table D.20 (cont'd)

Table D.20 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Potentilla argentea	0	0	0	0	0	0	0
Potentilla norvegica	0	0.10	0	0	0	0	0.02
Robinia pseudoacacia	0	0	0	0	0	0	0
Rumex aceta	0	0	0	0	0	0	0
Rumex acetosella	0	0	0	0	0	0	0
Setaria faberi	0	0	0	0	0	0	0
Setaria viridis	0	0	0	0	0	0	0
Solanum ptycanthum	0	0	0	4.10	0	0	0.68
Stellaria media	0	0	0	0	69.90	0	11.65
Taraxacum officinale	0	0	0	0	0	0.65	0.11
Trifoilum repens	0	0	0	0	14.10	0	2.35
Trifolium hybridum	0	0.05	0	0	0	0	0.01
Unknown dicots	0	0	0	0	0.10	0	0.02
Veronica peregrina	0	0	0	0	0	0	0
Block Total	448.45	74.90	2866.80	355.45	359.95	541.30	

[1] These plants were probably misidentified. The range of C. bonariensis is not known to extend north of Virginia.
[2] Formerly in the genus Agropyron.

Table D.21

Weed species (g/m^2) at the high planting density in July 1989

Table D.21

Weed species (g/m^2) at the high planting density in July 1989

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	69.15	0.05	64.75	0.30	0	7.70	23.66
Amaranthus albus	0	0	0.2	0	20.80	0	3.50
Amaranthus retroflexus	221.20	0	11.45	275.00	18.70	221.65	124.67
Ambrosia artemisiifolia	0	0	0	0	0	0	0
Apocynum cannabinum	3.20	0	0	0	0	0.30	0.58
Arabidopsis thaliana	0	0	0	0	0	0	0
Barbarea vulgaris	0	0	0	0	0	0	0
Chenopodium album	0	525.00	172.15	164.10	137.50	0	166.46
Conyza bonariensis[1]	0	0	1.35	0	0	0	0.22
Conyza canadensis	0	0	0.15	0	3.00	0	0.52
Cyperus esculentus	0	0	21.75	0	0	0	3.62
Digitaria sanguinalis	0	0	0	3.70	0	0	0.62
Echinochloa crusgali	0	0	0	0	0	0	0
Elytrigia repens[2]	0	0	0	0	0	73.55	12.26
Eragrostis cilianensis	0	0	0	0	0	0	0
Hypericum perforatum	0	0	0.25	0	0	0	0.04
Malva neglecta	0	0	0	5.50	0	0	0.92
Medicago sativa	0	0	0	0	0	99.30	16.55
Mirabilis nyctaginea	0	0	0	0	0	0	0
Mollugo verticillata	0	0	0	0	0	0	0
Oxalis stricta	0	0	0	0	0	0	0
Panicum capillare	0	0	0	0	0	0	0
Panicum dichotomiflorum	0	8.85	2.25	1.20	6.55	0	3.14
Phytolacca americana	0	0	0	0	0	0	0
Poa compressa	0	0	0	0	0	0	0
Portulaca oleracea	0	0	0	0	0	0	0

Table D.21 (cont'd)

Table D.21 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Potentilla argentea	0	0	0	0	0	0	0
Potentilla norvegica	0	0	0	0	0	0	0
Robinia pseudoacacia	0	0	0	0	0	0	0
Rumex aceta	0	0	0	0	0	0	0
Rumex acetosella	0	0	0	0	0	0	0
Setaria faberi	0	0	0	0	0	0	0
Setaria viridis	0	0	0	2.00	0	0	0.33
Solanum ptycanthum	0	0	0	0	0	0	0
Stellaria media	0	0	0	0.20	28.30	3.80	5.38
Taraxacum officinale	0.20	0	0	0	0	0	0.03
Trifoilum repens	0	0	0	0	5.00	0	0.83
Trifolium hybridum	0	6.10	0	0	0	0	1.02
Unknown dicots	0	0	0	0	0	0	0
Veronica peregrina	0	0	0	0	0	0	0
Block Total	293.75	540.00	274.30	452.00	219.85	406.30	

1 These plants were probably misidentified. The range of C. bonariensis is not known to extend north of Virginia.

2 Formerly in the genus Agropyron.

Table D.22

Weed species (g/m^2) at the low planting density in September 1989

Table D.22

Weed species (g/m^2) at the low planting density in September 1989

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	95.95	9.40	0	3.80	669.50	325.65	184.05
Amaranthus albus	0	0	0	0	0	0	0
Amaranthus retroflexus	186.65	0	0	21.65	0	0	34.72
Ambrosia artemisiifolia	0	2969.05	0	0	0	0	494.84
Apocynum cannabinum	0	11.40	0	0	0	0	1.90
Arabidopsis thaliana	0	0	0	0	0	0	0
Barbarea vulgaris	0	0	0	0	0	0	0
Chenopodium album	8.45	0	195.40	70.95	0	1163.20	239.67
Conyza bonariensis[1]	0	0	0	0	0	0	0
Conyza canadensis	1.75	0	0	0	0	0	0.29
Cyperus esculentus	0	0	0	0	0	0	0
Digitaria sanguinalis	0	0	0	2.80	0	14.50	2.88
Echinochloa crusgali	0	0	0	0	0	0	0
Elytrigia repens[2]	0	0	0	0	0	0	0
Eragrostis cilianensis	0	0	0	0	0	0	0
Hypericum perforatum	0	0	0	0	0	0	0
Malva neglecta	0	0	0	0	0	0	0
Medicago sativa	0	0	0	0	0	0	0
Mirabilis nyctaginea	0	0	0	0	0	0	0
Mollugo verticillata	0	0	0	0	0	0	0
Oxalis stricta	0	0	0	0	0	0	0
Panicum capillare	0	0	0	0	0	0	0
Panicum dichotomiflorum	65.70	35.00	477.00	38.40	0.60	0	102.78
Phytolacca americana	0	0	0	0	0	0	0
Poa compressa	0	0	0	0	0	0	0
Portulaca oleracea	0	0	0	0	0	0	0

Table D.22 (cont'd)

Table D.22 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Potentilla argentea	0.45	0	0	0	0	0	0.08
Potentilla norvegica	0	0	0	0	0	0	0
Robinia pseudoacacia	0	0	0	0	0	0	0
Rumex aceta	0	0	0	0	0	0	0
Rumex acetosella	0	0	0	0	0	0	0
Setaria faberi	0	0	0	781.00	0	0	130.17
Setaria viridis	0	0	0	0	0	0	0
Solanum ptycanthum	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	0	0	0
Taraxacum officinale	0	0	0	0	0	0	0
Trifoilum repens	15.85	0.35	0	0	0.85	0	2.84
Trifolium hybridum	0	0	0	0	0	0	0
Unknown dicots	0	0	0	0	0	0	0
Veronica peregrina	0	0	0	0	0	0	0
Block Total	374.80	3025.20	672.40	918.60	670.95	1503.35	

1 These plants were probably misidentified. The range of C. bonariensis is not known to extend north of Virginia.
2 Formerly in the genus Agropyron.

Table D.23

Table D.23

Weed species (g/m^2) at the medium planting density in September 1989

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	0	0	21.90	4.50	0	0	4.40
Amaranthus albus	0	0	4.05	0	0	0	0.68
Amaranthus retroflexus	331.20	209.20	164.90	39.15	791.70	0	256.02
Ambrosia artemisiifolia	0	0	0	0	0	1120.15	186.69
Apocynum cannabinum	0	77.70	0	0	0	0	12.95
Arabidopsis thaliana	0	0	0	0	0	0	0
Barbarea vulgaris	0	0	0	1.15	0	0	0.19
Chenopodium album	30.65	18.40	4.60	200.55	0	0	42.37
Conyza bonariensis[1]	0	0	0	0	0	0	0
Conyza canadensis	0	0	0	0	0	0	0
Cyperus esculentus	0	0	4.40	0	0	0	0.73
Digitaria sanguinalis	0	0	0	5.20	0	186.30	31.92
Echinochloa crusgali	0	0	0	0	0	0	0
Elytrigia repens[2]	0	0	0	0	0	0	0
Eragrostis cilianensis	0	0	0	0	0	0	0
Hypericum perforatum	0	0	0	0	0	0	0
Malva neglecta	0	0	0	0	0	0	0
Medicago sativa	0	0	0	0	0	0	0
Mirabilis nyctaginea	0	0	0	0	0	0	0
Mollugo verticillata	0	0	0	0	0	0	0
Oxalis stricta	0	0	0	0	0	0	0
Panicum capillare	0	0	0	0	0	0	0
Panicum dichotomiflorum	2.15	17.50	70.10	84.95	140.90	0	52.60
Phytolacca americana	0	0	0	0	0	0	0
Poa compressa	0	0	0	0	0	0	0
Portulaca oleracea	0	0	0	0	0	0	0

Table D.23 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Potentilla argentea	0	0	0	0	0	0	0
Potentilla norvegica	0	0	0	0	0	0	0
Robinia pseudoacacia	0	0	0	0	0	0	0
Rumex aceta	0	0	0	0	0	0	0
Rumex acetosella	0	0	0	0	0	0	0
Setaria faberi	0	0	0	0	0	0	0
Setaria viridis	0	0	0	0	0	0	0
Solanum ptycanthum	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	0	0	0
Taraxacum officinale	13.75	0	0	0.15	0	0	2.32
Trifoilum repens	0	0	22.30	0	62.80	0	14.18
Trifolium hybridum	0	0	0	0	0	0	0
Unknown dicots	0	0	0	0	0	0	0
Veronica peregrina	0	0	0	0	0	0	0
Block Total	377.75	322.80	292.25	335.65	995.4	1306.45	

[1] These plants were probably misidentified. The range of C. bonariensis is not known to extend north of Virginia.

[2] Formerly in the genus Agropyron.

Table D.24

Weed species (g/m^2) at the medium planting density in September 1989

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	152.05	310.70	31.00	0	0	15.6	84.89
Amaranthus albus	0	0	0	5.95	0	0	0.99
Amaranthus retroflexus	299.30	118.15	24.60	0	0	0	73.68
Ambrosia artemisiifolia	91.00	0	0	0	0	0	15.17
Apocynum cannabinum	0.30	0	0	0	0	0	0.05
Arabidopsis thaliana	0	0	0	0	0	0	0
Barbarea vulgaris	0	0	0	0	0	0	0
Chenopodium album	0	37.30	0.25	666.00	0	0	117.26
Conyza bonariensis[1]	0	0	0	0	0	0	0
Conyza canadensis	0	0	0	0	0	0	0
Cyperus esculentus	0	0	111.85	0	0	0	18.64
Digitaria sanguinalis	0	0	0	18.55	0	3.05	3.60
Echinochloa crusgali	0	0	0	0	0	0	0
Elytrigia repens[2]	0	0	0	0	0	0	0
Eragrostis cilianensis	0	4.35	0	0	0	0	0.72
Hypericum perforatum	0	0	0.15	0	0	0	0.02
Malva neglecta	0	0	0	0	0	0	0
Medicago sativa	0	0	0	0	0	32.35	5.39
Mirabilis nyctaginea	0	0	0	0	0	0	0
Mollugo verticillata	0	0	0	0	0	0	0
Oxalis stricta	0	0	0	0	0	0	0
Panicum capillare	0	0	0	0	0	0	0
Panicum dichotomiflorum	117.70	61.25	60.35	100.40	252.20	277.50	144.90
Phytolacca americana	0	0	0	0	0	0	0
Poa compressa	0	0	0	0	0	0	0
Portulaca oleracea	0	0.30	0	0	0	0	0.05

Table D.24 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Potentilla argentea	0	0	0	0	0	0	0
Potentilla norvegica	0	0	0	0	0	0	0
Robinia pseudoacacia	0	0	0	0	0	0	0
Rumex aceta	0	8.05	0	0	0	0	1.34
Rumex acetosella	0.15	0	0	0	0	0	0.02
Setaria faberi	0	0	0	0	0	0	0
Setaria viridis	0	0	0	0	0	0	0
Solanum ptycanthum	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	0	0	0
Taraxacum officinale	4.35	0	0	0	0	0	0.72
Trifoilum repens	7.25	0	0	0	98.20	0	17.58
Trifolium hybridum	0	0	0	0	0	0	0
Unknown dicots	0	0	0	0	0	0	0
Veronica peregrina	0	0.70	0	0	0	0	0.12
Block Total	672.10	540.80	228.20	790.90	350.4	328.5	

1 These plants were probably misidentified. The range of C. bonariensis is not known to extend north of Virginia.

2 Formerly in the genus Agropyron.

Table D.25

Nitrogen data from weeds sampled in July 1989

Blk	Trt	Species	Weight (g/m^2)	N Conc (%)	N Cont ($g\ N/m^2$)
1	1-0	Abutilon theophrasti	121.90	1.66	2.02
1	1-0	Amaranthus retroflexus	282.95	1.64	4.63
1	1-0	Chenopodium album	85.10	2.39	2.04
1	1-0	Other Species	21.70	2.14	0.46
1	2-0	Abutilon theophrasti	18.45	1.57	0.29
1	2-0	Amaranthus retroflexus	219.30	1.29	2.82
1	2-0	Chenopodium album	205.35	1.71	3.51
1	2-0	Other Species	5.35	1.85	0.10
1	3-0	Abutilon theophrasti	69.15	1.32	0.91
1	3-0	Amaranthus retroflexus	221.20	1.29	2.86
1	3-0	Apocynum cannabinum	3.20	1.51	0.05
1	3-0	Other Species	0.20	2.60	0.005
2	1-0	Amaranthus retroflexus	467.50	1.60	7.46
2	1-0	Ambrosia artemisiifolia	541.35	2.10	11.35
2	1-0	Chenopodium album	9.80	1.98	0.19
2	1-0	Other Species	4.60	1.83	0.08
2	2-0	Chenopodium album	62.25	2.37	1.48
2	2-0	Other Species	1.10	2.68	0.03
2	2-0	Oxalis stricta	2.80	1.47	0.04
2	2-0	Panicum dichotomiflorum	8.75	2.15	0.19
2	3-0	Chenopodium album	525.00	1.85	9.72
2	3-0	Other Species	0.05	1.62	0.001
2	3-0	Panicum dichotomiflorum	8.85	1.69	0.15
2	3-0	Trifolium hybridum	6.10	2.41	0.15
3	1-0	Abutilon theophrasti	17.90	1.04	0.19
3	1-0	Panicum dichotomiflorum	100.75	1.24	1.24
3	2-0	Chenopodium album	200.20	1.55	3.11
3	2-0	Other Species	83.85	1.67	1.41
3	3-0	Abutilon theophrasti	64.75	2.33	1.51
3	3-0	Chenopodium album	172.15	1.66	2.86
3	3-0	Cyperus esculentus	21.75	1.12	0.25
3	3-0	Other Species	15.65	1.78	0.28
4	1-0	Abutilon theophrasti	32.95	1.88	0.62
4	1-0	Amaranthus retroflexus	88.05	1.97	1.73
4	1-0	Chenopodium album	28.90	1.66	0.48
4	1-0	Other Species	27.95	1.89	0.53

Table D.25 (cont'd)

Blk	Trt	Species	Weight (g/m^2)	N Conc (%)	N Cont (g N/m^2)
4	3-0	Amaranthus retroflexus	275.00	1.21	3.32
4	3-0	Chenopodium album	164.10	1.51	2.47
4	3-0	Other Species	7.45	1.26	0.09
5	1-0	Mirabilis nyctaginea	0.20	2.52	0.005
5	1-0	Other Species	0.15	1.44	0.002
5	1-0	Robinia psuedoacacia	18.25	4.12	0.75
5	1-0	Stellaria media	14.35	0.83	0.12
5	2-0	Abutilon theophrasti	46.25	1.51	0.70
5	2-0	Amaranthus retroflexus	184.90	1.69	3.12
5	2-0	Other Species	58.90	2.14	1.26
5	2-0	Stellaria media	69.90	1.41	0.98
5	3-0	Amaranthus albus	20.80	1.92	0.40
5	3-0	Chenopodium album	137.50	2.77	3.81
5	3-0	Other Species	33.30	2.77	0.92
5	3-0	Stellaria media	28.30	1.22	0.34
6	1-0	Amaranthus albus	80.85	2.46	1.99
6	1-0	Chenopodium album	53.75	4.55	2.44
6	1-0	Digitaria sanguinalis	161.15	2.32	3.74
6	1-0	Other Species	54.50	2.32	1.26
6	2-0	Abutilon theophrasti	232.60	1.75	4.08
6	2-0	Amaranthus retroflexus	58.60	1.53	0.98
6	2-0	Chenopodium album	200.20	2.04	4.08
6	2-0	Other Species	49.90	1.98	0.99
6	3-0	Elytrigia repens	73.55	2.55	1.87
6	3-0	Amaranthus retroflexus	221.65	1.91	4.24
6	3-0	Medicago sativa	99.30	1.86	1.85
6	3-0	Other Species	11.80	2.95	0.35

Table D.26

Nitrogen data from weeds sampled in September 1989

Blk	Trt	Species	Weight (g/m^2)	N Conc (%)	N Cont ($g\ N/m^2$)
1	1-0	Abutilon theophrasti	95.95	0.70	0.67
1	1-0	Amaranthus retroflexus	186.65	0.87	1.63
1	1-0	Other species	26.50	2.16	0.57
1	1-0	Panicum dichotomiflorum	65.70	1.27	0.83
1	2-0	Amaranthus retroflexus	331.20	1.05	3.46
1	2-0	Chenopodium album	30.65	1.28	0.39
1	2-0	Panicum dichotomiflorum	2.15	1.38	0.03
1	2-0	Taraxacum officinale	13.75	2.29	0.31
1	3-0	Abutilon theophrasti	152.05	0.84	1.28
1	3-0	Amaranthus retroflexus	299.30	1.23	3.68
1	3-0	Other species	103.05	1.61	1.66
1	3-0	Panicum dichotomiflorum	117.70	1.52	1.79
2	1-0	Ambrosia artemisiifolia	2969.05	0.78	23.13
2	1-0	Apocynum cannabinum	11.40	1.37	0.16
2	1-0	Other species	9.75	0.40	0.04
2	1-0	Panicum dichotomiflorum	35.00	0.69	0.24
2	2-0	Amaranthus retroflexus	209.20	0.90	1.89
2	2-0	Apocynum cannabinum	77.70	1.28	0.99
2	2-0	Chenopodium album	18.40	1.17	0.22
2	2-0	Panicum dichotomiflorum	17.50	0.80	0.14
2	3-0	Abutilon theophrasti	310.70	0.78	2.43
2	3-0	Amaranthus retroflexus	118.15	1.01	1.19
2	3-0	Other species	50.00	1.24	0.62
2	3-0	Panicum dichotomiflorum	61.25	1.01	0.62
3	1-0	Chenopodium album	195.40	0.69	1.34
3	1-0	Panicum dichotomiflorum	477.00	0.64	3.03
3	2-0	Amaranthus retroflexus	164.90	1.04	1.71
3	2-0	Other species	34.95	1.21	0.42
3	2-0	Panicum dichotomiflorum	70.10	1.38	0.97
3	2-0	Trifolium repens	22.30	1.63	0.36
3	3-0	Abutilon theophrasti	31.00	0.81	0.25
3	3-0	Cyperus esculentus	111.85	0.59	0.66
3	3-0	Other species	25.00	1.44	0.36
3	3-0	Panicum dichotomiflorum	60.35	1.36	0.82

Table D.26 (cont'd)

Blk	Trt	Species	Weight (g/m^2)	N Conc (%)	N Cont ($g\ N/m^2$)
4	1-0	Chenopodium album	70.95	1.15	0.82
4	1-0	Other species	28.25	1.28	0.36
4	1-0	Panicum dichotomiflorum	38.40	1.15	0.44
4	1-0	Setaria faberi	781.00	0.42	3.29
4	2-0	Amaranthus retroflexus	39.15	0.94	0.37
4	2-0	Chenopodium album	200.55	0.55	1.11
4	2-0	Other species	11.00	1.47	0.16
4	2-0	Panicum dichotomiflorum	84.95	1.44	1.22
4	3-0	Chenopodium album	666.00	1.21	8.08
4	3-0	Digitaria sanguinalis	18.55	1.04	0.19
4	3-0	Panicum dichotomiflorum	106.35	1.44	1.53
5	1-0	Abutilon theophrasti	669.50	0.74	4.92
5	2-0	Amaranthus retroflexus	791.70	0.81	6.38
5	2-0	Panicum dichotomiflorum	140.90	0.85	1.20
5	2-0	Trifolium repens	62.80	2.22	1.30
5	3-0	Panicum dichotomiflorum	252.20	1.13	2.85
5	3-0	Trifolium repens	98.20	1.86	1.83
6	1-0	Abutilon theophrasti	325.65	0.76	2.48
6	1-0	Chenopodium album	1163.20	0.98	11.34
6	1-0	Digitaria sanguinalis	14.50	1.26	0.18
6	2-0	Ambrosia artemisiifolia	1120.15	1.62	18.19
6	2-0	Digitaria sanguinalis	186.30	1.32	2.46
6	3-0	Abutilon theophrasti	15.60	0.80	0.12
6	3-0	Panicum dichotomiflorum	277.50	1.24	3.45

Table D.27

Data from the July 1989 destructive tree sampling

Blk	Trt	Tree#	Height (m)	Diam (cm)	Leaf Wt (g)	Woody Wt (g)	Total Wt (g)	Leaf Area (m^2)	Leaf N Content (g)	Woody N Content (g)	Total N Content (g)
1	1-0	1	0.74	0.63	9.34	3.45	12.79	0.13	0.22	0.02	0.24
1	1-0	2	0.64	0.62	4.94	2.28	7.22	0.07	0.12	0.02	0.14
1	1-1	1	0.77	0.87	13.88	5.58	19.46	0.21	0.48	0.07	0.55
1	1-1	2	0.94	0.96	16.26	7.83	24.09	0.24	0.64	0.11	0.75
1	2-0	1	0.83	0.58	5.55	2.45	8.00	0.08	0.12	0.01	0.14
1	2-0	2	0.62	0.71	8.28	3.88	12.16	0.10	0.18	0.03	0.21
1	2-1	1	0.72	0.69	8.68	3.56	12.24	0.13	0.30	0.07	0.37
1	2-1	2	0.68	0.69	9.34	3.25	12.59	0.13	0.37	0.05	0.42
1	3-0	1	0.95	0.69	7.50	4.55	12.05	0.11	0.14	0.02	0.17
1	3-0	2	1.04	0.80	9.98	6.30	16.28	0.16	0.20	0.03	0.23
1	3-1	1	1.05	1.08	21.25	10.85	32.10	0.35	0.74	0.15	0.89
1	3-1	2	0.96	0.91	15.66	7.56	23.22	0.26	0.53	0.09	0.62
2	1-0	1	1.02	0.90	14.30	9.27	23.57	0.19	0.35	0.07	0.42
2	1-0	2	0.90	1.00	20.42	10.79	31.21	0.30	0.57	0.10	0.67
2	1-1	1	0.76	0.76	9.25	3.87	13.12	0.14	0.34	0.05	0.39
2	1-1	2	0.60	0.60	6.54	2.07	8.61	0.10	0.29	0.03	0.32
2	2-0	1	0.90	0.80	14.35	7.40	21.75	0.19	0.32	0.05	0.37
2	2-0	2	0.76	0.74	9.82	4.60	14.42	0.15	0.27	0.04	0.31
2	2-1	1	0.79	0.81	12.24	4.96	17.20	0.19	0.48	0.08	0.57
2	2-1	2	0.25	0.23	0.09	0.95	10.00	0.001	0.000	0	0.000
2	3-0	1	0.93	0.70	9.35	5.63	14.98	0.12	0.21	0.04	0.25
2	3-0	2	0.88	0.73	13.11	5.90	19.01	0.17	0.27	0.04	0.32
2	3-1	1	0.84	0.85	14.09	6.35	20.44	0.20	0.52	0.08	0.60
2	3-1	2	0.94	0.99	17.60	8.82	26.42	0.27	0.70	0.14	0.84
3	1-0	1	0.72	0.65	7.38	3.43	10.81	0.09	0.14	0.02	0.16
3	1-0	2	0.65	0.57	5.35	2.38	7.73	0.03	0.10	0.01	0.12
3	1-1	1	0.40	0.37	1.17	0.46	1.63	0.02	0.05	0.01	0.06

Table D.27 (cont'd)

Blk	Trt	Tree#	Height (m)	Diam (cm)	Leaf Wt (g)	Woody Wt (g)	Total Wt (g)	Leaf Area (m^2)	Leaf N Content (g)	Woody N Content (g)	Total N Content (g)
3	1-1	2	1.03	0.82	10.24	4.87	15.11	0.16	0.40	0.08	0.48
3	2-0	1	0.73	0.58	5.77	2.66	8.43	0.08	0.13	0.01	0.15
3	2-0	2	0.70	0.55	4.58	2.05	6.63	0.07	0.08	0.01	0.10
3	2-1	1	0.86	1.02	15.84	7.49	23.33	0.24	0.63	0.13	0.76
3	2-1	2	0.61	0.63	7.70	2.42	10.12	0.12	0.30	0.04	0.34
3	3-0	1	0.94	0.80	12.93	6.42	19.35	0.18	0.28	0.05	0.33
3	3-0	2	0.70	0.56	5.24	2.35	7.59	0.08	0.12	0.02	0.14
3	3-1	1	0.68	0.65	9.16	3.06	12.22	0.13	0.36	0.04	0.40
3	3-1	2	0.86	0.85	14.28	6.11	20.39	0.21	0.54	0.09	0.62
4	1-0	1	0.54	0.48	3.56	1.24	4.80	0.05	0.08	0.01	0.09
4	1-0	2	0.60	0.52	4.81	1.97	6.78	0.07	0.13	0.01	0.14
4	1-1	1	0.82	0.88	10.41	4.86	15.27	0.18	0.40	0.07	0.46
4	1-1	2	4.18	0.57	4.70	1.49	6.19	0.08	0.18	0.02	0.20
4	2-0	1	0.71	0.52	4.31	1.94	6.25	0.07	0.09	0.01	0.10
4	2-0	2	0.91	0.77	11.10	6.17	17.27	0.15	0.28	0.05	0.33
4	2-1	1	0.73	0.80	10.57	4.04	14.61	0.18	0.45	0.06	0.51
4	2-1	2	0.76	0.75	9.87	3.87	13.74	0.16	0.40	0	0.40
4	3-0	1	0.73	0.64	6.15	2.72	8.87	0.09	0.14	0.02	0.15
4	3-0	2	0.86	0.69	7.61	4.10	11.71	0.11	0.16	0.02	0.19
4	3-1	1	1.12	1.12	24.34	14.54	38.88	0.40	0.94	0.18	1.12
4	3-1	2	0.67	0.65	7.01	2.54	9.55	0.12	0.32	0.05	0.37
5	1-0	1	1.12	0.88	16.08	8.65	24.73	0.25	0.56	0.11	0.67
5	1-0	2	0.69	0.70	9.94	5.28	15.22	0.17	0.31	0.05	0.36
5	1-1	1	0.66	0.62	8.07	2.63	10.70	0.12	0.30	0.04	0.34
5	1-1	2	0.54	0.50	4.86	1.43	6.29	0.07	0.19	0.02	0.22
5	2-0	1	0.70	0.54	5.32	2.29	7.61	0.07	0.10	0.02	0.12
5	2-0	2	0.89	0.72	11.28	5.27	16.55	0.15	0.26	0.04	0.30
5	2-1	1	0.52	0.69	8.57	3.00	11.57	0.10	0.32	0.06	0.38

Table D.27 (cont'd)

Blk	Trt	Tree#	Height (m)	Diam (cm)	Leaf Wt (g)	Woody Wt (g)	Total Wt (g)	Leaf Area (m^2)	Leaf N Content (g)	Woody N Content (g)	Total N Content (g)
5	2-1	2	0.47	0.50	3.88	1.18	5.06	0.06	0.13	0.01	0.15
5	3-0	1	0.97	0.89	17.67	9.05	26.72	0.24	0.56	0.09	0.60
5	3-0	2	0.85	0.68	8.91	4.17	13.08	0.14	0.26	0.04	0.30
5	3-1	1	0.63	0.68	11.54	3.29	14.83	0.16	0.40	0.06	0.46
5	3-1	2	0.63	0.56	5.65	2.03	7.68	0.10	0.22	0.02	0.25
6	1-0	1	0.99	0.89	16.31	9.29	25.6	0.21	0.55	0.13	0.67
6	1-0	2	0.98	0.90	17.55	9.07	26.62	0.24	0.56	0.10	0.66
6	1-1	1	0.85	0.85	14.85	6.04	20.89	0.43	0.59	0.10	0.69
6	1-1	2	0.86	0.90	16.04	6.64	22.68	0.22	0.60	0.10	0.70
6	2-0	1	0.65	0.63	5.74	2.68	8.42	0.08	0.13	0.02	0.15
6	2-0	2	0.77	0.71	7.07	4.18	11.25	0.18	0.16	0.03	0.20
6	2-1	1	0.93	0.99	17.99	8.51	26.50	0.26	0.71	0.14	0.85
6	2-1	2	0.68	0.79	9.75	3.46	13.21	0.16	0.38	0.06	0.44
6	3-0	1	0.78	0.61	6.14	2.94	9.08	0.09	0.14	0.02	0.17
6	3-0	2	0.83	0.73	10.85	5.46	16.31	0.14	0.33	0.07	0.40
6	3-1	1	0.87	0.84	14.62	6.30	20.92	0.23	0.61	0.10	0.70
6	3-1	2	1.00	1.01	18.34	9.59	27.93	0.29	0.76	0.15	0.91

Table D.28

Data from the September 1989 destructive tree sampling

Blk	Trt	Tree#	Diam (cm)	Height (m)	Leaf Area (m^2)	Woody Wt(g)	Leaf Wt(g)	Total Wt(g)	Leaf N Content (g)	Woody N Content (g)	Total N Content (g)
1	1-0	1	0.92	1.06	0.15	16.3	15.4	31.7	0.32	0.08	0.40
1	1-0	2	1.31	0.95	0.46	25.8	21.6	47.4	0.54	0.16	0.70
1	1-1	1	0.63	0.56	0.09	3.9	8.3	12.2	0.31	0.04	0.35
1	1-1	2	1.93	1.61	0.80	89.3	74.3	163.6	2.61	0.65	3.26
1	2-0	1	1.46	1.37	0.46	44.7	41.9	86.6	1.01	0.22	1.23
1	2-0	2	1.23	1.43	0.33	33.3	29.9	63.2	0.66	0.20	0.86
1	2-1	1	1.27	1.22	0.34	32.5	33.2	65.7	1.18	0.28	1.46
1	2-1	2	1.05	0.97	0.26	18.0	25.2	43.2	0.97	0.17	1.14
1	3-0	1	1.26	1.70	0.25	37.7	21.4	59.1	0.50	0.24	0.74
1	3-0	2	0.98	1.49	0.18	23.0	15.0	38.0	0.33	0.15	0.48
1	3-1	1	1.58	1.73	0.64	59.6	51.6	111.2	1.57	0.46	2.03
1	3-1	2	1.91	1.92	0.93	104.7	75.2	179.9	1.96	1.25	3.21
2	1-0	1	0.94	1.19	0.15	18.3	14.8	33.1	0.29	0.09	0.38
2	1-0	2	0.94	1.10	0.15	17.5	15.1	32.5	0.30	0.08	0.38
2	1-1	1	1.64	1.39	0.65	65.4	57.0	122.4	2.17	0.58	2.75
2	1-1	2	1.66	1.42	0.71	67.2	62.8	130.0	2.12	0.60	2.72
2	2-0	1	1.25	1.38	0.30	37.0	30.3	67.3	0.48	0.16	0.64
2	2-0	2	0.59	0.73	0.07	4.5	5.4	9.9	0.09	0.02	0.11
2	2-1	1	1.28	1.24	0.39	31.7	34.9	66.6	1.32	0.26	1.58
2	2-1	2	0.76	0.80	0.19	9.6	16.0	25.6	0.56	0.10	0.66
2	3-0	1	1.23	1.57	0.35	43.5	31.7	75.2	0.60	0.18	0.78
2	3-0	2	0.60	0.52	0.05	2.2	4.1	6.3	0.10	0.01	0.12
2	3-1	1	1.75	1.46	0.72	73.7	63.2	136.9	2.13	0.52	2.65
2	3-1	2	0.64	0.73	0.11	5.6	10.0	15.6	0.33	0.05	0.37
3	1-0	1	0.77	0.81	0.07	8.6	7.1	15.7	0.04	0.15	0.18
3	1-0	2	1.00	1.18	0.18	16.7	19.1	35.8	0.25	0.05	0.30
3	1-1	1	2.37	1.54	1.39	140.2	113.6	253.8	4.22	1.22	5.44

Table D.28 (cont'd)

Blk	Trt	Tree#	Diam (cm)	Height (m)	Leaf Area (m^2)	Woody Wt(g)	Leaf Wt(g)	Total Wt(g)	Leaf N Content (g)	Woody N Content (g)	Total N Content (g)
3	2-0	1	0.65	0.83	0.09	7.8	8.3	16.1	0.19	0.06	0.25
3	2-0	2	1.15	2.21	0.26	36.5	24.8	61.3	0.62	0.46	1.08
3	2-1	1	1.88	2.36	0.82	60.1	75.9	136	2.48	0.52	2.99
3	2-1	2	1.42	1.28	0.39	40.4	37.1	77.5	1.22	0.36	1.58
3	3-0	1	0.86	0.98	0.14	11.7	13.2	24.9	0.34	0.09	0.43
3	3-0	2	0.79	0.91	0.13	0	0	0	0	0	0
3	3-1	1	1.51	1.45	0.57	57.1	54.7	111.8	1.82	0.48	2.30
3	3-1	2	1.61	1.50	0.59	61.1	58.5	119.6	1.92	0.61	2.52
4	1-0	1	0.88	0.95	0.18	17.2	16.0	33.2	0.34	0.10	0.44
4	1-0	2	1.29	0.33	0.32	38.1	32.1	70.2	0.68	0.23	0.91
4	1-1	1	1.81	1.48	0.76	64.3	66.2	130.5	2.15	0.50	2.65
4	1-1	2	2.34	1.60	1.07	147.1	98.0	245.1	3.57	1.46	5.04
4	2-0	1	0.81	0.94	0.15	11.1	13.2	24.3	0.29	0.06	0.35
4	2-0	2	0.92	0.90	0.12	10.9	10.9	21.8	0.24	0.06	0.31
4	2-1	1	2.57	1.67	1.72	181.4	154.4	335.8	5.43	1.36	6.78
4	2-1	2	1.58	1.32	0.67	14.8	57.0	71.8	2.16	0.16	2.31
4	3-0	1	0.68	0.76	0.10	2.9	0.7	0	0	0	0
4	3-0	2	0.77	0.92	0.12	14.6	18.1	32.7	0.23	0.05	0.28
4	3-1	1	1.64	1.48	0.73	91.9	64.3	156.2	2.16	0.80	2.96
4	3-1	2	0.87	0.91	0.19	11.8	16.4	28.2	0.59	0.10	0.68
5	1-0	1	1.98	1.84	1.04	119.3	80.1	199.4	2.57	0.82	3.39
5	1-0	2	1.17	1.74	0.10	38.2	25.0	63.2	0.58	0.25	0.82
5	1-1	1	1.71	1.48	0.82	84.3	71.2	155.5	2.46	0.85	3.31
5	1-1	2	2.29	1.70	1.25	137.0	105.7	242.7	3.64	1.10	4.73
5	2-0	1	0.62	0.77	0.07	5.5	6.7	12.2	0	0.12	0.12
5	2-0	2	1.09	1.10	0.22	23.6	23.3	46.9	0.40	0.09	0.50
5	2-1	1	1.65	1.48	0.65	71.6	61.5	133.1	2.13	0.60	2.73
5	2-1	2	0.99	0.88	0.21	15.3	20.9	36.2	0.70	0.12	0.82
5	3-0	1	1.13	1.30	0.28	29.4	26.5	55.9	0.50	0.12	0.62

Table D.28 (cont'd)

Blk	Trt	Tree#	Diam (cm)	Height (m)	Leaf Area (m^2)	Woody Wt(g)	Leaf Wt(g)	Total Wt(g)	Leaf N Content (g)	Woody N Content (g)	Total N Content (g)
5	3-0	2	1.15	1.47	0.29	26.7	31.5	58.2	0.65	0.10	0.75
5	3-1	1	1.25	1.35	0.34	35.7	34.0	69.7	1.02	0.30	1.32
5	3-1	2	1.37	1.36	0.36	42.6	36.4	79.0	1.19	0.37	1.56
6	1-0	1	1.21	1.22	0.26	22.7	23.1	45.8	0.60	0.13	0.73
6	1-0	2	1.37	1.54	0.32	43.8	32.0	75.8	0.77	0.28	1.04
6	1-1	1	2.41	1.69	1.25	140.8	107.4	248.2	3.25	1.16	4.41
6	1-1	2	1.88	1.58	0.76	86.6	73.6	160.2	2.56	0.66	3.22
6	2-0	1	0.58	0.87	0.08	4.7	6.3	11.0	0.12	0.04	0.15
6	2-0	2	0.76	0.90	0.12	8.9	10.0	18.9	0.24	0.06	0.31
6	2-1	1	1.72	1.60	0.62	68.9	60.3	129.2	2.48	0.50	2.98
6	2-1	2	1.66	1.56	0.55	63.8	54.6	118.4	1.95	0.46	2.41
6	3-0	1	0.67	1.01	0.14	9.5	11.0	20.5	0.25	0.04	0.30
6	3-0	2	1.16	1.55	0.30	32.2	26.1	58.3	0.60	0.14	0.74
6	3-1	1	1.92	1.72	1.06	98.4	71.2	169.6	2.73	0.90	3.63
6	3-1	2	1.61	1.55	0.57	63.2	52.0	115.2	1.95	0.53	2.48

APPENDIX E

APPENDIX E

1990 Data

Table E.1

Aboveground weed biomass (g/m^2) in 1990

	Planting Density		
Block	1	2	3
1	256.26	184.61	181.12
2	193.72	368.40	162.74
3	236.84	352.29	189.41
4	237.62	298.52	145.17
5	416.83	187.36	46.87
6	265.60	417.74	122.15
Average	267.81	301.49	141.24

Table E.2

Aboveground weed N content (g N/m^2) in 1990

	Planting Density		
Block	1	2	3
1	2.15		3.10
2	2.01	5.71	2.25
3		2.97	1.95
4	1.97	3.17	1.56
5	4.93	3.20	0.84
6	2.88	3.02	1.78
Average	2.79	3.62	1.92

Table E.3

Weed species (g/m^2) at the low planting density in 1990

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	0.02	0	0.90	0	0.14	0	0.10
Achillea millefolium	0.02	0	0	0	0	0	0.003
Ambrosia artemisiifolia	0	2.49	0	0	0	0.79	0.50
Anthemis cotula	3.61	0	0	0	0	0	0.60
Apocynum cannabinum	0	46.63	0	0	0	0	7.77
Asclepias syriaca	0	0	3.26	0	0	0	0.54
Barbarea vulgaris	0	0	0	0	0	0	0
Catalpa speciosa	0	0	0	0	2.81	0	0.40
Chenopodium album	0	0	0.08	0	0	1.40	0.25
Conyza bonariensis[1]	0	0	0	0	15.27	1.50	2.80
Conyza canadensis	213.24	82.39	153.13	227.64	345.31	100.30	187.00
Cyperus esculentus	0	0	0	0	0	0	0
Digitaria sanguinalis	0	0	0	0.09	0.07	138.06	23.04
Echinochloa crusgali	0	0	0	0	0	0	0
Elytrigia repens[2]	0	55.52	0	0	0	21.31	12.80
Erigeron strigosa	0	0	0	0	0	0	0
Hypericum perforatum	0	0	58.06	0.05	19.22	0	12.89
Juncus tenuis	0	0	0	0	0	0	0
Lactuca serriola	0	0	0	0	0	0	0
Lepidium virginicum	0.26	0	0	0	0	0	0.04
Malva parviflora	0	0	0	0	0.02	0	0.003
Medicago lupulina	0	0	0	0.005	0	0	0.001
Medicago sativa	0	0	0	0	0	0	0
Meliotus indica	0	0	0	0	0	0	0
Oxalis stricta	0	0	0	0.001	0	0	0
Panicum capillare	0	0	0	0	0	0	0

Table E.3 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Panicum dichotomiflorum	26.44	0	18.86	0	1.96	1.02	8.05
Plantago major	0	0	0	9.34	0	0	1.56
Poa compressa	0	0	0	0	0	0	0
Polygonum convolvulus	0	0	0	0	0	0	0
Populus x euramericana	0	0	0	0	0	0	0
Portulaca oleracea	0	0	0	0	0	0	0
Potentilla argentea	0	0	0	0	0	0	0
Potentilla norvegica	0	0	0	0	0	0	0
Potentilla recta	0	0	0	0	0	0	0
Robinia pseudoacacia	0	0	0	0	0	0	0
Rumex aceta	0.32	0	0	0	0	0	0.05
Rumex acetosella	0	0	0	0	0	0	0
Rumex crispus	0	0	0	0	0	0	0
Setaria glauca	0	0	0	0	0	0	0
Setaria viridis	0	0	0	0.41	0	0	0.07
Setaria faberi	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	0	0	0
Taraxacum officinale	7.67	0	0.04	0	1.22	1.22	1.69
Trifoilum repens	0	6.69	0	0.08	30.75	0	6.25
Trifolium hybridum	0	0	0	0	0	0	0
Trifolium pratense	0	0	0	0	0	0	0
Unknown dicots	4.68	0	2.51	0	0.06	0	1.21
Veronica peregrina	0	0	0	0	0	0	0
Block Total	256.26	193.72	236.84	237.62	416.83	265.6	

[1] These plants were probably misidentified. The range of C. bonariensis is not known to extend north of Virginia. [2] Formerly in the genus Agropyron.

Table E.4

Weed species (g/m^2) at the medium planting density in 1990

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	0.1	0.09	0	0.76	0	0.37	0.22
Achillea millefolium	0	0.02	0	0	0	0	0.003
Ambrosia artemisiifolia	3.71	3.82	0	0.27	1.27	0.63	1.62
Anthemis cotula	0	0	0	0	0	0	0
Apocynum cannabinum	0	0	10.94	0.04	0	0	1.83
Asclepias syriaca	0	0	0	0	0	0	0
Barbarea vulgaris	0	0	0	0.79	0	0	0.13
Catalpa speciosa	0	0	0	0	0	0	0
Chenopodium album	0	0	0.11	0.08	0	0	0.03
Conyza bonariensis[1]	0	0	0	0	0	290.91	48.48
Conyza canadensis	140.09	144.18	108.21	278.45	150.33	10.88	138.69
Cyperus esculentus	0	0	0	4.57	0	0	0.76
Digitaria sanguinalis	0	0	1.53	1.19	0	3.52	1.04
Echinochloa crusgali	0	0	0	0	0	0	0
Elytrigia repens[2]	0	0	0	0	0	0	0
Erigeron strigosa	0	0.46	0	0	0	0	0.08
Hypericum perforatum	0	0	0	0.03	0	0	0.005
Juncus tenuis	0	0.81	3.31	0.50	0	0	0.77
Lactuca serriola	0	0	200.46	0	0	0	33.41
Lepidium virginicum	0	0	0	0	0	0	0
Malva parviflora	0	0	0	0	0	0	0
Medicago lupulina	0	0	0	0.007	0	0	0.001
Medicago sativa	0	0	0	0	0	0	0
Meliotus indica	0	0	0	0	0	0	0
Oxalis stricta	0	0	0	0.01	0	0.10	0.02
Panicum capillare	0	0	0	0	0	0.07	0.01

Table E.4 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Panicum dichotomiflorum	4.63	8.47	19.42	11.13	0	9.06	8.78
Plantago major	0	0	0	0	0	0	0
Poa compressa	0	0	0	0	0	0	0
Polygonum convolvulus	0	0	0	0	0	0	0
Populus x euramericana	0	0	2.41	0	0	0	0.40
Portulaca oleracea	0	0	0	0	0	0	0
Potentilla argentea	0	0.61	0	0	4.49	0	0.85
Potentilla norvegica	0	42.98	2.01	0	0	34.55	13.26
Potentilla recta	0	0	0	0	0	0	0
Robinia pseudoacacia	0	0	0	0	0	0	0
Rumex aceta	0	1.66	0	0	0	2.39	0.68
Rumex acetosella	0	0	0	0	0	0	0
Rumex crispus	0	0	0	0	0	49.66	8.28
Setaria glauca	0	0	0	0	0	0	0
Setaria viridis	0	0	0	0	0	0	0
Setaria faberi	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	0	0	0
Taraxacum officinale	8.34	0.01	3.89	0.38	0.18	0.05	2.14
Trifoilum repens	0	0	0	0	0.35	7.64	1.33
Trifolium hybridum	0	10.55	0	0	0	0	1.76
Trifolium pratense	11.76	152.91	0	0	30.74	0	32.57
Unknown dicots	15.98	0	0	0.07	0	7.69	3.96
Veronica peregrina	0	1.83	0	0.24	0	0.22	0.38
Block Total	184.61	368.40	352.29	298.52	187.36	417.74	

[1] These plants were probably misindentified. The range of C. bonariensis is not known to extend north of Virginia. [2] Formerly in the genus Agropyron.

Table E.5

Weed species (g/m^2) at the high planting density in 1990

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	0.01	0.41	0	0.02	0	3.90	0.72
Achillea millefolium	0	0	0	0	0	0	0
Ambrosia artemisiifolia	11.13	3.19	0	0.29	0	0	2.44
Anthemis cotula	0	0	0	0	0	0	0
Apocynum cannabinum	5.79	0	8.12	0	0	0	2.32
Asclepias syriaca	0	0	0	0	0	0	0
Barbarea vulgaris	0	0	0	0.24	0	0	0.04
Catalpa speciosa	0	0	0	0	0	0	0
Chenopodium album	0	0	0.13	0	0	0	0.02
Conyza bonariensis[1]	2.16	0	0	0	0	36.27	6.40
Conyza canadensis	28.45	8.83	30.57	3.64	19.64	9.53	16.78
Cyperus esculentus	0	0	0	0	0	0	0
Digitaria sanguinalis	0	0	0	10.71	0	5.45	2.69
Echinochloa crusgali	0	0	0	0	0	0	0
Elytrigia repens[2]	0.61	0	0	0	0	0	0.10
Erigeron strigosa	0	0	0	0	0	0	0
Hypericum perforatum	0	0	106.71	28.00	0	0	22.45
Juncus tenuis	0	0	0	0.37	0	0	0.06
Lactuca serriola	0	0	0	0	0	0	0
Lepidium virginicum	0	0	0	0	0	0	0
Malva parviflora	0	0	0	0	0	0	0
Medicago lupulina	0	0	0	0	0	0	0
Medicago sativa	0	0	0	0	0	6.61	1.10
Meliotus indica	0	0	0.59	0	0	0	0.10
Oxalis stricta	0	1.11	0	0	0	0.09	0.20
Panicum capillare	0	0	0	0	0	0	0

Table E.5 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Panicum dichotomiflorum	0.97	1.13	2.00	14.60	0	8.02	4.45
Plantago major	0	0	0	0	0	0	0
Poa compressa	0.02	0	0	0	0	0	0.003
Polygonum convolvulus	0	0.04	0	0	0	0	0.01
Populus x euramericana	0	0.61	0	0	0	0	0.10
Portulaca oleracea	0	0	0	0	0	0	0
Potentilla argentea	0	0	0	0	11.08	0	1.85
Potentilla norvegica	0	125.54	38.99	82.58	4.12	0	41.87
Potentilla recta	0	0	0	0.01	0	0	0.002
Robinia pseudoacacia	0	0	0	0	0	0	0
Rumex aceta	3.72	3.23	0	0	0	0	1.16
Rumex acetosella	0	0	0	0	0	0	0
Rumex crispus	0	10.42	0	0	0	0	1.74
Setaria glauca	0	0	0	0	0	0.06	0.01
Setaria viridis	0	0	0	0	0	0	0
Setaria faberi	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	0	0	0
Taraxacum officinale	1.86	0	0	4.34	0	49.24	9.24
Trifoilum repens	52.3	0	0	0	12.03	0	10.72
Trifolium hybridum	73.06	7.95	0	0	0	0	13.50
Trifolium pratense	0	0	0	0.37	0	1.43	0.30
Unknown dicots	1.04	0.01	2.30	0	0	0.54	0.65
Veronica peregrina	0	0.27	0	0	0	0.92	0.20
Block Total	181.12	162.74	189.41	145.17	46.87	122.06	

[1] These plants were probably misidentified. The range of C. bonariensis is not known to extend north of Virginia. [2] Formerly in the genus Agropyron.

Table E.6

Nitrogen data from weeds sampled in August 1990

Blk	Trt	Species	Weight (g/m^2)	N Conc (%)	N Cont ($g\ N/m^2$)
1	1-0	Conyza canadensis	213.24	0.85	1.81
1	1-0	Panicum dichotomiflorum	26.44	0.96	0.26
1	1-0	Other species	8.91	0.94	0.08
1	1-0	Taraxacum officinale	7.67	*	*
1	2-0	Conyza canadensis	140.09	*	*
1	2-0	Other species	16.78	*	*
1	2-0	Unknown dicots	15.98	*	*
1	2-0	Trifolium pratense	11.76	*	*
1	3-0	Trifolium hybridum	73.06	1.81	1.32
1	3-0	Trifolium repens	52.30	1.99	1.04
1	3-0	Conyza canadensis	28.45	1.20	0.34
1	3-0	Other species	27.31	1.46	0.40
2	1-0	Conyza canadensis	82.39	0.97	0.80
2	1-0	Elytrigia repens[1]	55.52	0.79	0.44
2	1-0	Apocynum cannabinum	46.63	1.17	0.55
2	1-0	Other species	9.18	2.38	0.22
2	2-0	Trifolium pratense	152.91	2.01	3.08
2	2-0	Conyza canadensis	144.18	1.30	1.88
2	2-0	Potentilla norvegica	42.98	0.88	0.38
2	2-0	Other species	28.33	1.34	0.38
2	3-0	Potentilla norvegica	125.54	1.35	1.70
2	3-0	Other species	17.95	1.80	0.32
2	3-0	Rumex crispus	10.42	1.06	0.11
2	3-0	Conyza canadensis	8.83	1.33	0.12
3	1-0	Conyza canadensis	153.13	*	*
3	1-0	Hypericum perforatum	58.06	*	*
3	1-0	Panicum dichotomiflorum	18.86	*	*
3	1-0	Other species	6.79	*	*
3	2-0	Lactuca serriola	200.46	0.70	1.41
3	2-0	Conyza canadensis	108.21	1.00	1.08
3	2-0	Other species	24.20	1.22	0.30
3	2-0	Panicum dichotomiflorum	19.42	0.96	0.19
3	3-0	Hypericum perforatum	106.71	1.06	1.13
3	3-0	Potentilla norvegica	38.99	0.81	0.32
3	3-0	Conyza canadensis	30.57	1.16	0.35
3	3-0	Other species	13.14	1.14	0.15

Table E.6 (cont'd)

Blk	Trt	Species	Weight (g/m^2)	N Conc (%)	N Cont ($g\ N/m^2$)
4	1-0	Conyza canadensis	227.64	0.83	1.89
4	1-0	Plantago major	9.34	0.79	0.07
4	1-0	Setaria viridis	0.41	0.86	0.004
4	1-0	Other species	0.23	1.54	0.004
4	2-0	Conyza canadensis	188.03	1.09	2.06
4	2-0	Conyza canadensis	90.42	1.00	0.90
4	2-0	Panicum dichotomiflorum	11.13	1.00	0.11
4	2-0	Other species	8.94	1.09	0.10
4	3-0	Potentilla norvegica	82.58	0.92	0.76
4	3-0	Hypericum perforatum	28.00	1.25	0.35
4	3-0	Other species	19.99	1.39	0.28
4	3-0	Panicum dichotomiflorum	14.60	1.18	0.17
5	1-0	Conyza canadensis	345.31	1.13	3.91
5	1-0	Trifolium repens	30.75	1.98	0.61
5	1-0	Other species	21.55	0.93	0.20
5	1-0	Hypericum perforatum	19.22	1.11	0.21
5	2-0	Conyza canadensis	150.33	1.52	2.29
5	2-0	Trifolium pratense	30.74	2.64	0.81
5	2-0	Potentilla argentea	4.49	1.61	0.07
5	2-0	Other species	1.80	1.72	0.03
5	3-0	Conyza canadensis	19.64	1.73	0.34
5	3-0	Trifolium pratense	12.03	2.53	0.30
5	3-0	Potentilla argentea	11.08	1.29	0.14
5	3-0	Other species	4.12	1.26	0.05
6	1-0	Digitaria sanguinalis	138.06	0.98	1.35
6	1-0	Conyza canadensis	100.30	1.23	1.24
6	1-0	Elytrigia repens[1]	21.31	0.96	0.20
6	1-0	Other species	5.93	1.55	0.09
6	2-0	Conyza bonariensis	290.91	0.54	1.57
6	2-0	Rumex crispus	49.66	0.67	0.33
6	2-0	Other species	42.62	1.74	0.74
6	2-0	Potentilla norvegica	34.55	1.08	0.37
6	3-0	Taraxacum officinale	48.26	1.69	0.82
6	3-0	Conyza bonariensis	36.27	0.89	0.32
6	3-0	Other species	28.09	1.77	0.50
6	3-0	Conyza canadensis	9.53	1.57	0.15

[1] Formerly in the genus Agropyron.

Table E.7

Data from the September 1990 detructive tree sampling

Blk	Trt	Diam (cm)	Height (m)	Woody Wt (g)	Leaf Wt (g)	Total Wt (g)
1	2-0*	3.5	3.23	570	102	672
1	2-1*	4.8	3.9	1381	189	1570
1	3-0	2.25	2.79	200	38	238
1	3-1	4.08	4.09	1008	142	1150
2	2-0*	3.46	2.81	552	107	659
2	2-1*	4.86	3.76	1412	237	1649
2	3-0	3.35	3.5	483	74	557
2	3-1	3.31	3.41	515	73	588
3	2-0*	3.66	3.5	706	159	865
3	2-1*	6.34	4.31	2342	412	2754
3	3-0	1.68	2.25	97	22	119
3	3-1	2.87	3.03	368	61	429
4	2-0*	4.04	3.3	719	120	839
4	2-1*	5.54	3.43	1787	290	2077
4	3-0	2.85	3.4	364	55	419
4	3-1	3.58	3.33	600	81	681
5	2-0*	3.45	3.44	545	143	688
5	2-1*	5.45	4.19	1234	346	1580
5	3-0	2.84	2.91	342	79	421
5	3-1	3.6	3.52	693	85	778
6	2-0*	3.24	3.07	508	82	590
6	2-1*	5.1	4.74	1662	217	1879
6	3-0	3.23	4.09	538	168	706
6	3-1	3.61	3.72	643	102	745

* These trees were actually removed from the extra '2x1m planting', not from the treatment plots. See Figure 2, page 15.

The trees from the no weed control plots were not used in the regression analysis. These representative trees at the medium density were not linear when combined with trees from 1989 and 1991.

Table E.8

Prediction equations for total poplar biomass in 1990

Treatment[1]	Equation[3]	R^2	N
Weed Control	-189.837 + 84.313 (diam2)	0.957	83
SE of Coeff[4]	[50.506] [1.978]		
No Weed Control	55.942 + 46.040 (diam2)	0.747	70
SE of Coeff	[29.942] [3.252]		

[1] All densities are combined into one equation.
[3] Predicted biomass (g), diameter (cm) at 15 cm above the ground. Data used for anlaysis was a compilation from destructive tree sampling in Sept 1989, Sept 1990 (from weed control plots only) and Sept 1991.
[4] Standard error of the coefficient.

Table E.9

Total Poplar biomass as predicted from regression equations

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	277	21	773	141	1674	439
2	356	32	642	116	1155	541
4	268	34	722	94	968	474
5	256	64	642	146	708	573
6	355	35	615	108	1172	404
Average	302	37	679	121	1135	486

APPENDIX F

APPENDIX F

1991 Data

Table F.1

Poplar diameters (cm) in September 1991*

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	7.34	3.29	6.36	3.33	4.77	3.04
2	7.52	2.16	5.52	3.30	4.42	4.18
4	6.88	2.42	6.47	2.86	3.00	2.36
5	6.46	4.92	5.78	3.60	4.25	3.10
6	7.95	3.64	5.31	3.85	3.34	3.38
Average	7.23	3.29	5.89	3.39	3.96	3.21

* Diameter at 15cm above the ground, from destructive sampling

Table F.2

Poplar total height (m) in September 1991 from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	5.48	2.94	5.78	3.61	5.56	3.88
2	5.74	2.17	5.00	3.58	4.54	5.08
4	5.22	2.38	5.47	3.27	4.02	3.82
5	5.66	4.04	5.58	3.80	4.93	3.69
6	6.26	3.17	5.62	3.70	4.78	4.64
Average	5.67	2.94	5.49	3.59	4.77	4.22

Table F.3

1991 Poplar leader length (m)

Block	Treatment 1-1	1-0	2-1	2-0	3-1	3-0
1	2.15	1.06	1.84	1.30	1.47	1.40
2	2.14	0.87	1.72	1.48	1.34	1.99
4	2.24	1.12	2.22	1.34	1.38	1.50
5	2.08	1.34	2.22	1.69	1.72	1.78
6	2.11	1.29	2.17	1.47	0.92	1.76
Average	2.14	1.14	2.03	1.46	1.37	1.69

Table F.4

Individual poplar leaf area (m^2) in 1991
from destructive sampling

Block	Treatment 1-1	1-0	2-1	2-0	3-1	3-0
1	4.42	0.60	2.39	0.45	0.80	0.34
2	5.04	0.39	1.47	0.68	0.67	1.00
4	4.83	0.61	1.99	0.65	0.54	0.20
5	2.82	1.54	5.50	1.01	0.86	0.48
6	5.03	1.66	1.55	0.92	0.29	0.59
Average	4.43	0.96	2.58	0.74	0.58	0.52

Table F.5

Poplar woody dry weight (g/tree) in 1991
from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	3985	486	2656	566	1431	494
2	4386	214	1984	616	1270	1021
4	3902	286	3380	432	634	332
5	2408	668	2244	1134	1526	534
6	4893	738	2044	738	677	653
Average	3915	479	2462	697	1107	607

Table F.6

Poplar total aboveground dry weight (g/tree) in 1991
from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	4422	552	2900	619	1519	532
2	4938	255	2149	692	1321	1118
4	4465	344	3609	502	663	353
5	2736	834	2451	1242	1624	585
6	5488	906	2234	802	705	710
Average	4410	578	2669	771	1166	660

Table F.7

Poplar woody N content (g N/tree) in 1991
from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	22.13	3.11	7.90	3.24	7.24	2.80
2	39.88	1.30	10.10	3.74	18.31	5.34
4	21.53	1.72	15.98	3.65	3.19	2.10
5	12.46	4.43	11.71	7.05	5.99	2.85
6	58.06	4.42	11.83	4.09	4.24	3.51
Average	30.81	3.00	11.50	4.35	7.79	3.32

Table F.8

Poplar total aboveground N content (g N/tree) in 1991
from destructive sampling

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	31.95	3.90	13.35	4.49	9.78	3.71
2	50.60	2.14	13.76	5.32	19.42	7.63
4	34.74	3.01	20.51	5.34	3.65	2.63
5	21.09	7.89	16.64	9.26	8.39	4.15
6	72.69	14.47	16.48	5.49	4.95	4.90
Average	42.22	6.28	16.15	5.98	9.24	4.60

Table F.9

Leaf Area Index in September 1991
from prediction equations

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.63	0.09	1.01	0.28	0.76	0.70
2	0.80	0.20	0.69	0.32	0.54	0.92
4	0.67	0.19	0.96	0.26	0.54	0.74
5	0.60	0.19	0.84	0.50	0.44	0.98
6	0.78	0.18	0.89	0.34	0.76	0.79
Average	0.70	0.17	0.88	0.34	0.61	0.82

Table F.10

Standing tree woody biomass (g/m^2) in 1991
from prediction equations

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	544.2	31.8	1436.7	193.7	2027.4	821.8
2	720.7	83.0	936.7	227.6	1567.0	1021.2
4	586.8	139.6	1267.9	198.6	1338.4	866.1
5	509.0	138.7	1266.8	399.9	1109.0	1082.3
6	695.1	130.2	1218.3	258.4	1718.9	909.5
Average	611.2	104.7	1225.3	255.6	1552.1	940.2

Table F.11

Total standing poplar biomass (g/m^2) in 1991 from prediction equations

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	643.3	37.8	1560.2	220.0	2161.8	897.9
2	840.9	100.0	1021.3	258.1	1661.3	1117.9
4	690.9	168.8	1378.3	225.5	1413.4	946.6
5	603.9	167.6	1377.1	452.4	1165.3	1185.2
6	812.2	157.3	1357.2	292.9	1826.8	994.4
Average	718.2	126.3	1338.8	289.8	1645.7	1028.4

Table F.12

Leaf Area Index in July as determined by canopy transmittance

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.26	0.05	1.70	0.26	1.89	1.29
2	0.28	0.05	1.37	0.35	1.47	0.98
4	0.60	0.08	1.24	0.29	1.88	1.19
5	0.20	0.10	1.40	0.63	1.38	1.38
6	0.39	0.05	1.54	0.26	1.74	2.45
Average	0.35	0.07	1.45	0.42	1.67	1.46

Table F.13

Foliar N concentration (%) in July 1991

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	2.88	2.07	3.24	2.39	3.18	3.11
2	3.14	2.59	2.99	2.87	3.14	3.12
4	3.16	2.38	3.18	3.18	2.98	3.29
5	3.29	2.86	2.98	2.94	3.32	3.56
6	3.03	2.92	6.31	2.92	3.43	2.93
Average	3.10	2.57	3.12	2.86	3.21	3.19

Table F.14

Abovground weed biomass (g/m^2) in 1991

	Planting Density		
Block	1	2	3
1	253.48	154.68	99.87
2	361.63	223.11	64.50
4	313.12	235.04	167.16
5	368.58	255.88	52.14
6	880.42	286.08	56.90
Average	435.45	226.16	88.11

Table F.15

Aboveground weed N content (g N/m^2) in 1991

	Planting Density		
Block	1	2	3
1	3.60	2.48	1.26
2	6.13	3.07	1.36
4	5.12	6.36	2.82
5	5.24	5.00	0.96
6	10.78	4.06	1.06
Average	6.18	3.80	1.49

Table F.16

Weed species (g/m^2) at the low planting density in 1991

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	0	1.12	0.03	1.12	1.13	2.51	1.08
Achillea millefolium	29.46	0	0	0	0	0	4.91
Ambrosia artemisiifolia	0.02	0.79	0.30	0	0	0	0.19
Apocynum cannabinum	1.48	175.00	23.81	0	0	0	33.38
Asclepias syriaca	0	0	0	0	0	0	0
Aster pilosus	39.58	5.15	2.46	0	30.14	779.68	142.83
Carduus nutans	0	0	0	0	0	0	0
Catalpa speciosa	0	0	0	0	250.00	0	41.67
Cirsium arvense	0.55	0	0	0	0	0	0.09
Cirsium vulgare	0	0	0	0.04	0	0	0.01
Conyza canadensis	0	6.14	115.62	3.06	0.055	0.005	20.81
Cyperus esculentus	0	0	0	0	0	0	0
Dactylis glomerata	0	0	0	0	0	0	0
Daucus carota	0	0	0	0	0.54	0	0.09
Digitaria sanguinalis	0	0	0	0.86	0.08	1.15	0.35
Eleusine indica	0.72	0	0	0	0	0	0.12
Elytrigia repens[1]	0	23.04	0	0	0	0	3.84
Erigeron annuus	130.49	59.54	0	29.88	14.58	0	39.08
Erigeron strigosus	0.61	0	0.06	0	0	0	0.11
Hypericum perforatum	0	0	65.59	252.06	0	82.01	66.61
Juncus tenuis	0.64	0.14	0	0	0	0	0.13
Lactuca serriola	0	2.28	0	0	0.78	0	0.51
Medicago sativa	0	0	0	0	0	0	0
Oxalis stricta	0.98	0.12	0	0.02	0.58	0.03	0.29
Panicum dichotomiflorum	0.48	0.18	0	0.50	0.28	0	0.24
Parthenocissus quinquefolia	0	0	0	0	0	0	0

Table F.16 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Plantago major	0	0	0	0	0	0	0
Phleum pratense	1.24	0	0	0	0	0	0.21
Poa annua	0	0	0	2.15	0	0	0.36
Polygonum pensylvanicum	0	0	0	0	0	0	0
Populus X euramericana	0	0	0	0	6.58	0	1.10
Potentilla argentea	0	0	0	0	0	0	0
Potentilla recta	0	0	0	0	0	0	0
Prunus serotina	0	0	0	0.52	0	0	0.08
Prunus virginiana	0	0	0	0	0	0	0
Rhus radicans	0	0	0	0	0	0	0
Robinia psuedoacacia	0	0	0	0	7.60	0	1.27
Rosa multiflora	0	0	0	0	0	0	0
Rumex acetosella	9.56	0.26	0	2.26	10.64	0	3.78
Setaria glauca	0	0	0	2.89	0	0	0.48
Setaria faberi	0	0	0	0.26	0	0	0.04
Solidago graminifolia	0	0	0	0	0	0	0
Solidago nemoralis	0	0	10.62	1.28	1.64	0	2.26
Taraxacum officinale	20.55	7.09	8.30	15.82	37.38	14.98	17.35
Trifolium hybridum	0	0.30	0	0	0	0	0.05
Trifolium pratense	0	56.48	0	0	0	0	9.41
Trifolium repense	16.09	2.82	0	0.25	6.08	0	4.21
Unknown dicots	1.03	0.58	0	0.16	0.23	0	0.33
Verbascum thapsus	0	0	0	0	0	0.06	0.01
Block Average	253.48	341.04	226.78	313.12	368.30	880.42	

1 Formerly in the genus Agropyron.

Table F.17

Weed species (g/m^2) at the medium planting density in 1991

Species	Block 1	2	3	4	5	6	Species Average
Abutilon theophrasti	0.18	0.73	2.11	1.92	0	0.02	0.83
Achillea millefolium	4.02	0	0	0	0	0	0.67
Ambrosia artemisiifolia	0.02	3.64	0	0	2.06	0.10	0.97
Apocynum cannabinum	16.88	3.62	29.30	3.31	0	6.56	9.94
Asclepias syriaca	0	0	0	0	0	0	0
Aster pilosus	74.77	14.14	0	0	6.98	115.16	35.18
Carduus nutans	0	0	0	0	0	0	0
Catalpa speciosa	0	0	0	0	0	0	0
Cirsium arvense	0.88	0	0	0	0	0	0.14
Cirsium vulgare	0	0	0	38.11	98.52	0	22.77
Conyza canadensis	2.20	42.65	135.56	112.58	4.74	20.04	52.96
Cyperus esculentus	0	0	0.15	0	0	0	0.02
Dactylis glomerata	0	0	0	0	0	0	0
Daucus carota	0	0	0	0	0	0	0
Digitaria sanguinalis	0	0	0	0.04	0	0.02	0.01
Eleusine indica	0	0	0	0	0	0	0
Erigeron annuus	0	45.94	0	14.46	10.36	16.32	14.51
Erigeron strigosus	3.58	13.90	0	0.88	0.58	0	3.16
Elytrigia repens[1]	0	0	0	0	0	91.90	15.32
Hypericum perforatum	0	0	363.24	2.32	0	0	60.93
Juncus tenuis	3.36	0	0	0.09	3.22	0	1.11
Lactuca serriola	0	0.32	0.08	0	0.45	0	0.14
Medicago sativa	0	0	0	15.86	0	8.84	4.12
Oxalis stricta	0	0	0.08	0	1.34	0.18	0.27
Panicum dichotomiflorum	0.38	0.04	0	0	0.01	0.06	0.08
Parthenocissus quinquefolia	0	0	0	0	0	4.57	0.76

Table F.17 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Plantago major	0	0	0	0	0	0	0
Phleum pratense	0	0	0	0	0	0	0
Poa annua	9.54	0	0	0.93	0	0	1.74
Polygonum pensylvanicum	0	0	0	0	0	0	0
Populus X euramericana	0	0	0	0	0	0	0
Potentilla argentea	0	0	0	0	4.01	0	0.67
Potentilla recta	0	2.35	3.25	0.26	0	0	0.98
Prunus serotina	0	0	0	0	0	0	0
Prunus virginiana	0	0	0	0	0	0	0
Rhus radicans	0	0	0	0	0.11	0	0.02
Robinia psuedoacacia	0	0	0	0	0	0	0
Rosa multiflora	1.54	0	0	0	0	0	0.26
Rumex acetosella	1.94	54.89	0	0	0.005	0.09	9.49
Setaria glauca	0	0	0	0	0	0	0
Setaria faberi	0	0	0	0.18	0	0.02	0.03
Solidago graminifolia	0.68	0	0	0	0	0	0.11
Solidago nemoralis	0	0	25.22	7.88	55.61	0.48	14.86
Taraxacum officinale	21.74	8.99	0.74	33.16	27.44	18.72	18.46
Trifolium hybridum	0	0	0	0	0	2.66	0.44
Trifolium pratense	0	1.72	0	0.30	0	0	0.34
Trifolium repense	12.72	3.05	0	2.28	40.28	0.10	9.74
Unknown dicots	0.24	0	0.20	0.50	0.16	0.24	0.22
Verbascum thapsus	0	0	0	0	0	0	0
Block Average	154.68	195.97	559.94	235.04	255.88	286.08	

[1] Formerly in the genus Agropyron.

Table F.18

Weed species (g/m^2) at the high planting densitiy in 1991

	Block						
Species	1	2	3	4	5	6	Species Average
Abutilon theophrasti	0.39	0.04	0	0.45	0.01	0.12	0.17
Achillea millefolium	0	0	0	0	0	0	0
Ambrosia artemisiifolia	2.32	0	0	0	1.53	0	0.64
Apocynum cannabinum	51.20	24.44	29.54	0	22.19	0	21.22
Asclepias syriaca	0	0	0	2.64	0	0	0.44
Aster pilosus	5.14	0	0	12.28	0	2.99	3.40
Carduus nutans	0.28	0	0	0	0	0	0.05
Catalpa speciosa	0	0	0	0	0	0	0
Cirsium arvense	0	0	0	0	0	0	0
Cirsium vulgare	0	0	0	0.02	0	0	0.002
Conyza canadensis	6.44	14.97	3.52	1.46	5.60	0	5.33
Cyperus esculentus	0	0	0.01	0	0	0	0.001
Dactylis glomerata	8.80	0	0	5.53	0	0	2.39
Daucus carota	0	0	0	0	0.07	0	0.01
Digitaria sanguinalis	0	0	0	0	0	0.02	0.003
Eleusine indica	0	0	0	0	0	0	0
Elytrigia repens[1]	0	0	0	0	0	33.50	5.58
Erigeron annuus	0	0	2.12	0	9.97	0	2.02
Erigeron strigosus	0	0	0	0	1.02	0	0.17
Hypericum perforatum	0	0	95.84	136.04	0	0	38.64
Juncus tenuis	3.62	0	0	1.87	0.45	0	0.99
Lactuca serriola	0	0	0	0	0	0	0
Medicago sativa	0	0	0	0	0	9.28	1.55
Oxalis stricta	0	0	0	0	0	0.65	0.11
Panicum dichotomiflorum	0.20	0.09	0	0	0.66	0	0.16
Parthenocissus quinquefolia	0	0	0	0	0	0	0

Table F.18 (cont'd)

Species	Block 1	2	3	4	5	6	Species Average
Plantago major	0.68	0	0	0	0	0	0.11
Phleum pratense	0	0	0	0	0	0	0
Poa annua	0	0	0	0	0	0	0
Polygonum pensylvanicum	0	0	0	0	0	0.02	0.003
Populus X euramericana	0	0	0	0	0	0	0
Potentilla argentea	0	0	0	0	0	0	0
Potentilla recta	0.34	0	0	0	0.66	0.35	0.23
Prunus serotina	0	0	0	0	0	0	0
Prunus virginiana	0	0	0	0.10	0.02	0	0.02
Rhus radicans	0	0	0	0	0	0.14	0.02
Robinia psuedoacacia	0	0	0	0	0	0	0
Rosa multiflora	0	0	0	0	0	0	0
Rumex acetosella	0.08	3.07	0.51	0.27	0.06	0	0.66
Setaria glauca	0	0	0	0	0	0.005	0
Setaria faberi	0	0	0	0	0	0	0
Solidago graminifolia	4.88	0	0	0	4.45	0.98	1.72
Solidago nemoralis	0	0.46	0	0	0.44	0	0.15
Taraxacum officinale	3.93	0.24	0.64	2.08	2.19	8.82	2.98
Trifolium hybridum	0	0	0	0	0	0.02	0.004
Trifolium pratense	0.91	0	0	6.34	0.70	0	1.32
Trifolium repense	0.15	19.45	0	0	2.02	0	3.60
Unknown dicots	0.31	1.72	0.20	0.85	0.09	0.01	0.53
Verbascum thapsus	0	0	0	0.01	0	0	0.001
Block Average	89.68	64.50	132.38	169.92	52.14	56.90	

1 Formerly in the genus Agropyron.

Table F.19

Nitrogen data from weeds sampled in August 1991

Blk	Trt	Tree	Species	Weight (g/m^2)	N conc (%)	N cont ($g\ N/m^2$)
1	1-0	1	Erigeron annuus	154.56	1.14	1.76
1	1-0	1	Other species	50.07	1.77	0.89
1	1-0	1	Aster pilosus	44.00	1.42	0.62
1	1-0	1	Achillea millefolium	31.66	1.07	0.34
1	1-0	2	Erigeron annuus	106.42	1.02	1.09
1	1-0	2	Other species	52.92	1.84	0.97
1	1-0	2	Aster pilosus	35.15	1.77	0.62
1	1-0	2	Trifolium repens	32.18	2.77	0.89
1	2-0	1	Other species	41.04	1.48	0.61
1	2-0	1	Taraxacum officinale	29.13	2.12	0.62
1	2-0	1	Trifolium repens	25.45	2.55	0.65
1	2-0	1	Apocynum cannabinum	24.81	1.27	0.32
1	2-0	2	Aster pilosus	128.33	1.39	1.79
1	2-0	2	Other species	27.17	1.24	0.34
1	2-0	2	Poa annua	19.09	1.65	0.32
1	2-0	2	Taraxacum officinale	14.35	2.30	0.33
1	3-0	1	Apocynum canabinnum	56.81	1.72	0.98
1	3-0	1	Aster pilosus	10.28	1.48	0.15
1	3-0	1	Other species	1.67	2.24	0.04
1	3-0	1	Taraxacum officianle	1.25	2.34	0.03
1	3-0	2	Other species	46.16	2.08	0.96
1	3-0	2	Apocynum cannabinum	45.58	*	*
1	3-0	2	Aster pilosus	20.38	*	*
1	3-0	2	Dactylis glomerata	17.61	2.08	0.36
2	1-0	1	Apocynum cannabinum	350.00	1.61	5.63
2	1-0	1	Other species	13.60	2.11	0.29
2	1-0	1	Erigeron annuus	11.65	1.14	0.13
2	1-0	1	Taraxacum officinale	9.85	2.27	0.22
2	1-0	2	Trifolium pratense	112.96	2.11	2.39
2	1-0	2	Erigeron annuus	107.44	1.46	1.57
2	1-0	2	Other species	74.62	1.80	1.34
2	1-0	2	Elytrigia repens[1]	43.14	1.56	0.68
2	2-0	1	Erigeron annuus	91.87	1.48	1.36
2	2-0	1	Rumex acetosella	67.12	0.97	0.65
2	2-0	1	Conyza canadensis	43.89	1.80	0.79
2	2-0	1	Other species	36.20	1.98	0.72

Table F.19 (cont'd)

Blk	Trt	Tree	Species	Weight (g/m^2)	N conc (%)	N cont ($g\ N/m^2$)
2	2-0	2	Rumex acetosella	42.66	1.21	0.51
2	2-0	2	Conyza canadensis	41.41	1.97	0.82
2	2-0	2	Other species	40.80	2.01	0.82
2	2-0	2	Aster pilosus	28.27	1.65	0.47
2	3-0	1	Trifolium repens	33.99	3.16	1.07
2	3-0	1	Conyza canadensis	23.97	1.70	0.41
2	3-0	1	Reumex acetosella	5.71	1.46	0.08
2	3-0	1	Other species	1.58	2.70	0.04
2	3-0	2	Apocynum cannabinum	48.88	1.54	0.75
2	3-0	2	Conyza canadensis	5.97	2.30	0.14
2	3-0	2	Trifolium repens	4.91	3.19	0.16
2	3-0	2	Other species	3.98	1.70	0.07
3	1-0	1	Conyza canadensis	175.91	1.32	2.32
3	1-0	1	Apocynum cannabinum	40.85	0.95	0.39
3	1-0	1	Taraxacum officinale	1.80	1.54	0.03
3	1-0	1	Other species	0.06	0.71	0.000
3	1-0	2	Hypericum perforatum	131.18	1.22	1.60
3	1-0	2	Conyza canadensis	55.32	1.30	0.72
3	1-0	2	Other species	27.21	1.12	0.30
3	1-0	2	Solidago nemoralis	21.24	1.35	0.29
3	2-0	1	Hypericum perforatum	700.00	1.91	13.37
3	2-0	1	Apocynum cannabinum	58.59	1.33	0.78
3	2-0	1	Potentilla recta	6.50	1.46	0.09
3	2-0	1	Other species	0.30	0.89	0.003
3	2-0	2	Conyza conadensis	271.12	1.28	3.47
3	2-0	2	Solidago nemoralis	50.44	1.32	0.66
3	2-0	2	Hypericum perforatum	26.49	1.26	0.33
3	2-0	2	Other species	6.44	1.28	0.08
3	3-0	1	Hypericum perforatum	135.04	1.78	2.40
3	3-0	1	Apocynum cannabinum	16.22	1.49	0.24
3	3-0	1	Conyza canadensis	6.88	1.72	0.12
3	3-0	1	Other species	2.70	2.18	0.06
3	3-0	2	Hypericum perforatum	56.63	1.35	0.76
3	3-0	2	Apocynum cannabinum	42.86	0.87	0.37
3	3-0	2	Erigeron annuus	4.25	0.79	0.03
3	3-0	2	Other species	0.19	1.67	0.003

Table F.19 (cont'd)

Blk	Trt	Tree	Species	Weight (g/m^2)	N conc (%)	N cont ($g\ N/m^2$)
4	1-0	1	Hypericum perforatum	241.65	1.60	3.88
4	1-0	1	Taraxacum officinale	27.07	2.12	0.57
4	1-0	1	Other species	8.01	1.81	0.14
4	1-0	1	Rumex acetosella	4.51	1.74	0.08
4	1-0	2	Hypericum perforatum	262.48	1.74	4.56
4	1-0	2	Erigeron annuus	59.76	0.87	0.52
4	1-0	2	Other species	16.97	2.19	0.37
4	1-0	2	Setaria glauca	5.78	1.94	0.11
4	2-0	1	Taraxacum officinale	56.95	2.25	1.28
4	2-0	1	Cirsium vulgare	55.40	1.38	0.76
4	2-0	1	Other species	16.71	2.30	0.38
4	2-0	1	Hypericum perforatum	4.63	2.01	0.09
4	2-0	2	Conyza canadensis	220.57	1.85	4.09
4	2-0	2	Other species	55.19	1.74	0.96
4	2-0	2	Medicago sativa	31.71	2.65	0.84
4	2-0	2	Erigeron annuus	28.91	1.13	0.33
4	3-0	1	Hypericum perforatum	264.46	1.65	4.36
4	3-0	1	Trifolium pratense	12.67	2.82	0.36
4	3-0	1	Other species	11.64	1.87	0.22
4	3-0	1	Aster pilosus	6.80	1.50	0.10
4	3-0	2	Aster pilosus	17.77	1.43	0.25
4	3-0	2	Other species	8.08	2.07	0.17
4	3-0	2	Hypericum perforatum	7.61	1.19	0.09
4	3-0	2	Asclepias syriaca	5.29	1.41	0.07
5	1-0	1	Catalpa speciosa	500.00	1.21	6.03
5	1-0	1	Other species	74.98	2.12	1.59
5	1-0	1	Taraxacum officinale	31.33	2.20	0.69
5	1-0	1	Erigeron annuus	29.15	1.06	0.31
5	1-0	2	Aster pilosus	48.65	1.28	0.62
5	1-0	2	Taraxacum officinale	43.42	2.34	1.02
5	1-0	2	Trifolium repens	4.89	2.56	0.12
5	1-0	2	Other species	4.73	1.85	0.09
5	2-0	1	Cirsium vulgare	195.48	1.61	3.15
5	2-0	1	Other species	18.61	1.61	0.30
5	2-0	1	Trifolium repens	14.82	2.62	0.39
5	2-0	1	Taraxacum officinale	9.01	2.74	0.25

Table F.19 (cont'd)

Blk	Trt	Tree	Species	Weight (g/m^2)	N conc (%)	N cont ($g N/m^2$)
5	2-0	2	Solidago nemoralis	104.95	1.67	1.76
5	2-0	2	Trifolium repens	65.75	2.66	1.74
5	2-0	2	Other species	57.27	1.89	1.08
5	2-0	2	Taraxacum officinale	45.88	2.90	1.33
5	3-0	1	Apocynum cannabinum	44.38	1.86	0.82
5	3-0	1	Erigeron annuus	19.94	1.41	0.28
5	3-0	1	Other species	11.71	2.12	0.25
5	3-0	1	Conyza canadensis	9.67	1.90	0.18
5	3-0	2	Solidago graminifolia	8.90	1.96	0.17
5	3-0	2	Other species	5.83	1.92	0.11
5	3-0	2	Taraxacum officinale	1.99	2.17	0.04
5	3-0	2	Trifolium repens	1.85	2.71	0.05
6	1-0	1	Aster pilosus	809.35	1.03	8.34
6	1-0	1	Hypericum perforatum	164.02	0.94	1.54
6	1-0	1	Taraxacum officinale	9.36	1.68	0.16
6	1-0	1	Other species	1.06	1.57	0.02
6	1-0	2	Aster pilosus	750.00	1.47	11.02
6	1-0	2	Taraxacum officinale	20.60	1.84	0.38
6	1-0	2	Abutilon theophrasti	4.18	1.94	0.08
6	1-0	2	Other species	2.28	1.85	0.04
6	2-0	1	Aster pilosus	159.17	1.42	2.26
6	2-0	1	Other species	52.20	1.50	0.78
6	2-0	1	Conyza canadensis	39.90	2.00	0.80
6	2-0	1	Taraxacum officinale	35.91	2.22	0.80
6	2-0	2	Elytrigia repens[1]	183.81	1.05	1.93
6	2-0	2	Aster pilosus	71.16	1.49	1.06
6	2-0	2	Medicago sativa	17.68	2.85	0.50
6	2-0	2	Other species	12.33	*	*
6	3-0	1	Elytrigia repens[1]	66.99	1.71	1.14
6	3-0	1	Medicago sativa	18.57	1.91	0.36
6	3-0	1	Taraxacum officinale	4.16	1.97	0.08
6	3-0	1	Other species	3.52	2.18	0.08
6	3-0	2	Taraxacum officinale	13.47	2.42	0.33
6	3-0	2	Aster pilosus	5.98	1.88	0.11
6	3-0	2	Oxalis stricta	0.67	1.57	0.01
6	3-0	2	Other species	0.43	2.73	0.01

[1] Formerly in the genus Agropyron.

Table F.20

Data from the September 1991 destructive tree sampling

Blk	Trt	Tree#	Diam (cm)	Height (m)	Leaf Area (m^2)	Leaf Wt(g)	Woody Wt(g)	Total Wt(g)	Leaf N Cont(g)	Woody N Cont(g)	Total N Cont(g)
6	1-0	100	4.53	3.54	2.57	252.13	1065	1317.13	5.93	6.44	24.74
6	1-0	101	2.74	2.80	0.76	83.48	411	494.48	1.80	2.40	4.20
6	1-1	102	7.64	6.38	5.30	643.05	4825	5468.05	16.26	28.60	44.86
6	1-1	103	8.26	6.14	4.76	545.67	4961.5	5507.17	12.99	87.53	100.52
6	2-0	104	4.64	4.20	1.22	61.53	982	1043.53	1.35	5.04	6.39
6	2-0	105	3.06	3.20	0.63	66.41	495	561.41	1.45	3.13	4.58
6	2-1	106	4.85	5.19	1.10	143.93	1469	1612.93	3.58	10.14	13.72
6	2-1	107	5.77	6.05	2.01	237.19	2618	2855.19	5.72	13.52	19.24
6	3-0	108	3.39	5.07	0.59	65.46	729	794.46	1.51	3.94	5.44
6	3-0	109	3.38	4.20	0.60	48.27	577	625.27	1.26	3.09	4.35
6	3-1	110	3.68	4.97	0.51	49.42	837	886.42	1.26	5.03	6.29
6	3-1	111	3.01	4.59	0.07	7.12	517	524.12	0.16	3.45	3.61
5	1-0	112	3.47	3.65	0.83	90.78	623	713.78	2.06	3.47	5.54
5	1-0	113	6.37	4.43	2.25	241.97	713	954.97	4.86	5.38	10.25
5	1-1	114	5.51	4.72	1.78	213.53	1963	2176.53	6.03	11.89	17.92
5	1-1	115	7.41	6.59	3.87	441.06	2854	3295.06	11.24	13.04	24.27
5	2-0	116	2.87	3.31	0.84	86.56	1314	1400.56	1.04	7.28	8.32
5	2-0	117	4.33	4.29	1.18	129.11	954	1083.11	3.39	6.82	10.21
5	2-1	118	5.62	5.53	1.38	151.02	2046	2197.02	3.86	11.28	15.14
5	2-1	119	5.93	5.63	9.63	263.43	2442	2705.43	6.02	12.13	18.15
5	3-0	120	2.15	2.74	0.14	12.59	172	184.59	0.29	1.02	1.31
5	3-0	121	4.05	4.64	0.82	91.12	895	986.12	2.31	4.68	6.99
5	3-1	122	4.08	4.71	0.59	67.27	981	1048.27	1.42	4.70	6.11
5	3-1	123	4.42	5.15	1.14	128.47	2071	2199.47	3.37	7.29	10.66
1	1-0	124	2.90	2.76	0.48	54.56	386	440.56	1.15	2.78	3.93
1	1-0	125	3.68	3.13	0.71	76.79	587	663.79	0.42	3.44	3.86
1	1-1	126	7.77	5.95	5.66	527.64	4358	4885.64	11.67	23.61	35.28

Table F.20 (cont'd)

Blk	Trt	Tree#	Diam (cm)	Height (m)	Leaf Area (m^2)	Leaf Wt(g)	Woody Wt(g)	Total Wt(g)	Leaf N Cont(g)	Woody N Cont(g)	Total N Cont(g)
1	1-1	127	6.92	5.01	3.18	346.6	3612	3958.60	7.98	20.64	28.63
1	2-0	128	2.84	3.56	0.49	59.29	452	511.29	1.37	3.04	4.41
1	2-0	129	3.82	3.66	0.41	47.65	679	726.65	1.13	3.43	4.56
1	2-1	130	6.01	5.47	2.20	189.71	3187	3376.71	4.25	5.56	9.81
1	2-1	131	6.71	6.09	2.58	296.35	2126	2422.35	6.64	10.24	16.89
1	3-0	132	3.09	4.01	0.29	35.64	531	566.64	0.88	2.62	3.50
1	3-0	133	3.00	3.74	0.38	40.43	457	497.43	0.95	2.97	3.92
1	3-1	134	5.09	5.66	1.00	116.73	1412	1528.73	3.75	7.48	11.24
1	3-1	135	4.45	5.47	0.59	58.55	1450	1508.55	1.31	7.00	8.31
2	1-0	136	1.60	1.70	0.17	14.88	107	121.88	0.31	0.74	1.06
2	1-0	137	2.73	2.64	0.62	66.84	322	388.84	1.36	1.86	3.22
2	1-1	138	7.99	6.18	5.36	587.94	5183	5770.94	10.82	54.95	65.78
2	1-1	139	7.04	5.31	4.72	516.36	3588	4104.36	10.63	24.81	35.43
2	2-0	140	3.51	3.66	0.78	89.28	696	785.28	2.24	4.19	6.43
2	2-0	141	3.10	3.50	0.59	62.06	536	598.06	0.91	3.30	4.21
2	2-1	142	5.14	4.68	1.26	137.20	1614	1751.20	2.96	8.43	11.39
2	2-1	143	5.89	5.32	1.68	192.68	2355	2547.68	4.36	11.78	16.13
2	3-0	144	4.09	5.19	0.72	55.68	1020	1075.68	1.22	5.32	6.54
2	3-0	145	4.27	4.98	1.27	139.11	1022	1161.11	3.37	5.35	8.72
2	3-1	146	5.13	4.68	0.91	54.11	1802	1856.11	1.17	32.33	33.50
2	3-1	147	3.70	4.41	0.44	48.40	737	785.40	1.05	4.30	5.35
3	1-0	148	0.82	0.99	0.02	1.46	42	43.46	0.03	0.38	0.41
3	1-0	149	1.89	1.57	0.13	14.41	97	111.41	0.27	0.62	0.89
3	1-1	150	5.23	4.71	2.68	295.76	2130	2425.76	7.08	23.59	30.67
3	1-1	151	1.26	1.61	0.15	13.27	68	81.27	0.39	0.55	0.94
3	2-0	152	1.11	1.60	0.07	7.97	78	85.97	0.14	0.54	0.68
3	2-0	153	2.33	3.14	0.40	45.30	309	354.30	1.09	1.86	2.94
3	2-1	154	2.68	3.44	0.15	14.74	341	355.74	0.32	2.12	2.44

Table F.20 (cont'd)

Blk	Trt	Tree#	Diam (cm)	Height (m)	Leaf Area (m^2)	Leaf Wt(g)	Woody Wt(g)	Total Wt(g)	Leaf N Cont(g)	Woody N Cont(g)	Total N Cont(g)
3	2-1	155	3.94	3.84	0.80	89.35	871	960.35	1.97	4.66	6.63
3	3-0	156	2.97	3.90	0.45	30.9	547	577.90	0.66	3.49	4.14
3	3-0	157	2.05	3.21	0.06	5.51	222	227.51	0.12	1.36	1.48
3	3-1	158	2.99	4.19	0.11	7.92	504	511.92	0.18	1.57	1.75
3	3-1	159	2.85	4.20	0.17	20.92	495	515.92	0.46	2.96	3.43
4	1-0	160	2.96	2.98	0.74	78.68	421	499.68	1.74	2.51	4.27
4	1-0	161	1.88	1.78	0.48	36.24	152	188.24	0.85	0.90	1.76
4	1-1	162	5.23	4.10	2.62	270.48	1426	1696.48	7.30	10.11	17.41
4	1-1	163	8.54	6.34	7.04	855.37	6378	7233.37	19.11	32.96	52.07
4	2-0	164	2.36	2.84	0.20	20.44	243	263.44	0.46	2.94	3.39
4	2-0	165	3.36	3.70	1.10	118.39	622	740.39	2.92	4.36	7.28
4	2-1	166	6.18	4.89	1.48	161.36	2662	2823.36	1.81	10.74	12.55
4	2-1	167	6.76	6.05	2.51	295.63	4099	4394.63	7.25	21.21	28.46
4	3-0	168	2.77	4.13	0.33	36.47	444	480.47	0.88	2.82	3.70
4	3-0	169	1.95	3.50	0.06	6.12	220	226.12	0.18	1.37	1.55
4	3-1	170	1.98	3.19	0	0	188	188.00	0	0.96	0.96
4	3-1	171	4.01	4.86	0.54	58.97	1079	1137.97	0.91	5.42	6.33

Table F.21

Soil moisture content (%), August 5-6, 1991

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	7.34	8.89	8.42	8.04	21.46	16.06
2	12.74	11.97	8.68	9.94	10.29	11.17
4	11.83	11.40	10.71	13.37	11.38	7.84
5	12.45	13.44	12.91	12.51	7.07	7.69
6	14.54	12.56	11.68	18.82	11.04	16.30
Average	12.10	13.17	11.10	13.39	12.82	14.07

Table F.22

Extractable NH_4-N (μg N/g soil), August 5-6, 1991

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.84	1.99	1.02	1.75	1.50	2.09
2	1.94	2.53	0.63	3.34	1.92	2.17
4	1.82	2.39	1.64	3.32	1.66	2.26
5	2.29	3.15	3.04	3.06	1.31	2.49
6	2.42	3.02	2.21	4.49	3.78	4.66
Average	2.22	2.87	1.90	3.30	2.17	3.39

Table F.23

Extractable NO_3-N (μg N/g soil), August 5-6, 1991

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.72	5.19	2.10	4.12	8.16	10.82
2	1.40	1.49	5.38	0.68	0.56	5.80
4	2.83	7.10	0.97	1.23	0.51	3.75
5	1.74	0.71	1.13	4.00	0.87	3.80
6	1.79	2.15	0.83	3.13	0.97	2.39
Average	1.85	1.67	1.05	1.92	0.98	1.38

Table F.24

Mineralization rates (μg N/g soil/day), August 5-6, 1991

	Treatment					
Block	1-1	1-0	2-1	2-0	3-1	3-0
1	0.12	0.27	0.14	0.26	0.49	1.28
2	0.50	0.33	0.31	0.45	0.29	0.43
4	0.12	0.54	0.12	0.64	0.16	0.26
5	0.04	0.58	0.17	0.69	0.13	0.48
6	0.38	0.47	0.28	0.61	0.29	0.48
Average	0.23	0.44	0.20	0.53	0.27	0.59

APPENDIX G

APPENDIX G

Community Values

Table G.1

Data used to determine community biomass values

Block	Trt	1989 Leaves g/m^2	1989 Weeds g/m^2	1990 Leaves g/m^2	1990 Weeds g/m^2	1991* Trees g/m^2	1991 Weeds g/m^2	Total Biomass g/m^2
1	1-0	3.1	374.8	7.1	256.3	38	253.5	933
2	1-0	2.6	3025.2	5.4	193.7	100	361.6	3688
4	1-0	4.1	918.6	6.9	237.6	169	313.1	1649
5	1-0	8.9	669.5	17.8	416.8	168	368.6	1649
6	1-0	4.7	1503.4	18.3	265.6	157	880.4	2830
1	1-1	7.0		41.4		643		692
2	1-1	10.2		55.0		841		906
4	1-1	14.0		53.0		691		758
5	1-1	15.0		34.6		604		654
6	1-1	15.4		53.9		812		881
1	2-0	17.9	377.8	22.5	184.6	220	154.7	977
2	2-0	8.9	322.8	23.2	368.4	258	196.1	1178
4	2-0	6.0	335.6	20.5	298.5	226	235.0	1121
5	2-0	7.5	995.4	30.0	187.4	452	255.9	1929
6	2-0	4.1	1306.4	45.2	417.7	293	286.1	2352

Table G.1 (cont'd)

Block	Trt	1989 Leaves g/m^2	1989 Weeds g/m^2	1990 Leaves g/m^2	1990 Weeds g/m^2	1991 Trees g/m^2	1991 Weeds g/m^2	Total Biomass g/m^2
1	2-1	14.6		65.7		156		1640
2	2-1	12.7		58.6		1021		1093
4	2-1	52.8		80.4		1378		1512
5	2-1	20.6		63.8		1377		1462
6	2-1	28.7		57.4		1357		1443
1	3-0	36.4	672.1	56.0	181.1	898	99.9	1943
2	3-0	35.8	540.1	115.6	162.7	918	64.5	1837
4	3-0	18.8	790.9	30.4	145.2	947	167.2	2099
5	3-0	58.0	350.4	80.8	46.9	1185	52.1	1773
6	3-0	37.2	293.1	73.0	122.2	994	56.9	1577
1	3-1	126.8		150.0		2162		2439
2	3-1	73.2		88.0		1661		1822
4	3-1	80.8		99.0		1413		1593
5	3-1	70.4		131.0		1165		1367
6	3-1	123.2		90.0		1827		2040

* Total aboveground biomass in 1991, woody components and foliage.

Table G.2

Community N content data for September 1989

Block	Treatment	Poplar g N/m^2	Weeds g N/m^2	Total g N/m^2
1	1-0	0.09	3.71	3.80
2	1-0	0.06	23.56	23.62
3	1-0	0.04	4.37	4.41
4	1-0	0.11	4.91	5.02
5	1-0	0.36	4.92	5.28
6	1-0	0.15	14.00	14.15
1	1-1	0.31		0.31
2	1-1	0.46		0.46
3	1-1	0.92		0.92
4	1-1	0.65		0.65
5	1-1	0.68		0.68
6	1-1	0.65		0.65
1	2-0	0.52	4.20	4.72
2	2-0	0.19	3.24	3.43
3	2-0	0.33	3.47	3.80
4	2-0	0.16	2.86	3.02
5	2-0	0.005	8.98	8.98
6	2-0	0.12	20.65	20.76
1	2-1	0.65		0.65
2	2-1	0.56		0.56
3	2-1	1.44		1.44
4	2-1	2.28		2.28
5	2-1	0.89		0.89
6	2-1	1.35		1.35
1	3-0	1.22	8.40	9.62
2	3-0	0.90	4.87	5.77
3	3-0	0.86	2.09	2.95
4	3-0	0.56	9.80	10.36
5	3-0	1.36	4.68	6.04
6	3-0	1.04	3.58	4.62
1	3-1	5.24		5.24
2	3-1	3.02		3.02
3	3-1	4.84		4.84
4	3-1	3.64		3.64
5	3-1	2.88		2.88
6	3-1	6.12		6.12

Table G.3

Community N content data for 1991

Block	Treatment	Poplar g N/m^2	Weeds g N/m^2	Total g N/m^2
1	1-0	0.66	3.60	4.26
2	1-0	0.36	6.13	6.49
4	1-0	0.51	5.12	5.63
5	1-0	1.34	5.24	6.58
6	1-0	2.46	10.79	13.25
1	1-1	5.43		5.43
2	1-1	8.60		8.60
4	1-1	5.90		5.90
5	1-1	3.58		3.58
6	1-1	12.36		12.36
1	2-0	2.24	2.48	4.72
2	2-0	2.66	3.07	5.73
4	2-0	2.67	4.37	7.04
5	2-0	4.63	5.00	9.63
6	2-0	2.74	4.06	6.80
1	2-1	6.68		6.68
2	2-1	6.88		6.88
4	2-1	10.26		10.26
5	2-1	8.32		8.32
6	2-1	8.24		8.24
1	3-0	7.42	4.06	11.48
2	3-0	15.26	1.36	16.62
4	3-0	5.26	2.81	8.07
5	3-0	8.30	0.96	9.26
6	3-0	9.80	1.06	10.86
1	3-1	19.56		19.56
2	3-1	38.84		38.84
4	3-1	7.30		7.30
5	3-1	16.78		16.78
6	3-1	9.90		9.90

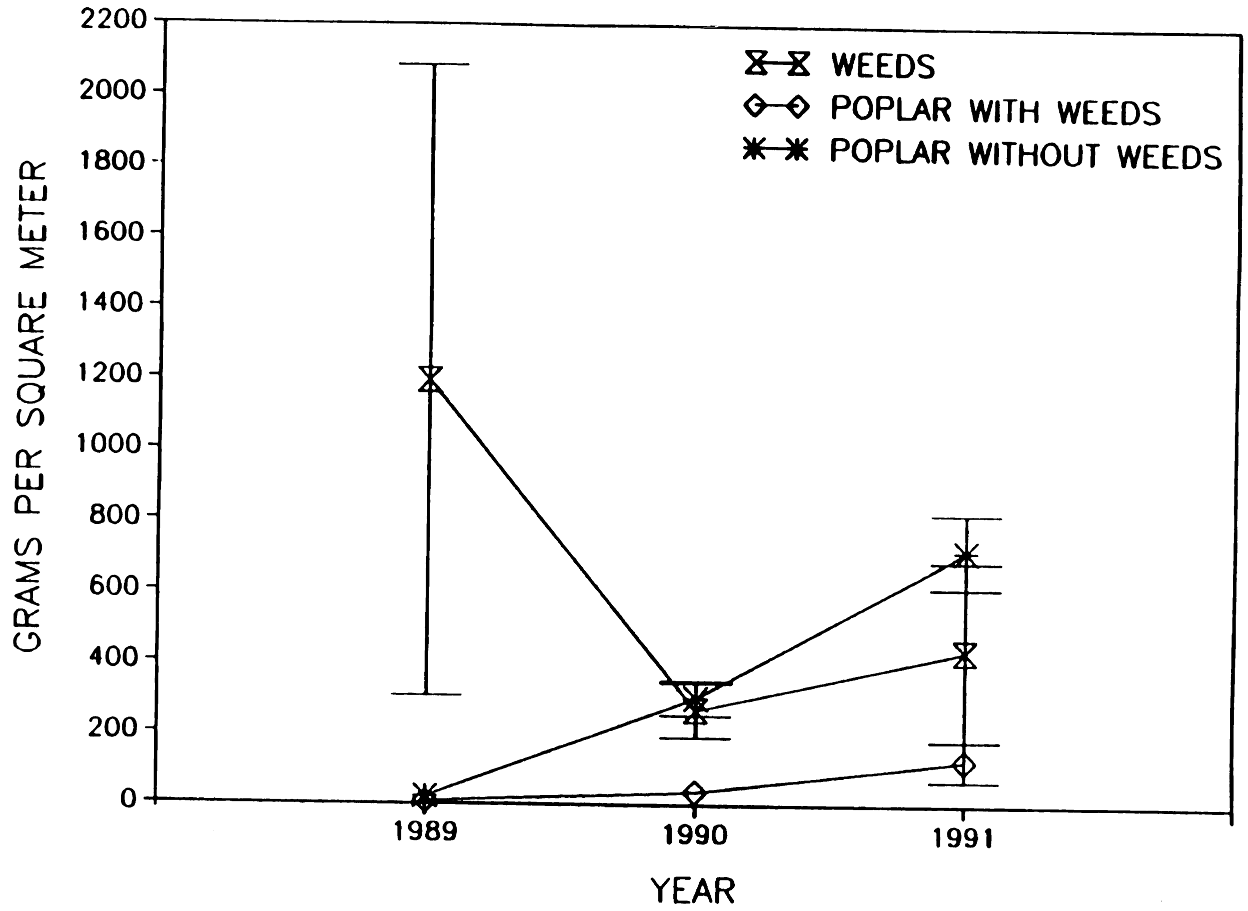

Figure G.1

Aboveground poplar and weed biomass in the low planting density from 1989 to 1991

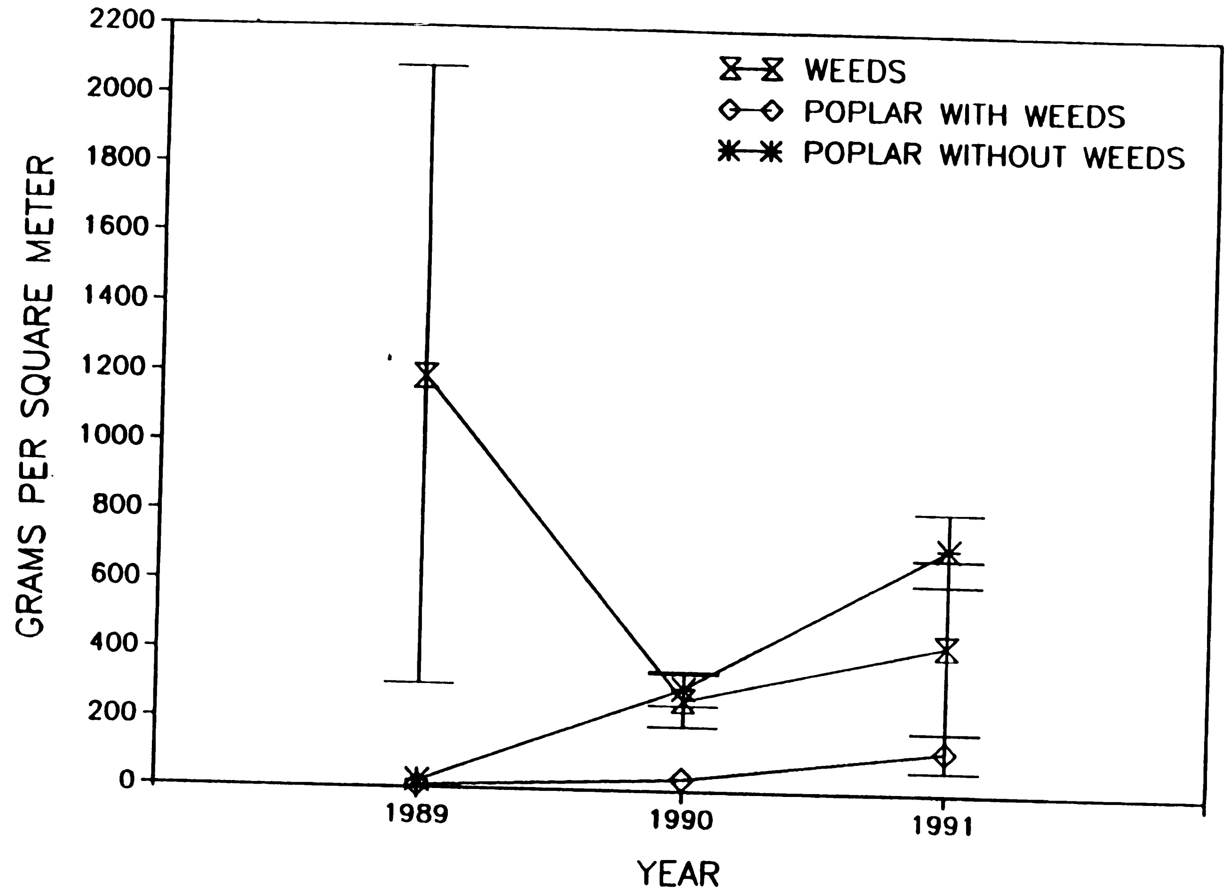

Figure G.2

Aboveground poplar and weed biomass in the medium planting density from 1989 to 1991

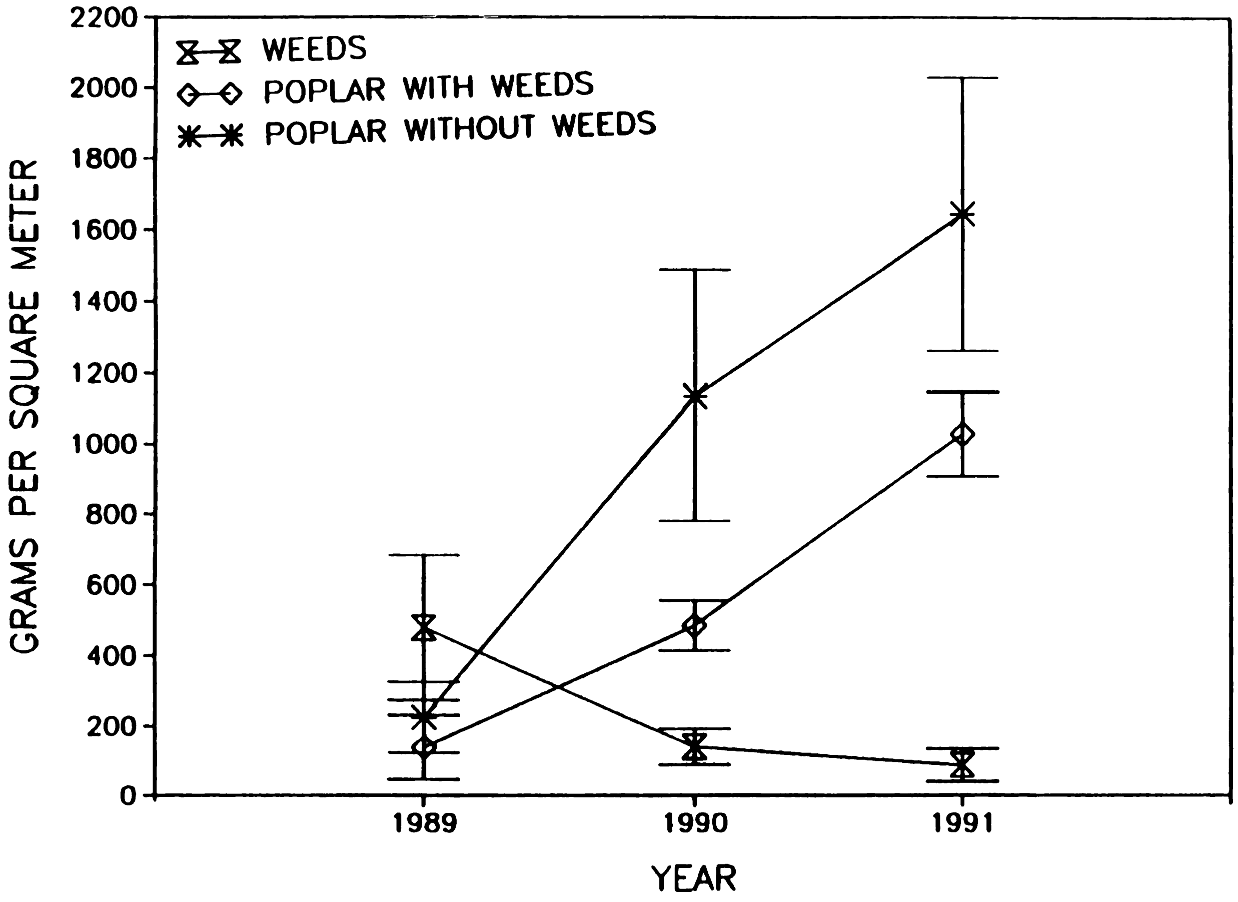

Figure G.3

Aboveground poplar and weed biomass in the high planting density from 1989 to 1991