FERTILIZATION AND ITS EFFECT ON THE ESTABLISH-
MENT OF DRIP IRRIGATED WINDBREAKS
IN WESTERN OKLAHOMA

By

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CHAPTER I

INTRODUCTION

Windbreaks and shelterbelts have played a very important role in Oklahoma history. Thousands of miles, consisting of more than 29 million trees, were planted in the "Dust Bowl" days of the 1930's and early 1940's to aid in the stabilization of the agricultural lands of western Oklahoma (31). But since this massive campaign of the Prairie states Forestry Project (1935-1942), interest in windbreak/shelterbelt plantings has declined to the point where the total amount of acreage removed annually exceeds that being planted (116, 120).

There are several probable reasons for this decline in interest throughout the Great Plains. The first is that we are several generations of landowners past the "Dust Bowl" days of the 1930's; as some of the ownerships have changed so have the attitudes toward windbreaks. Today, the traditional 10-15 row windbreaks are seen as a nuisance which not only take up vital crop acreage, but are also thought to be a habitat for crop-threatening insects and disease. Because of this change in attitude, most of the old windbreaks planted in the 1930's are in very poor condition due to a lack of management. Their usefulness is overshadowed by their appearance. Also, many farmers, most economists, and some technical agriculturists claim that soil management systems such as strip cropping, stubble mulching, minimum and no tillage eliminate the need for windbreaks and shelterbelts (113).

A second reason for the decline in windbreak/shelterbelt interest is the wide spread use of center-pivot irrigation systems for some crops. Use of these systems has brought about the removal of windbreaks that are in the way of the pivoting watering system.

Thirdly, because of recent world-wide grain shortages, landowners were encouraged to maximize production; thus, land occupied by windbreaks/shelterbelts (i.e., non-income generating) was cleared to allow crop production.

Finally, due to the energy crisis, the need for more efficient use of fuel has lead to the removal of tree rows to allow more manueverability by combines and other farm machinery.

Modern technology has shown that two or three row windbreaks are just as effective as ones consisting of 15-20 rows (32, 64). But there remains the basic problem of changing landowners attitudes on the usefulness of windbreaks, specifically field windbreaks. This is indeed a hard task to do, particularly when windbreak research has failed to keep pace with the improvements in agricultural research and practices. There is information available on the benefits of windbreaks and shelterbelts, however, the majority of this information is over twenty years old. Shelterbelts (also called field windbreaks) are important in crop production since they decrease wind velocities from 33 to 50 percent, to a distance of 15 times the height of the shelterbelt (33, 64, 5, 104). This wind speed reduction increases soil moisture and reduces stress from evapotranspiration. Shelterbelts can increase crop yields from 5 to 25 percent on protected fields depending on the crop and the shelterbelt composition (5, 7, 11, 32, 75, 76, 85, 105).

Windbreaks and shelterbelts are also important to livestock.

Livestock eat less feed, have higher weight gains and less calf and lamb mortality when sheltered from the winter by windbreaks or shelterbelts (3, 32, 35, 96, 104, 123, 127). Dairy cows produce more when protected from winter's effects (32, 127).

Windbreaks also provide a favorable environment for wildlife, providing shelter, nesting areas and food (32, 82, 85, 93, 106). More recently, research has focused on the benefits derived from farmstead windbreaks on energy consumption. A homestead with a typical windbreak composition of two rows of evergreens and one row of decidous trees planted on the north and northwest sides of the home can reduce winter home fuel consumption by 10 to 50 percent. In addition, the windbreak also controls snow drifting around the home and feedlots which allows easier accessibility to roads and livestock (73, 105, 130).

Until more current supporting evidence is given to field agents of the various governmental agencies, the widespread use of windbreaks and shelterbelts will remain minimal.

Historically, the mortality of newly planted windbreaks has been great. Many landowners, after trying year after year to establish a windbreak/shelterbelt, have finally given up after repeatedly experiencing seedling survival rates of less than 50 percent. But in 1978, the Soil Conservation Service (SCS), OSU Extension Service and the Oklahoma Forestry Division collectively (with other state and federal agencies) mounted a campaign to promote the planting of more windbreaks/shelterbelts in Oklahoma. Although this campaign was effective in re-educating the public on the importance of windbreaks, there was still the big problem of low seedling survival rates once they were planted.

The main obstacle to greater survival of seedlings in western

Oklahoma is the lack of soil moisture during the hot, dry summer months when peak evapo-transpiration demands occur. For hundreds of years, man has irrigated his crops and fields by means of a gravity fed watering system, but this has required a large amount of available surface water, such as rivers and streams. While this system is not applicable to western Oklahoma, the advent of sprinkler systems and center-pivot irrigation using subsurface water sources has become popular for crops and fields in this area (37, 113).

However, there are some problems involved with sprinkler systems. Not only are the costs per hectare limiting, there is a growing evidence that the underground aquifiers used for this irrigation are drying up (18, 131). Also, while these forms of irrigation are functional for agronomic crops, their usage on newly planted windbreaks is questionable. The linear forms and wide spacings of seedlings in windbreaks are not designed for use with these sprinkler systems. In addition, using these irrigation systems on windbreaks wastes water because they water not only the area around the trees, but also the area between the tree rows.

Therefore, another system of watering the windbreak trees was needed to assure survival, yet efficiently utilize the water available. Such a system, called drip irrigation, has been developed. Drip irrigation is a relatively new concept of irrigation for windbreaks, although its use for crops and orchards has been an effective and efficient means of providing water. Most of the preliminary work with drip irrigation dealt with turning arid lands into productive farmland. Israel was the leader in the development of drip systems in the 1960's. Since that time, the concept has spread world-wide, and in California it is a mainstay in the production of many crops.

It wasn't until 1976 that the idea of drip irrigating windbreaks formed in Oklahoma; the first drip systems for this purpose were established in 1978 (103). Since then, the word has spread with the help of the SCS, Oklahoma Forestry Division, and Agricultural Stabilization and Conservation Service cost-sharing. SCS records indicate an increase in survival rates with drip systems of two to three fold. The typical survival rate of a windbreak planting in western Oklahoma without irrigation is 30 to 50 percent. With the drip system, survival rates are normally above 90 percent, and have been recorded as high as 100 percent. Similar data has been collected for much of the Great Plains area as well (26, 94, 103, 111).

The objective of this study was to quantify the effects of various types of fertilizers on the survival and growth of drip irrigated windbreaks and shelterbelts in western Oklahoma. It was hypothesized that the effect of supplemental fertilization would (1) decrease the overall amount of water and time needed for tree establishment under a drip system and (2) shorten the interval between initial establishment and the formation of an actively functioning windbreak.

Even though it is expected to take at least two to three years to study the total effectiveness of the fertilization program, this thesis will deal with the first year growth response by fertilized trees in newly planted, drip irrigated windbreaks and shelterbelts in western Oklahoma.

CHAPTER II

LITERATURE REVIEW

Drip Irrigation

Considerable research has been conducted on crop and orchard production using drip (or trickle) irrigation to determine its effects on water requirements and on plant development and growth, but there has been little, if any, research in this area related to windbreaks and none has been done in Oklahoma. The following is a summary of drip irrigation studies.

History

Drip irrigation is the application of a controlled amount of water at a slow rate to a point adjacent to the plant being irrigated (17, 92). It has only recently been used in windbreak establishment, but was developed in Israel in the 1930's (84). Only with the development of suitable rubber tubing and plastics in the 1960's did drip system technology flourish (84, 95). The first systems were originally perforated plastic lines which were installed entirely underground, but due to frequent clogging, the lines were placed above ground and an adapter (emitter) was designed to control the rate of water discharge pressure (37, 50, 95).

In the United States, drip irrigation techniques were first used in greenhouses to aid in nursery production in the 1960's. It was first used in orchards and row crops in California in 1968. Within five years 16,200 hectares were drip irrigated and by 1978 over 162,000 hectares were under drip irrigation (41, 95). Even though drip irrigation was a standard agricultural practice in regions with either low rainfall amounts or a limited supply of useable water, drip irrigation was not used in windbreak establishment until the late 1970's. In Oklahoma drip irrigation was first used for this purpose in 1978. However, there has been no scientific information on its performance to this date (26, 80, 103).

Design

Different theoretical design models have been developed to discover the proper combination of emitter spacing, discharge rate and irrigation frequency for various climates, crop and soil conditions (21, 23). These models are a good basis for developing a proper design but differences between theory and actual field data must be considered when designing a functional drip system (60, 84).

The components of a typical drip irrigation system are (1) a main pipeline, usually polyethylene and/or polyvinyl chloride (PVC) plastic with a diameter of 15 to 30 centimeters. It is usually installed underground and extends from a water source to the area irrigated, (2) a control center (head) with control valve or hydrant pressure regulators and gauges, and filters, (3) manifold and lateral lines (usually flexible PVC pipe with a diameter of 12 to 16 millimeters) placed above ground which allow 5.6 to 7 kilograms per square centimeter of water pressure, and (4) emitters which can be classified as either low pressure (applying 2 to 6 liters per hour at 0.14 to 0.35 kilograms per square centimeter) or high pressure emitters (4 or more liters per hour at 1.0

kilograms per square centimeter) (30, 36, 37, 45, 50, 51, 55, 72, 92, 95, 110, 117, 125).

Advantages

The principle advantage of a drip system over a conventional sprinkler or furrow irrigation system is the more efficient use of water. Applying the water directly to the plant area eliminates the watering of areas between the plants. In drip irrigated apple orchards only 35 to 65 percent of the total area of the orchard was wetted during the summer (17). Comparisons of drip to furrow and sprinkler irrigation on green pepper production indicated that, given a necessary rate of water to sustain a desired yield, the drip systems saved about one-third the water to sustain a desired yield, the drip systems saved about one-third the water required as compared to the furrow or sprinkler irrigation under experimental conditions. Under field conditions, for an annual crop such as peppers, the water savings under a drip system could be up to 50 percent due to the greater evaporative rates and the effects of wind on sprinklers and to the inequalities of application and infiltration of furrow irrigation (11). Similar results were reported on gourds and watermelons. The water use efficiency with drip irrigation was doubled compared to overhead sprinkling of furrow irrigation (99).

Much work has been done on equations to determine the proper amount of water required by various species of plants under a drip system (4, 24, 34, 37, 46, 65). However, no research has been published concerning the most efficient use of water by windbreak species. The SCS recommends a watering rate for windbreaks in western Oklahoma of 20 liters per week for the first growing season and 40 liters per week for each subsequent season. It is recommended that the system be run long enough to wet an area around the plant 45 centimeters in diameter (118). However, in Kansas watering rates of only 4 liters per week for the first year and 8 liters per week for each subsequent year are recommended (110). A survey in Nebraska showed that in actuality landowners were watering an average of 16 to 56 liters per week (111).

Another advantage of drip irrigation is the plant's ability to better utilize the available soil moisture. Until 1971 little information was available on the mechanisms involved in plant development, specifically root distribution, as influenced by drip watering (38). In arid areas as well as areas having heavy rainfall amounts, a reasonable design objective is to wet minimum of 33 percent and 20 percent, respectively, of the potential root volume of a widely spaced plant (37, 52). In general, the wetting profile is in the shape of an onion but with drip irrigation the profile can vary depending on the discharge rate of the water and the soil properties. On any given soil, the higher the discharge rate, the narrower the wetting front; with a given discharge rate, the finer the soil, the wider the wetting front (37, 58, 60, 89, 107).

The majority of the active root system of a plant is concentrated in the area wetted by the drip system (37, 38, 39, 59, 89, 96). Moreover, once the plant matures, the total root area may be concentrated only in the wetted area, but these roots are more efficient in water and nutrient uptake (9, 19, 20, 129).

The third major advantage of drip irrigation is that higher rates of saline water can be utilized (37). Salts accumulate at the periphery of the wetting front and are continuously leached out of the root zone by additional irrigation. Care must be taken when using saline water to apply more water than needed by the plant to insure leaching does occur (37, 47, 98, 114, 126).

The fourth advantage of drip irrigation is the significant reduction in energy cost. Drip system pumping pressures range from 0.35 to 1 kilogram per square centimeter, compared to conventional irrigation (sprinkler) pressures of 3 to 8 kilograms per square centimeter (37, 92, 95). The lower pressure means less power is needed to drive the system. Although this point may seem minute to landowners with only a few hectares of windbreak trees, it is a considerable savings to those landowners with thousands of hectares in crop and orchard production.

Another advantage is the increased survival rates in the establishment of trees. This is particularly true on disturbed sites such as steep slopes and on mining spoils (1, 2, 14). An increase in survival rates has also been reported in windbreak plantings. In Colorado, an increase from 55 to 95 percent was reported and in Nebraska there was an increase from 40 to 50 percent to 90 to 100 percent with the drip system (94, 111). These findings are similar to those observed for Oklahoma (26, 103).

The final advantage of drip irrigation is the increase in yields and growth rates for plants under drip irrigation. In crop production, drip irrigation maintained or increased yield while utilizing substantially lower amounts of water than the conventional irrigation systems (24, 37, 43, 44, 97, 128). Tomato yields doubled using a slightly lower than average amount of water with a drip system (88). Trunk diameter increases on various ornamental tree species nearly doubled that of non-drip irrigated trees (81). In orchards, the trend of higher yields continued.

There was concern that with daily watering an increase in fertilization would be necessary to maintain nutrient levels in the trees (25, 28, 57, 68, 81, 101). This indicates a need for studying the interaction between drip irrigation and fertilization.

Fertilization

Fertilization with drip systems can be done two ways. The first method is by applying the fertilizer through the drip system itself. This is accomplished by using mineral fertilizers dissolved in a holding tank which is attached to the head of the drip system (Appendix A, Figure 1) (37, 42, 53). The most common forms of soluble nutrients used in drip systems are potassium nitrate, ammonium nitrate, potassium chloride, and orthophosphoric acid (8, 10, 37, 40, 48, 49, 53, 77). The second method is broadcast or band applied fertilizers (28, 54, 63, 69, 70, 77, 78).

Optimum application of fertilizer and the conclusions are varied. In crop or orchard production, where daily irrigation is a prerequisite, fertilizer application through the system is more efficient than broadcast or band applications. This is particularly true with nitrogen, a mobile nutrient. With phosphorus, a rather immobile nutrient, fertilization through the system may cause accumulation of phosphorus solely around the emitters (8, 10, 49, 53, 54, 63, 77, 78, 102, 109).

Fertilizing through a drip system may cause emitter clogging. The pH rises and precipitation of soluble calcium and magnesium with amonia injection may clog lines or emitters (53). Also, if the water contains appreciable amounts of calcium phosphate, fertilizers react with the calcium to form precipitate which can also clog emitters (37, 40, 53, 87). In addition microbial activity may occur with fertilization which can also block emitters (79).

Fertilization through a drip system requires more equipment and maintenance to keep the system functional. With mass crop and fruit production fertilization through the drip system may be justifiable, but to a landowner establishing a drip irrigated windbreak, a broadcast application around the trees once or twice a year may be more time and cost efficient.

Fertilizers can be either broadcast or placed in the area affected by a drip system. They can be grouped into two major descriptive categories: (1) readily soluble fertilizers and (2) slow release fertilizers. Readily soluble fertilizers such as those used through the drip system dissolve when they come in contact with water, allowing the nutrients to become immediately available to the plant. With continuous amounts of water being applied, the nutrients (nitrogen specifically) may be leached out beyond the root zone becoming unavailable to the plant (13, 112, 124).

Slow release fertilizers release nutrients slowly and continuously over a length of time. This is accomplished by coating the fertilizer with either a wax or a molten sulfur, or by compressing the fertilizer into pellet or tablet form (27, 66, 67, 74, 91, 115).

Comparisons between the readily soluble and slow release fertilizers on crops, showed a greater initial uptake of nitrogen with the readily soluble fertilizers. With the slow release fertilizers there was a greater amoung of nitrogen available in the root zone which, over several years of application, produced greater yields (61, 66, 90). Studies with tree seedlings on acid forest soils showed high levels of readily soluble fertilizers with high rates of soluble salts, such as amonium nitrate and urea, sharply reduced growth. However, sulfur coated urea, a slow release fertilizer, increased dry weight matter after nine months (15). The growth response of the seedlings is also partially dependent on the soil. A comparison of slow release and readily soluble fertilizers on mining sites showed an increased growth response to the slow release fertilizer which appeared in either the first or second growing seasons, depending on the species, and lasted through the fourth growing season. With the readily soluble fertilizer, increased growth response did not appear until the third growing season and was short-lived; some species had no response (29). A sulfur coated urea study on Monterey pine (*Pinus radiata* D. Don) showed the slow release fertilizer was more effective on strongly weathered clay soils than urea (a readily soluble fertilizer) for increasing height growth of the trees after three years. On more fertile pumice soil no response to either of the fertilizers was found (67).

Little literature has been found on the fertilization of windbreaks. In 1962 Bagley (6) studied the affects of fertilization on newly planted seedlings and found no significant differences in survival or initial growth. He stated that soil moisture may be a more important factor than fertilization. Van Haverbeke (122) conducted a similar study and concluded there was no significant growth or survival response to the fertilizer. Past fertilizer practices and continued fertilizer applications to the crops around the windbreak trees may have been a factor in the study.

No research has been reported on the effect of fertilization on drip irrigated windbreaks. This study has been designed to obtain this information.

CHAPTER III

PROCEDURES

In order to locate prospective windbreak planting sites, letters and questionnaires were mailed to Oklahoma district office of the Soil Conservation Service (SCS) and the Oklahoma Forestry Division (OFD), the primary agencies involved with windbreak plantings in Oklahoma. The criteria for selection of sites included geographic location, soil type, species composition, size of planting, planting dates, past history of weed control, and presence or absence of a drip system. Sites located through responses from these agencies and other sites found by personal contacts were grouped by species composition and age to facilitate the selection. Four privately owned sites were chosen. All four of the sites were in northwest Oklahoma. Sites 1, 2 and 3 are in Woodward County and Site 4 is in Alfalfa County (Appendix A, Figure 2). All of the windbreak plantings had one row of Russian-olive (Elaeagnus angustifolia L.) and one row of Austrian pine (Pinus nigra Arnold); Sites 1, 3 and 4 had a row of juniper (Juniperus virginiana L.) while Site 2 had oriental arborvitae (Thuja orientalis L.) instead of the juniper.

There are some age variations between the sites at the time of the fertilizer application. Plants at Site 3 had finished the second "on site" growing season, while the rest of the trees had finished one growing season. In addition, a fire on Site 2 destroyed all treated species; the site was replanted in April, 1982.

Soil samples were taken on all sites before the application of fertilizer. Ten to fifteen cores were bored randomly on each site, and samples were extracted at the surface and at the depths of 30 centimeters and 60 centimeters. Samples from each depth were mixed and a composite sample of each depth was submitted to the Oklahoma State Soil Testing Laboratory for analysis of soil pH, NO_3-nitrogen, phosphorus, potassium, calcium, magnesium, iron, zinc, manganese, and boron. Soil surveys indicated soil types ranging from a loamy sand to a find silt loam (Appendix B, Table I).

The surface application method of fertilization was chosen for this study. While it is more labor intensive than fertigation (application of nutrients via the drip system) it is a simpler means of providing a more complete complement of nutrients. It also requires less expenditures for the maintenance of the drip system.

Three types of fertilizers which are available to landowners were chosen for use in this study. Two of the three types were slow-release formula fertilizers that, under normal rainfall conditions, dissolve slowly, allowing the nutrients to become available to the tree over a period of several months. One is a tablet, tradename Agriform, which has the N-P-K formulation of (20-10-5) and the other is a sulfur-coated urea with a formulation of (24-4-10). The third type of fertilizer tested was a mixture of ammonium nitrate (34-0-0) and the common garden type fertilizer (10-20-10), yielding a blended N-P-K formulation of (24-8-4). This is a readily soluble mixture that becomes available immediately to the tree. Table II (Appendix B) provides an analysis of these fertilizers.

Soil testing revealed nitrogen was the most limiting macronutrient in the soil at all the sites (Appendix B, Table I). Nitrogen, being mobile in the soil, is easily leached out of the root zone when there is an abundant amount of moisture, as is the case with an operating drip system. This is the principle reason why a comparison between the slow-release and the readily-soluble fertilizers was made.

Using these three different types of fertilizers with varying compositions of the major nutrients (nitrogen, phosphorus, and potassium) created a problem of balancing each treatment with the other. Nitrogen levels of each fertilizer type were balanced in order that each tree would receive an equal amount of that nutrient as specified by the experimental design.

Another comparison made in this study was between the various rates of fertilizers applied to the trees. The test plots were designed to have a low, medium and high rate of fertilizer equivalent to 8.4, 16.8, and 33.6 grams of actual nitrogen, respectively. Where there was not a sufficient number of trees at some sites to test all three rates the medium rate was eliminated and testing was done for only the low and high rates. In all plots there was a control tree which received no fertilizer.

Due to the linear arrangement of the windbreaks a split-plot design was used. Each ten tree replication was divided into three rates of fertilizer, which were then subdivided into the three types of fertilizer and the control. The location of each fertilizer rate and type, including the control, was randomly selected. Figures 3 and 4 (Appendix A) are schematic views of the treatments using (1) low, medium and high and (2) low and high. Each tree was numbered and tagged (Appendix A, Figure 5).

The treatments were applied in the fall of 1981 when the drip systems were not being used. This allowed the fertilizer to breakdown naturally under normal rain/snow fall conditions, and be available for root growth in the fall and for the initiation of shoot growth in the early spring.

Site 2, destroyed by fire originally, had only two species under treatment, Russian-olive and arborvitae. The Russian-olive resprouted, but the collected data was lost due to die-back. The landowner had another windbreak with the same species composition approximately a quarter of a mile from the original site, so the Russian-olive from this additional site was treated in the spring of 1982. The arborvitae were replanted in the same holes as the burned trees and no further fertilizer treatments were done. On this same site the landowner planted a row of Austrian pine in early April just east of the arborvitae row to replace a row which had died in 1981. Treatments were carried out on this row several weeks after planting. The newly planted bare root arborvitae were not treated with fertilizer in order to minimize the chance of fertilizer burn. Since the Austrian pine was planted as containerized stock and the drip system was operational at the time of planting, these trees were fertilized.

To determine fertilizer effectiveness, measurements of tree height in centimeters and stem diameters at root crown in millimeters were taken. Readings were originally taken in November, 1981, while trees were dormant, but due to inconsistencies in collection of data, measurements were retaken early in 1982, again while the trees were still dormant. A plastic marker was placed in the ground next to the tree to facilitate a consistent measurement location of 10 centimeters above the root crown. This was necessary because soil filled in around the trees and changed the depth at which the stem was exposed. The stem diameter was measured to the nearest tenth of a millimeter using a stainless steel millimeter caliper. Tree height was measured on the south side of the tree from the top of the plastic marker (10 centimeters above the root crown) to the dominant terminal bud using a meterstick and was recorded to the nearest five-tenths of a centimeter. Stem diameter measurements were taken in a consistent manner with the caliper facing the tree row. In November, 1982, after the first growing season following application of fertilizers, height and diameter measurements were taken using the methods previously described.

In order to relate the height and diameter measurements of the trees to the applied treatments, foliar samples of randomly selected plots were taken and analyzed using all species and fertilizer types on all sites. Only trees receiving the high and low rates in each plot were sampled. Nitrogen levels were analyzed using the modified macro-Kjeldhal method (22). Statistical analyses were computed to determine the analysis of variance between the fertilizer types and rates for each species on each site. The data used was the percent difference between the initial measurement and the measurement after one growing season for the height in centimeters and the root crown diameter in millimeters. The nitrogen concentration from the foliar analysis was statistically analyzed to determine differences, if any, between the fertilizer treatments for each species at each site. Results of the analysis producing an observed significance level (OSL) of $p \leq 0.05$ were considered statistically significant.

Although water was no longer a limiting factor for the trees due to the use of drip systems, the problem of working with four different landowners had to be addressed. Three of the four landowners had similar systems using the same type of emitters, the fourth owner used a system that emitted twice the amount of water in a given time (Appendix B, Table III). To monitor the amounts of water used by each landowner, notebooks were given to the landowners to record the length of each watering period. Rainfall totals were also recorded so that total levels of added moisture would be quantified for each site (Appendix B, Table IV).

In anticipation of problems with insect defoliation on Site 2, a spraying schedule of Sevimol-4 at 1.5 liters to 400 liters of water during the months of July and August was designed for the landowner to minimize damage. A weed control plan was also discussed with the landowners.

CHAPTER IV

RESULTS

Site 1

General Description

This site is a homestead windbreak planting in Woodward, Oklahoma (Appendix A, Figure 2) with one short row of Russian-olive (Elaeagnus angustifolia L.) as the southern row, with a row of juniper (Juniperus virginiana L.) and Austrian pine (Pinus nigra Arnold) to the north, respectively. The windbreak rows surround the house on the east, south and southwest sides of the property. The trees were planted in the spring of 1981; the Russian-olive were planted as bare root stock from the Oklahoma state tree nursery while the juniper and pine were planted as containerized stock from the Colorado state nursery.

The trees were planted in sprigged bermuda grass which was regularly mowed. The grass competed with the trees for the moisture from the drip system, but in mid-summer, 1982, glyphosate (Roundup) was applied to the area around each tree, using wick applicators. There were no follow up treatments but grass was pulled from around each tree in November, 1982, when measurements were taken. The landowners also had the property commercially sprayed with glyphosate for weed control.

There was no major insect damage, although red spiders were numerous on the juniper during the summer of 1982.

Watering rates and rainfall totals are given in Tables III and IV (Appendix B).

Russian-olive

Survival. Two out of 30 Russian-olive died the first year after treatment (93.33% survival). One of the two dead trees was treated with a low rate of SCU (sulfur coated urea) while the other was a control (Appendix B, Table V).

Height Growth. The percent change in height from the initial measurement to each additional measurement was calculated. The additional measurement was taken in November, 1982, one growing season after fertilization. The mean percent increase in growth for each fertilizer rate and type is shown in Appendix A, Figure 6 and in Appendix B, Table VIII. The results show that out of the three high and low treatments only the high rate of SCU and the low rate of the RSM (readily soluble mixture) had a percent increase in height growth greater than or equal to the control.

Statistical analysis indicates no significant interaction of fertilizer rates and types, although there appears to be differences between plot locations (Appendix B, Table IX).

Root Crown Diameter Growth. The percent change in diameter was calculated from the initial measurement to the additional measurement, as with height. The results of the means (Appendix A, Figure 7 and Appendix B, Table VIII) show that only the high rate of SCU and both rates of the RSM had a percent increase in diameter greater than or equal to the control.

There were no statistical differences in the mean increase in diameter although there was indication of differences in plot location.

Foliar Nitrogen Content. Leaf samples of the low and high rates of each fertilizer type were taken in September, 1982, to determine if the percent nitrogen in the foilage showed a significant difference in treatments due to nutrient uptake by the plant. A significant interaction of fertilizer rate and type was found. The low rate RSM and high rate AGT (Agriform tablet) were significantly higher than the low rate SCU; in comparison to the control, they were significant at the 0.10 level (Appendix B, Tables VI and VII).

Juniper

Survival. Eight juniper out of 60 died during the first year after fertilizer treatment (86.67% survival). Of the eight trees, two were treated with low rate SCU, one with medium rate AGT, one with high rate AGT, one with high rate SCU and three with high rate RSM (Appendix A, Table V).

Height Growth. The mean percent increases in height for all of the fertilizer treatments were above the control (Appendix B, Table VIII and Appendix A, Figure 8).

Statistical analysis indicated significant differences between the medium rate SCU and the high rate RSM to the control at the OSL $\leq$ 0.05 level, while the high rate AGT and high rate SCU were significantly different than the control at the OSL $\leq$ 0.10 level (Appendix B, Table IX). There also appeared to be differences in plot location (Appendix B, Table IX).

Root Crown Diameter. The mean percent increase in diameter for all the fertilizer treatments were also above the control (Appendix A, Figure 9 and Appendix B, Table VII).

However, statistical analysis indicated only the high rate of SCU to be significantly different from the control at the OSL $\leq$ 0.05 level (Appendix B, Table IX).

Foliar Nitrogen Content. The foliar analysis showed only the low rate SCU had a higher percent of nitrogen than the control. This level was almost equivalent to the control, while two other treatments (low rate AGT and low rate RSM) were significantly lower than the control (Appendix B, Tables VI and VII).

Austrian Pine

Survival. Twenty-four out of 65 Austrian pine were dead after one year of the fertilizer treatment (63.08% survival). Mortality was highest with the RSM fertilizer (16 of the 24). A breakdown of mortality by fertilizer rate and type shows five low rate RSM, one medium rate AGT, five medium rate RSM, two high rate AGT, four high rate SCU, all six of the high rate RSM, and one control (Appendix B, Table V).

Height Growth. The results indicated differences in mean increases in growth, with the medium rates of both AGT and SCU below the control. The low and medium rates of the RSM were also below the control but only one tree per rate was still alive. Besides the high rate RSM, which were all dead, only the high rate SCU was significantly different than the control (Appendix A, Figure 10 and Appendix B, Tables VII and IX).

An additional measurement was taken in May, 1983, after bud break and candle elongation, to estimate the response in the second year after fertilization. There was a larger increment of growth for all of the fertilizer treatments compared to the control, which increased in growth 65 percent. The low rates of AGT, SCU and RSM (one tree only) increased 140 percent, 97 percent and 72 percent, respectively. The medium rates of AGT, SCU and RSM (one tree only) increased 81 percent, 86 percent and 105 percent, respectively. The high rate AGT increased 88 percent and the high rate SCU increased 81 percent. The high rate RSM were all dead (Appendix A, Figure 10).

However, the statistical analysis of the mean increase in growth from the initial measurement to the additional measurement indicated no significant differences between the fertilizer treatments and the control (Appendix B, Tables VIII and IX).

Root Crown Diameter. All of the fertilizer treatments except the high rates of each type of fertilizer were above that of the control (Appendix B, Table VII and Appendix A, Figure 11). Except for the high rate RSM, where all trees were dead, there was no significant differences between fertilizer treatments and the control (Appendix B, Tables VII and IX).

An additional measurement estimating second year response was taken in May, 1983. The control treatment appeared to have a greater than or equal to percent increase except for the medium rate SCU (Appendix A, Figure 11 and Appendix B, Table VIII). Statistical analysis indicated no significant differences in any of the treatment.

Foliar Nitrogen Content. Foliar analysis indicated differences between the fertilizer treatments and the control. In all of the fertilizer treatments (except for high rate RSM where all trees were dead) the percent nitrogen was above the 1.00 percent level; the control had a mean percent nitrogen content level of 0.69 percent (Appendix B, Table VI). Statistical analysis revealed no significant differences at the OSL $\leq$ 0.05 level; the low rate of AGT and SCU were significant at the OSL $\leq$ 0.10 level (Appendix B, Table VII).

Site 2

General Description

This site was on the east and south sides of a love grass pasture approximately six miles south of Woodward, Oklahoma (Appendix A, Figure 2). The tree rows consisted of one row of ponderosa pine (*Pinus ponderosa* Law) to the south, one row of oriental arborvitae (*Thuja orientalis* L.) and one row of Russian-olive (*Elaeagnus angustifolia* L.) to the north, respectively. All of the planting stock was planted as bare root material from the Oklahoma state tree nursery and were planted in the spring of 1981. All the pine had died before fertilizer treatment in November, 1981, so only the arborvitae and Russian-olive were treated. In February, 1982, while the landowner was burning off his pasture, a shift in wind direction caused the fire to spread to the windbreak. All of the trees except for a few arborvitae were damaged or destroyed and adjustments to the fertilizer study had to be made. In April, 1982, the site was replanted replacing all of the dead arborvitae and all of the Russian-olive that had not resprouted. All of the pine were replaced with containerized Colorado stock Austrian pine (P. *nigra* Arnold). The replanting and treating of the Austrian pine not only allowed us to test fertilizer effects on newly planted seedlings, it also was a means to compare spring fertilizer application to fall fertilization as well as its effect on growth.

The nine replications of arborvitae were not retreated because the new trees were planted in the same holes as the old trees. One replication was added to the study and the trees were treated a week after planting. The treated Russian-olive were a total loss to the study, but the landowner had anothe windbreak with Russian-olive approximately a quarter of a mile from the original site. This site, designated as Site 5, was the same age as Site 2, although some Russian-olive were planted to replace dead ones. This site was treated with fertilizer in the spring of 1982, approximately a week after the replanting of Site 2.

Grasshoppers were a problem, particularly to the arborvitae. Although a spraying schedul was designed for the windbreak, the landowner sprayed only once during the summer of 1982. Considerable damage was also inflicted by gophers, rabbits, and field mice on the east side of the windbreak even though preventative measures (applying gopher poison around each tree) were taken.

Site 5, the additional Russian-olive site, was planted in a bermuda grass pasture. Although weeds were controlled by either hoeing around each tree or by applying glyphosphate, the Russian-olive on Site 5 were overtaken by the bermuda grass.

The love grass was kept mowed in strips around the trees on Site 2. Watering rates and rainfall totals are given in Tables III and IV (Appendix B).

Austrian Pine

Survival. Seven out of 100 Austrian pine treated died their first growing season after being outplanted (93.00% survival). At least one was lost to rabbits or gophers. Table V (Appendix B) shows the mortality by fertilizer rates and types.

Height Growth. Statistical analysis indicated no significant differences between fertilizer treatments and the control (Appendix B, Table IX); however, for the first growing season after the fertilizer was applied, only the medium and high rate of SCU were below the increased growth of the control (Appendix A, Figure 12 and Appendix B, Table VIII).

An additional measurement was taken in May, 1983, in order to estimate the height growth response of a second growing season. There were no significant differences due to fertilizer treatments (Appendix A, Figure 12 and Appendix B, Tables VIII and IX).

Root Crown Diameter. The mean percent increase in root crown diameter was dramatic for all treatments. The lowest percent increase was 120 percent for the high rate RSM. The control increased by 134 percent while all other treatments were greater than the control (Appendix A, Figure 13 and Appendix B, Table VIII).

Statistical analysis indicated no significant differences (Appendix B, Table IX). An additional measurement was taken, as with height, to estimate the response of second year growing season. The increases in diameter were minor compared to those of the first year. The range of percent increases from the first year to the second year estimate was

9 to 31 percent with the control having a 28 percent increase (Appendix A, Figure 13 and Appendix B, Table VIII). No significant differences in treatments were found.

Foliar Nitrogen Content. Foliar analysis for nitrogen indicated a significant difference in percent nitrogen between the low rate SCU and the control only (Appendix B, Tables VI and VIII).

Arborvitae

Survival. Seventeen out of 97 arborvitae treated died in the first growing season after being outplanted (82.47% survival). Four of the 17 were from the new replication which had been fertilized a week after planting (Appendix B, Table V).

Height Growth. The mean percent increase in height was minimal. The control increased in height only 5 percent from its original height, while the trees planted in treated holes increased in height from 17 percent (medium rate AGT and high rate RSM) to 48 percent (high rate AGT). There was no statistical difference although there was some indication of interaction within the treatment heights (Appendix A, Figure 14 and Appendix B, Tables VIII and IX).

Root Crown Diameter. The percent increase in root crown diameter was much greater than that of height. The control increased in diameter by 51 percent, whereas all of the other treatment percent increases except the high rate RSM (49% increase) were above the control (Appendix A, Figure 15 and Appendix B, Table VIII). Statistical analysis indicated no significant differences between fertilizer treatments and the control (Appendix B, Table IX).

Foliar Nitrogen Content. Foliar analysis indicated virtually no differences between the fertilizer treatments and the control. There was only 0.165 percent difference between all treatments with the control having the highest percent nitrogen (2.0498%) with the exception of the high rate AGT, which had 2.0702 percent nitrogen level (Appendix B, Table VI). Statistical analysis indicated a significant difference between plot locations but no difference between the fertilizer treatments (Appendix B, Table VII).

Russian-olive (Site 5)

Survival. Thirty-two out of 80 Russian-olive died after the first growing season, eight months after fertilizer treatment (60.00% survival) (Appendix B, Table V). There were 16 newly planted seedlings in the study plots replacing the trees that had died before the study began. Fifteen out of those 16 died. There appeared to be no trends to relate mortality with fertilizer type. The main reason for low survival on this site was the lack of maintenance. When fertilizer was applied in mid-April of 1982, an area was cleared around each tree. In July, 1982, the bermuda grass was encroaching this cleared area. At that time glyophosate was wick applied around each tree to deter the bermuda grass. When leaf samples were taken in September, 1982, the trees were in very poor condition even though the drip system was operational. By the time additional measurements were taken in November, 1982, it was apparent that the bermuda grass had overrun the windbreak. Rabbits were also a problem to the Russian-olive.

Height Growth. The mean percent height growth was small. The percent increase of the control (31%) was higher than most of the fertilizer treatments. Only the low rate SCU (43% increase) and the medium rate AGT (34%) were larger than the control (Appendix A, Figure 16 and Appendix B, Table VIII). The statistical analysis indicated no significant differences between treatments and the control (Appendix B, Table IX).

Root Crown Diameter. The results found the percent increases in the control was 40 percent while the medium rate SCU had a percent increase of 119 percent and the high rate RSM had an 88 percent increase in diameter. All of the other treatments were similar to the control (Appendix A, Figure 17 and Appendix B, Table VIII).

There were no significant statistical differences between the fertilizer treatments and the control (Appendix B, Table IX).

Foliar Nitrogen Content. Foliar nitrogen content was not analyzed because of insufficient plant tissue remaining on the trees.

Site 3

General Description

This site was a farmstead windbreak planted to the north and curving to the west of the home, separating the living area from a wheat field. This was the only site to have the windbreak to the north of the area to be protected. The tree rows consisted of a row of juniper (*Juniperus virginiana* L.) to the north, with Austrian pine (*Pinus nigra* Arnold), black locust (*Robinia pseudoacacia* L.) and Russian-olive (*Elaeagnus angustifolia* L.) to the south, respectively. The trees were planted in the spring of 1980. The Russian-olive and black locust were planted as bare root stock from the Oklahoma state tree nursery, while the juniper and pine were planted as containerized stock from Colorado. During the summer of 1982 the drip system was operational on the juniper and pine only, except when severe drought conditions existed and water was given to the Russian-olive and black locust. Watering rates and rainfall totals are given in Tables III and IV (Appendix B).

There are two major problems on Site 3. The first was the stunted growth of the pine caused by the continual clipping of the terminal buds by the landowner's two pet sheep. This problem was remedied in the summer of 1982. The second problem was weed control. The landowner disked between the rows, which was very effective, but the area around the trees was highly overgrown with weeds. The use of a pre-emergent herbicide was discussed but was not followed through and the pines were overshadowed by weeds.

Russian-olive

Survival. There was no mortality in the 71 Russian-olive planted on this site (100% survival) (Appendix B, Table V).

Height Growth. All of the trees had finished their second on-site growth season when fertilizer treatments were administered. The height growth for the two growing seasons before fertilization was good. The shortest tree was 52 centimeters in height and the tallest tree was 2.16 meters.

The mean increase in height growth for the third growing season, one year after fertilization, showed the control increased growth 54 percent; all the fertilizer treatments except the low rate AGT (49%) were greater than 54 percent (Appendix A, Figure 18 and Appendix B, Table

VIII). No significant differences were found between fertilizer treatments and the controls at the OSL $\leq$ 0.05 level; however, at the OSL $\leq$ 0.10 level there were significant differences between the low rates of the SCU and RSM and the control (Appendix B, Table IX).

Root Crown Diameter. The mean percent increase in diameter for the control (77%) increased more than all of the fertilizer treatments except for the medium rate RSM which increased 82 percent (Appendix A, Figure 19 and Appendix B, Table VIII).

Statistical analysis of the results were similar to the height growth increases. The only significant differences to the control were at the OSL $\leq$ 0.10 level for the low rates of SCU and RSM (Appendix B, Table IX).

Foliar Nitrogen Content. Foliar analysis indicated no significant differences between fertilizer treatments and the control (Appendix B, Table VII). The control had the greatest amount of foliar nitrogen with 2.9640 percent (Appendix B, Table VI).

Juniper

Survival. There was no mortality in the 91 juniper planted on this site (100% survival) (Appendix B, Table V).

Height Growth. The height for the drip irrigated juniper after two growing seasons and before fertilizer treatment was good. The shortest height was 57.0 centimeters whereas the tallest height was 1.515 meters. In the third growing season (the first year after fertilization) the low rate AGT (57% increase) and all of the high rates (AGT 57%, SCU 61%, and RSM 68%) were above the 55 percent increased growth of the control (Appendix A, Figure 20 and Appendix B, Table VIII).

Statistical analysis indicated no significant differences between the fertilizer treatments and the control, but within fertilizer treatments there were significant differences. All were between the high rate RSM and five of the other fertilizer treatments. There was a significant difference between the percent increased growth of the low rates SCU and RSM and the percent increase growth of the high rate RSM. The difference between the smaller increased growth for all the medium rates of each fertilizer type and the larger percent increased growth of high rate RSM was highly significant at the OSL $\leq$ 0.01 level (Appendix B, Table IX). There were highly significant differences in plot locations along the windbreak row (Appendix B, Table IX).

Root Crown Diameter. The mean percent increase in diameter varied little between fertilizer treatments and the control. The range in mean percent increase was 52 percent for the high rate RSM to 73 percent for the low rate RSM, while the control increased 61 percent (Appendix A, Figure 21 and Appendix B, Table VIII).

Statistical analysis indicated similar results with no significant differences between the fertilizer treatments and the control. There was a significant difference within the fertilizer treatments. The percent increased diameter growth of the low rate RSM was significantly larger than that of the high rate RSM (Appendix B, Table IX). Statistical analysis also indicated significant differences among plot locations in the windbreak row.

Foliar Nitrogen Content. Foliar analysis indicated all of the fertilizer treatments except for the low rate RSM had percent nitrogen levels above the control. The percent nitrogen of the control was 1.4690 percent. The highest percent nitrogen was 1.8284 percent for the high rate RSM (Appendix B, Table VI). There were no significant differences between fertilizer treatments and the control although the percent nitrogen of the low rate SCU and high rate RSM were significantly greater than the percent nitrogen of the low rate RSM (Appendix B, Table VII).

Austrian Pine

Survival. Ten out of 80 pine died after the third growing season (one year after fertilization) for an 87.50 percent survival rate. All ten trees had been grazed by sheep although there was possibly a connection to the fertilizer treatment. The relationship of mortality to fertilizer treatment was the following: at the low rate, two SCU and one RSM dead; at the medium rate, one AGT and two RSM dead; at the high rate, three RSM dead; and one control dead (Appendix B, Table V).

Height Growth. The mean percent increase in height growth for the first three growing seasons was greatly influenced by the terminal bud grazing of the sheep. However, data for the third growing season (the first year after fertilization) indicated differences in height increase between the fertilizer treatments and the control. The percent increase for the control was 21 percent with all the rates of the AGT. The high rate SCU and the low and high rates RSM showed responses which were greater than or equal to the increased growth of the control (Appendix A, Figure 22 and Appendix B, Table VIII).

There were no significant differences between the percent increase of the fertilizer treatments and the control. However, the analysis indicated significant differences within the fertilizer treatments. The low rate AGT increased in growth compared to the low, medium and high rates of SCU and the medium rates of RSM (Appendix B, Table IX).

An additional measurement was taken to give an estimate of the response of the fourth growing season "which was free from grazing." This measurement was taken in May, 1983, after terminal bud elongation. The data indicated tremendous growth increases from the previous year. All of the fertilized treatments had at least tripled in the percent increase in growth from the previous year. The AGT low, medium and high rates showed increased percent growth of 78 percent, 63 percent and 48 percent, respectively; the SCU low, medium and high rates had an increased percent growth of 51 percent, 46 percent and 18 percent, respectively, and the RSM low, medium and high rates had increased percent growth of 67 percent, 53 percent and 24 percent, respectively. The control increased in percent growth by only 21 percent (Appendix A, Figure 22).

There were significant differences between the low rate AGT and the control, while within fertilizer treatments the significant differences were with the low rate AGT and the medium rate SCU, high rate SCU, and the high rate RSM. There were also significant differences with the medium rate AGT and the high rate SCU and RSM as well as with the low rate RSM and the high rate of SCU and RSM (Appendix B, Table IX).

Root Crown Diameter. The data for the mean percent increase in diameter for the third growing season (first year after fertilization) indicated all of the fertilizer treatments, excep the low and medium rate of SCU, had nearly tripled the percent increase of the control (Appendix A, Figure 23 and Appendix B, Table VII).

Statistical analysis indicated the percent increase in growth of the medium rate of SCU was significantly higher than all the other fertilizer treatments except for the low and high rates of the RSM. The percent increase in diameter for the medium rate SCU was significantly (OSL $\leq$ 0.01) higher than the control (Appendix B, Table IX).

The additional measurement taken in May, 1983, to estimate the response of the fourth growing season (the second year after fertilization), found less difference within fertilizer treatments, although the three times difference was still apparent between the fertilizer treatments and the control (Appendix A, Figure 23 and Appendix B, Table VIII). The medium rate SCU and the control were the only treatments that were statistically different (Appendix B, Table IX).

Foliar Nitrogen Content. Foliar analysis indicated a very low level of percent nitrogen. The low rate AGT had the highest nitrogen level with 1.049 percent, which was significantly higher than the 0.8556 percent and the 0.8605 percent for the high rates of AGT and SCU, respectively. The control had a 0.9876 percent nitrogen level (Appendix B, Tables VI and VII).

Site 4

General Description

This site was a three row windbreak planted to the south and west of a workshed-barn and a future homesite in Cherokee, Oklahoma. The rows were Russian-olive (*Elaeagnus angustifolia* L.) to the south and juniper (*Juniperus virginiana* L.) and Austrian pine (*Pinus nigra* Arnold) to the north, respectively. The trees were planted in the spring of 1981. The Russian-olive were planted as bare root stock and the juniper and pine were planted as containerized stock, all from the Colorado state nursery. A different type of drip system was used on this site. Only one hose, alternating from row to row, was used. The system also used a different type of emitter which allowed an average of four times more water to be applied in a given period of time (Appendix B, Table III). This higher rate of water caused puddling due to the fine texture of the soil on this site.

The site was disked between the rows and hand hoed within the rows. There were some problems. The landowner had the tendency to disk closely against the trees, especially the Russian-olive and juniper. Not only did this root prune the trees, it piled additional soil close to the trees, particularly the pines. When the pine were initially measured they were buried 10 to 15 centimeters above the root crown. The soil was cleared from the pines and bark mulch and wood shingles were added to keep the soil from settling back.

At this site the water application schedule for the 1982 growing season was lost, therefore, only rainfall amounts were recorded (Appendix B, Table III).

Russian-olive

Survival. One tree out of 62 Russian-olive died after the growing season (one year after fertilization) giving a 98.39 percent survival rate. The treatment of this tree was low rate AGT and was in the first replication closest to the road (Appendix B, Table V).

Height Growth. Initial measurements taken after one growing season and before the fertilization treatments showed good growth. The smallest tree was 46 centimeters while the tallest tree was 1.33 meters. For the second growing season (one year after fertilization) the mean percent increase in height for all treatments was approximately 74 percent while the percent increase in growth for the control was slightly higher (85%) (Appendix A, Figure 24 and Appendix B, Table VIII). There were no significant differences found in the percent increase in height although there was indication of significant differences within the replication locations (Appendix B, Table IX).

Root Crown Diameter. The percent increase in growth for the control of 81 percent was a larger percent increase than most of the fertilizer treatments except for the high rate AGT (84%), the low rate SCU (90%) and the medium rate SCU (107%) (Appendix A, Figure 25 and Appendix B, Table VIII).

Statistical analysis indicated no significant differences between the fertilizer treatments and the control although there was an indication of significant differences within plot locations (Appendix B, Table IX).

Foliar Nitrogen Analysis. Foliar analysis indicated no significant differences in the percent nitrogen between the fertilizer treatments and the control. Only the low rate AGT (3.5075%) was lower than the control (3.5402%). The highest mean percent nitrogen was found in the high rate AGT (4.0290%). There was also an indication of significant differences (OSL < 0.01) within plot locations.

Juniper

Survival. One out of 55 junipers died after the second growing season (one year after fertilization) with a 98.18 percent survival rate

(Appendix B, Table V). The tree was a low rate AGT treatment but was the first tree in the row, closest to the road. There were indications the roadbed had been sprayed with a herbicide during the second growing season.

Height Growth. This species was treated with only the low and high rates of each fertilizer type to allow more replications to be studied. The mean percent increases in height varied between all treatments but no significant differences were found between the control and the fertilizer treatments (Appendix B, Table IX). The average percent increase for all treatments was 110 percent while the control increased 115 percent in the height growth. The lowest percent increase in growth was found in the low rate AGT (73%). The low rates of SCU and RSM and the high rate SCU all had percent increases in growth above the control (Appendix A, Figure 26 and Appendix B, Table VIII).

Root Crown Diameter. The mean percent increases in diameter were all well above 100 percent. The percent increase for the control was 167 percent; only the low rate SCU had a higher percent increase (170%). The lowest percent increase in growth (124%) was the high rate RSM (Appendix A, Figure 27 and Appendix B, Table VIII). However, none of the differences were statistically significant (Appendix B, Table IX).

Foliar Nitrogen Content. Foliar analysis indicated that the control had the highest nitrogen content (1.8094%). The lowest nitrogen content was the high rate AGT with 1.6307% (Appendix B, Table VI). There were no significant differences in percent nitrogen between fertilizer treatments and the control at the OSL $\leq$ 0.05 level; however, at the 0.10

level there were significant differences between the control and the low rate AGT and the high rates of AGT and RSM (Appendix B, Table VII).

Pine

Survival. Ten out of 49 Austrian Pine died by the end of the second growing season (one year after fertilization) with a 79.59 percent survival rate. There was no real trend between mortality and fertilizer treatment although six out of the ten trees were treated at high rates (Appendix B, Table V).

Height Growth. The average percent increase in height for all treatments was approximately 95 percent. This was influenced by the large percent increase of growth by the high rate AGT (127%) and the low rate SCU (101%). The increase in growth for the control was 88 percent. The lowest increase in growth was 74 percent for the high rate SCU and the low rate RSM (Appendix A, Figure 28 and Appendix B, Table VIII). There was no significant differences between fertilizer treatments and the control although within fertilizer treatments the percent increase growth of the high rate AGT was significantly larger than that of the low rate RSM. There was also significant differences between plot locations (Appendix B, Table IX).

An additional measurement was taken in May, 1983, to estimate the growth increase response for the third growing season (the second year after fertilization). The results showed a dramatic percent increase in growth. The control increased in growth by 131 percent while the smallest increase in growth from the previous season was 117 percent by the high rate SCU. The largest increases in growth from the previous season's growth were 192 percent and 180 percent by the low rate RSM and the high rate AGT, respectively (Appendix A, Figure 28). However, there was no significant difference in increased height growth between fertilizer treatments and the control although there was a significant difference between plot locations (Appendix B, Table IX).

Root Crown Diameter. The mean percent increases in diameter for all the fertilizer treatments were larger than the control. The increase in growth for the control was 47 percent while the largest increase in diameter growth was 71 percent for the low rate AGT (Appendix A, Figure 29 and Appendix B, Table VIII). Statistical analysis indicated no significant differences between the fertilizer treatments and the control (Appendix B, Table IX). An additional measurement was also completed for an estimate of the response of the third growing season diameter growth (the second year after fertilization). The result indicated much more varied differences than for the second growing season data. The control increased diameter growth by only 17 percent while all the fertilizer treatment increases were greater than the control. The highest increase in diameter growth from the previous year was 39 percent from the high rate SCU (Appendix A, Figure 19). The differences in percent increase in growth for the high rate SCU and the low rate AGT were significantly larger than that of the control. There was also indication of significant differences between plot locations (Appendix B, Table IX).

Foliar Nitrogen Content. Foliar analysis indicated that only the high rate AGT had a higher nitrogen content (1.8355%) than the control (1.8750%). The lowest nitrogen content was found in the low rate RSM (1.5608%) (Appendix B, Table VI). While there was no significant differences between fertilizer treatments and the control, there were significant differences within the fertilizer treatments. The high rate AGT had a significantly higher percent nitrogen than the low rates of SCU and RSM (Appendix B, Table VII).

CHAPTER V

DISCUSSION

Site 1

In general, there were few significant differences in increased growth or increased percent foliar nitrogen levels. There are several hypotheses for this lack of response. One reason may be the age of the trees. The trees were planted in the spring of 1981, and even though adequate moisture was present, the roots may not have been sufficiently developed to provide for efficient nutrient uptake. This may have been especially true for the pine. In May 1983, the area around selected pines was excavated to observe root development. The roots appeared to be concentrated around the containerized core with little or not root development ten centimeters away from this planting core. Therefore, any nutrient uptake was probably from mass flow to the roots. This, however, did not inhibit the detrimental fertilizer effects which occurred. The mean percent increase diameter for the pine at the high rate for all fertilizer types combined was significantly lower than the increase at the low fertilizer rate for all types combined (Appendix B, Table X). This detrimental effect is also reflected in the fact that all of the trees treated with the high rate RSM were dead. This pattern was observed by Bengtson (16) on certain southern pine seedlings subjected to high rates of nitrogen and phosphorus fertilizer.

The larger Russian-olive at the time of fertilization suggested a more developed root system to better utilize the fertilizer, but no significant fertilizer trends were established. This may be because Russian-olive is a nitrogen fixing species.

Zimmerman (132) studied fertilizer treatments of hardwood seedlings on mine spoils and found no significant response to slow release fertilizers after one year. Davidson and Sowa (29) found similar responses to slow release fertilizers on various conifer species planted on mine spoils. They did find significant growth responses to fertilizer treatments after the second year, but the height differences after four years were relatively small.

The effects of the drip watering system may be another reason for low fertilizer response. In May, 1983, soil tests were taken in the drip area for each type of fertilizer, on the high rate treatments only. The results of these soil tests showed no apparent increases in nitrate levels in the soil although the phosphorus level in the 0-10 centimeter depth increased dramatically. The nitrogen, a relatively mobile nutrient, may have leached out of the root zone (Appendix B, Table I). The Salinity of the soil was also investigated but the total soluble salts were all in the normal range.

The management of the area could have also effected fertilizer response. The area around the trees was not kept clean of competing vegetation and the trees were subject to rodent and man-made damage.

Site 2

There were no significant differences found for increased height, diameter, or foliar nitrogen content with respect to fertilizer treatments.

The replanting of this site in the spring of 1982 allowed data to be collected for newly planted seedlings. Although no significant differences were indicated, in general, to fertilizer treatments, the growth responses of the seedlings was an interesting phenomenon. The pine, which were planted as containerized stock, grew very little in height, but they more than doubled in diameter. This may indicate the first growing season was primarily one of root establishment although excavation showed no lateral spread of the root system more than a few centimeters away from the containerized core. An estimate of the second growing season which would be one year after fertilization revealed no significant differences in fertilizer treatments, but the percent increase in height was much greater than that for diameter. The arborvitae were bare root stock planted in an already fertilized area. There were some observed height growth responses although the trees were damaged by grasshoppers. There were no significant differences within fertilizer rates but the mean increase in diameter growth for each fertilizer rate (fertilizer types combined within each rate) was significantly larger than the control. This was the same for types as well. The mean increase in diameter growth for each fertilizer type (rates combined within each type) was significantly larger than the control (Appendix B, Table X). Therefore, residual fertilizer did have an effect on growth response on bare rooted, newly planted arborvitae on this site.

The additional Russian-olive (Site 5) was a virtual waste of time and effort. Most of the trees were in poor condition throughout the 1983 growing season. The main reason for the poor condition of the trees was not because of the fertilizer treatments but rather the lack of care and maintenance at this particular site. All of the Russian-olive were surrounded by a dense mat of bermuda grass runners which competed heavily for the available water from the drip system. In the pine and arborvitae rows, love grass competition was kept away from the trees, although some of the trees were buried by drifting sand due to sandy soil conditions. Rodents were also a problem on both Sites 2 and 5 at this location.

Site 3

The oldest trees of all four sites were on this site. The trees were planted in the spring of 1980. They had completed their second growing season before fertilization. It was presumed that the root systems of these trees were more developed than on the other sites, therefore the response to fertilizer might have been expected to have been more apparent. For the Russian-olive the only significant response to fertilizer treatment was that the control had a significantly larger percent increase in diameter growth than the low fertilizer rate (all types combined) (Appendix B, Table X). Again this may have been due to the nitrogen fixation process of Russian-olive. For the juniper the only significant response was for the high fertilizer rate (all types combined) (Appendix B, Table X). The nitrogen analysis indicated, however, that the low rate of SCU and the high rate of RSM were significantly greater than the percent nitrogen of the low rate RSM (Appendix B, Table VII). Just how the growth and the percent nitrogen responses relate to one another in this case is not clear. A possible reason for the lack of further response by the juniper to the fertilizer treatments may have been due to the weed competition around each tree. During the summer of 1982 the weeds were as tall as the juniper.

The growth of the Austrian pine on this site was an interesting case to study. Ther terminal buds on most of the pine had been continually clipped by sheep for the first three growing seasons. The problem was eliminated in the summer of 1982 but no further height growth occurred until candle elongation in the spring of 1983, due to the determinant pattern of shoot growth in this species. Measurements were taken for the 1982 growing season with the only significant response being that of the AGT treatment (all rates combined), showing a larger increase in height growth when compared to the SCU treatment (Appendix B, Table X). The measurements taken in May, 1983, estimating the growth of the first growing season free from grazing pressure, indicated several significant growth responses to fertilizer treatments. Similar to the response of pine at Site 1, the low rate (all types combined) had a significantly larger height growth response than the high rate of fertilizer. The pattern of significant differences between AGT and SCU was continued and the height growth increase of the AGT high rate was also significantly higher than the control. The diameter growth increase measured in May, 1983, estimating the 1983 growing season growth, indicated that the medium rate (all types combined) had a significantly higher percent increase in growth than the control. The percent increase in diameter growth of the AGT (all rates combined) was significantly larger than the control (Appendix B, Table X).

Therefore, Austrian pine, after three growing seasons in the field, had some significant response to fertilizer treatments. One may conclude that the root systems of the pine were developed sufficiently to utilize the fertilizer.

Care must be taken to prevent further animal damage and to control week competition.

Site 4

For the 1982 growing season (one year after planting) no significant growth response to fertilizer treatments was indicated. However, all species grew exceptionally well. This growth response may be explained by the fact that this site had the best soil type of all the four sites studied. Another reason may be weed elimination due to the very good maintenance provided. The area between the tree rows was disked regularly and the area around the trees hoed keeping weed competition to a minimum.

The growth of the pines was arrested the first growing season (1981) because of soil accumulation which buried approximately half of the total seedling. This problem was remedied during the spring of 1982 by placing mulch and wood shingles around each tree. In May, 1983, an additional measurement was taken on the pine to estimate the increased growth of the second growing season after fertilization. The results indicated a dramatic increase in height growth compared to the previous season, but there were no significant differences indicated. The diameter growth, although having much smaller percentages of increased growth, indicated significantly higher growth responses between the high fertilizer rates (all types combined) and the control (Appendix B, Table X).

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Fertilization of newly-planted, one, two, and three year old windbreak plantings under drip irrigation had never been previously assessed. Therefore, the information gained from this study is beneficial. In fact, there has been little to no information reported on survival rates and growth response of windbreak plantings influenced by a drip watering system.

Here are several conclusions that can be made from this study:

1. Survival rates of windbreak plantings in Western Oklahoma using drip irrigation with additional fertilization were from 80 to 100 percent.

2. The response to fertilization varied depending on the species. The Russian-olive was the least affected while the Austrian pine was more sensitive to fertilizer application. Therefore, care must be taken in applying high rates of readily soluble fertilizer on clay soils.

3. In general, the statistical analysis indicated little, if any, significant effects of the fertilizer treatments, compared to the control, but the error term in the analysis was very high indicating that the development of a better model may be needed.

4. A one year period after fertilization, particularly for one and two year old plantings, may not be enough time to fully evaluate the effects of the fertilizer treatments.

5. Weed control is just as important to growth and development as fertilizer.

6. A more controlled research area, such as the Southern Plains Range Research Station in Woodward, Oklahoma, would facilitate experimental procedure.

Much more research needs to be conducted to establish definitive conclusions regarding the effects of fertilization on drip irrigated windbreaks. This research needs to be conducted on land that is under the control of the researcher. This would provide a much greater basis for experimentation and minimize damage to experimental plots.

Research is also needed to study not only fertilization effects but also to examine more basic factors such as the determination of optimum watering rates; the effects on physiological processes including root development; the effects of weed control; the role of planting stock (containerized versus bare root); the degree of species variation; and finally, the overall plant growth and development compared to non-drip irrigated plantings. This research needs to be conducted over a period of time sufficient to monitor the effects at all stages of windbreak development.

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APPENDIX A

FIGURES

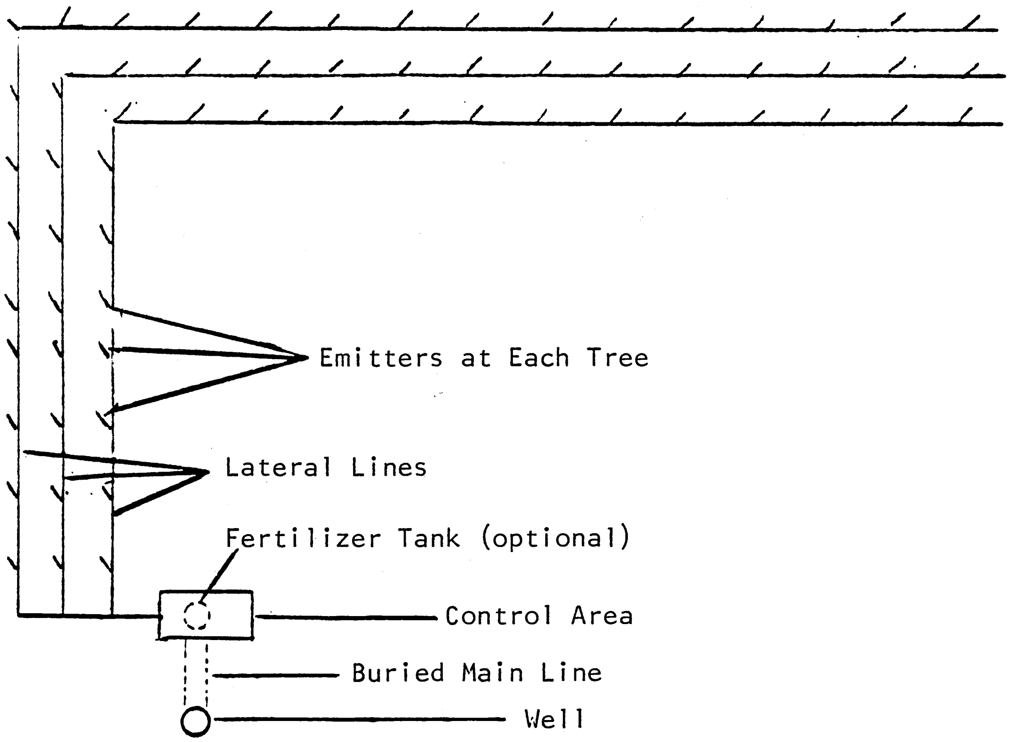

Figure 1. Diagram of a Drip Irrigation System

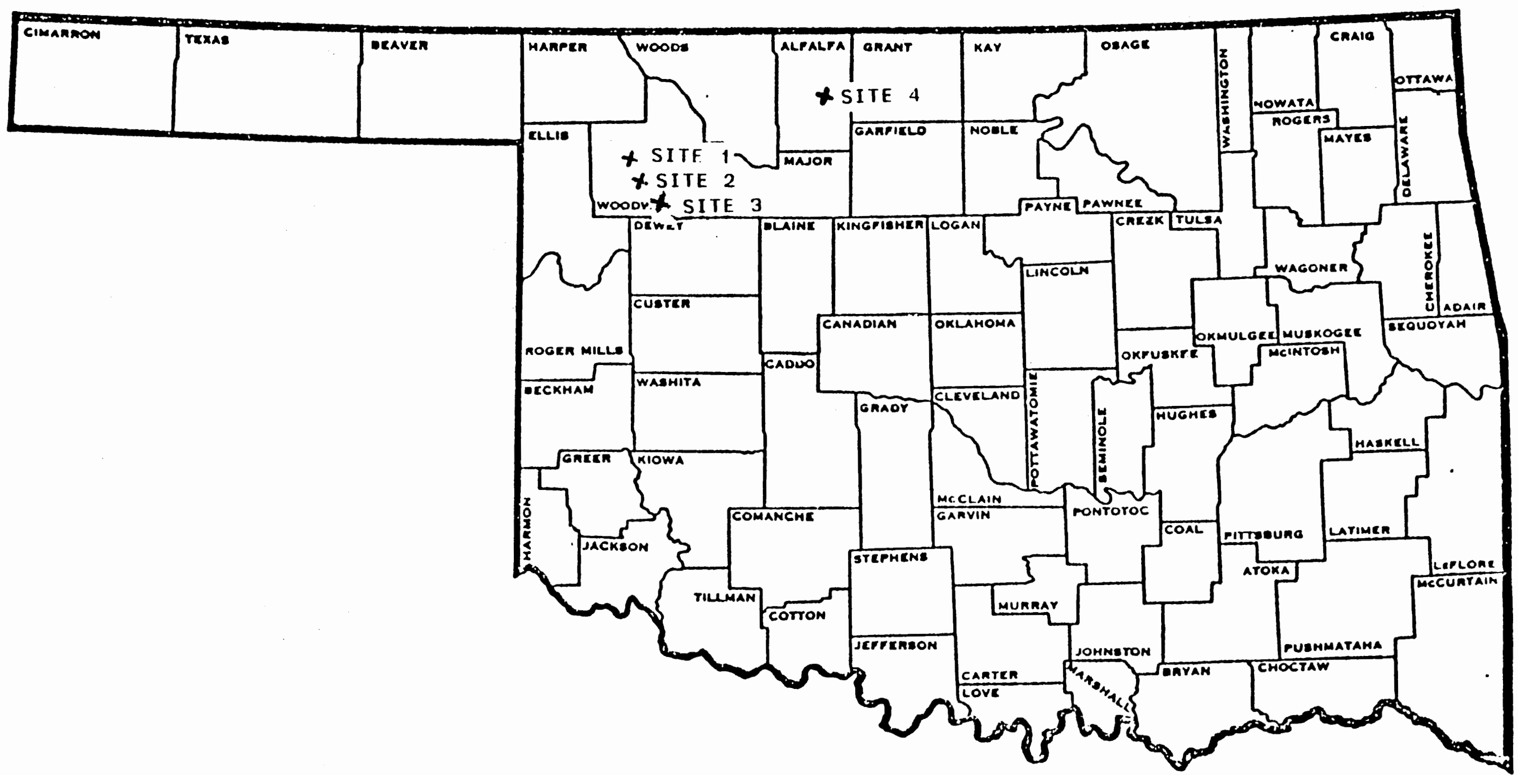

Figure 2. Site Locations

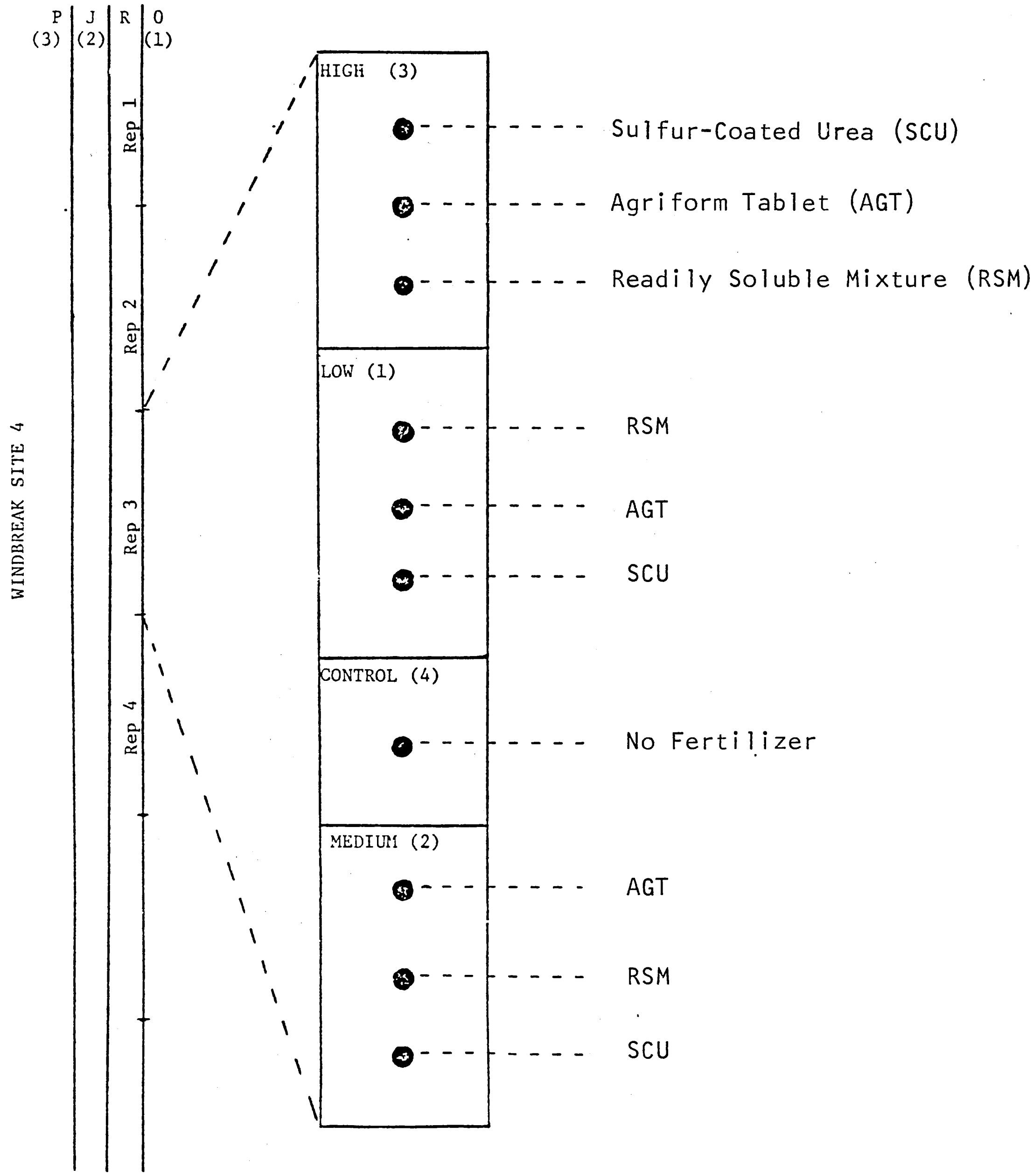

Figure 3. Schematic View of Fertilizer Treatment Design (High, Medium and Low)

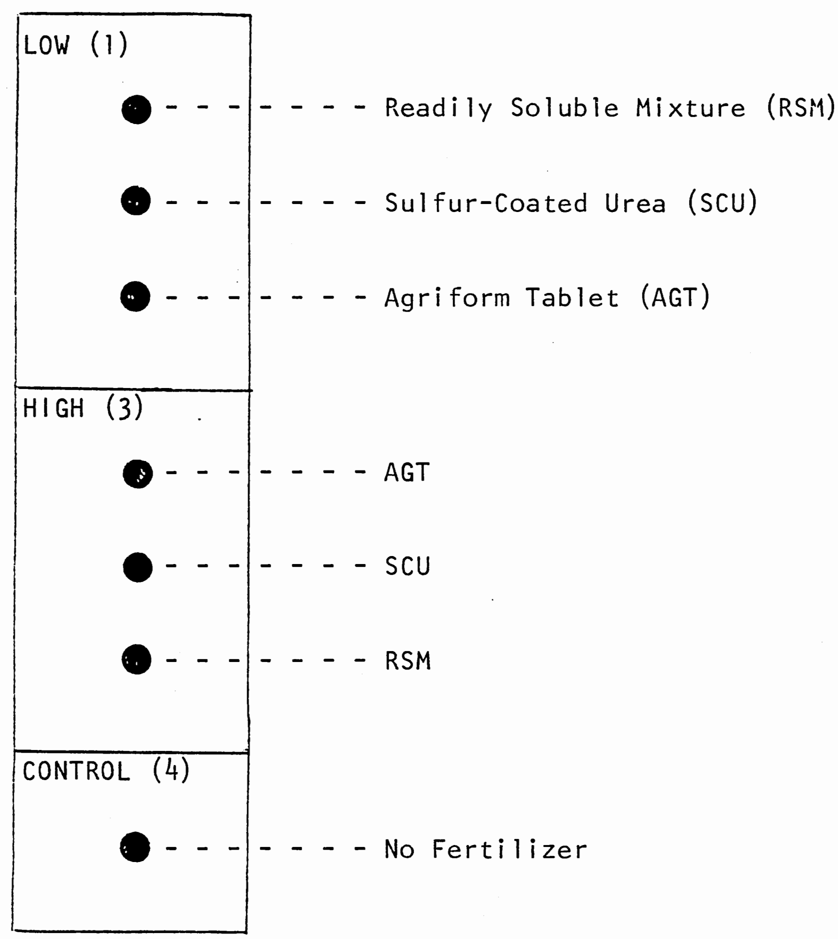

Figure 4. Schematic View of Fertilizer Treatment Design (High and Low)

Example: 41332

First digit is the site of the windbreak

Second digit is the tree species number:
1 - Russian-olive (*Elaeagnus angustifolia*)
2 - Juniper (*Juniperus virginiana*)
3 - Austrian Pine (*Pinus nigra*)
4 - Arborvitae (*Thuja orientalis*)

Third digit is the replication block number

Fourth digit is the rate of the fertilizer:
1 - Low rate (2 tablets, 35 grams)
2 - Medium rate (4 tablets, 70 grams)
3 - High rate (8 tablets, 140 grams)
4 - No fertilizer

Fifth digit is the type of fertilizer:
1 - Agriform Table (20-10-5)
2 - Sulfur Coated Urea (24-4-10)
3 - Quick Release Mixture (34-0-0 + 10-2-10) or (24-3-4)

Figure 5. Explanation of Identification Tag Code

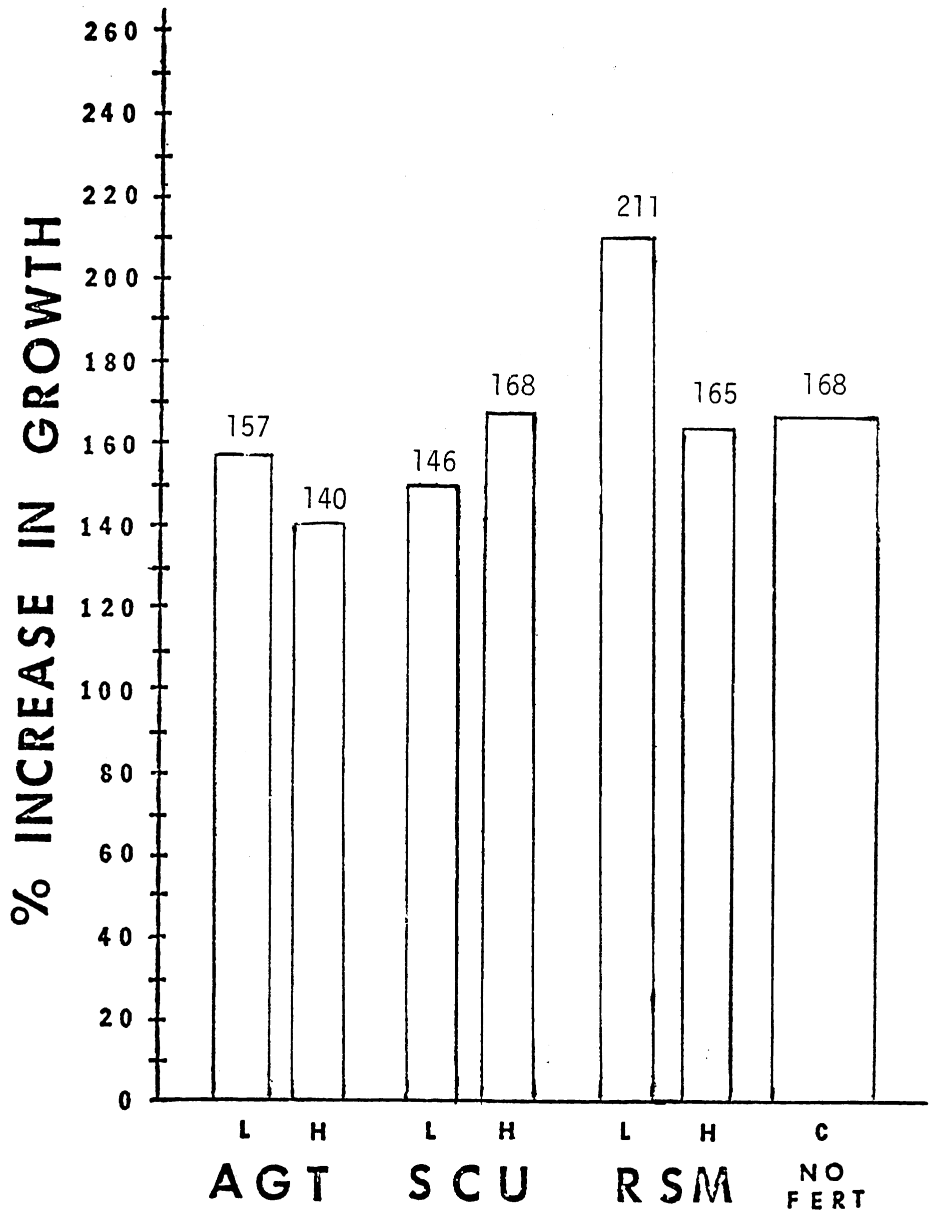

Figure 6. Mean Percent Increase in Height by Fertilizer Site 1, Russian-olive, the First Growing Season After Fertilization

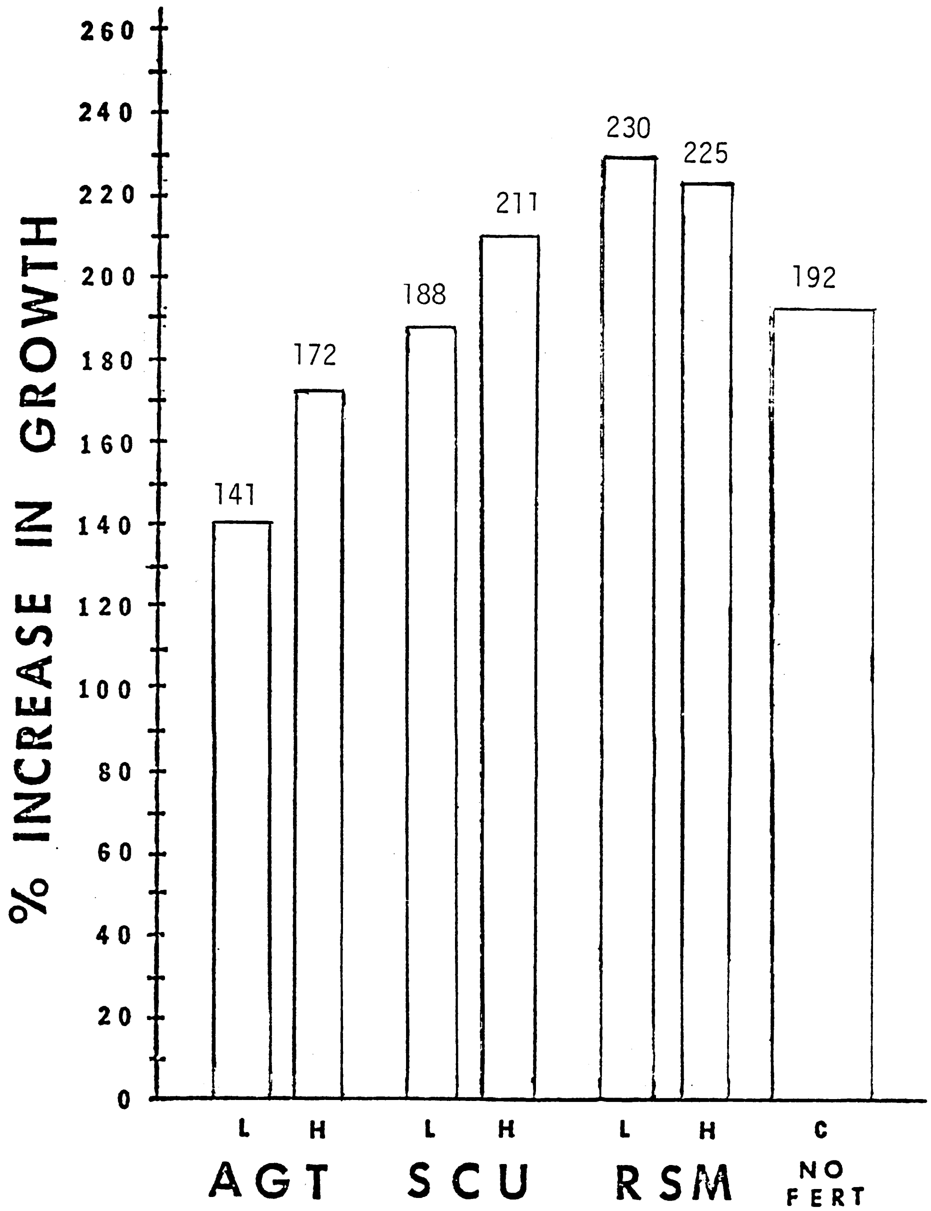

Figure 7. Mean Percent Increase in Diameter by Fertilizer Site 1, Russian-olive, the First Growing Season After Fertilization.

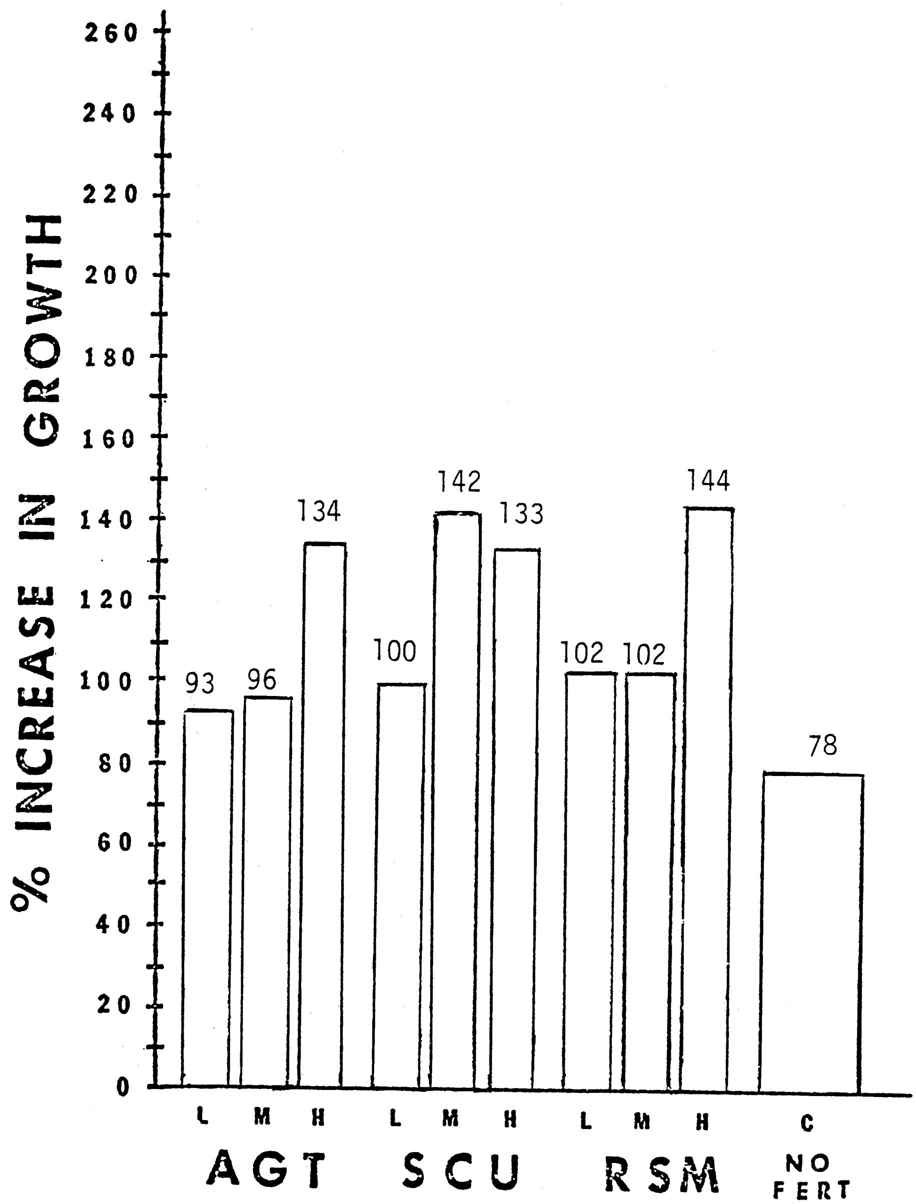

Figure 8. Mean Percent Increase in Height by Fertilizer Site 1, Juniper, the First Growing Season After Fertilization

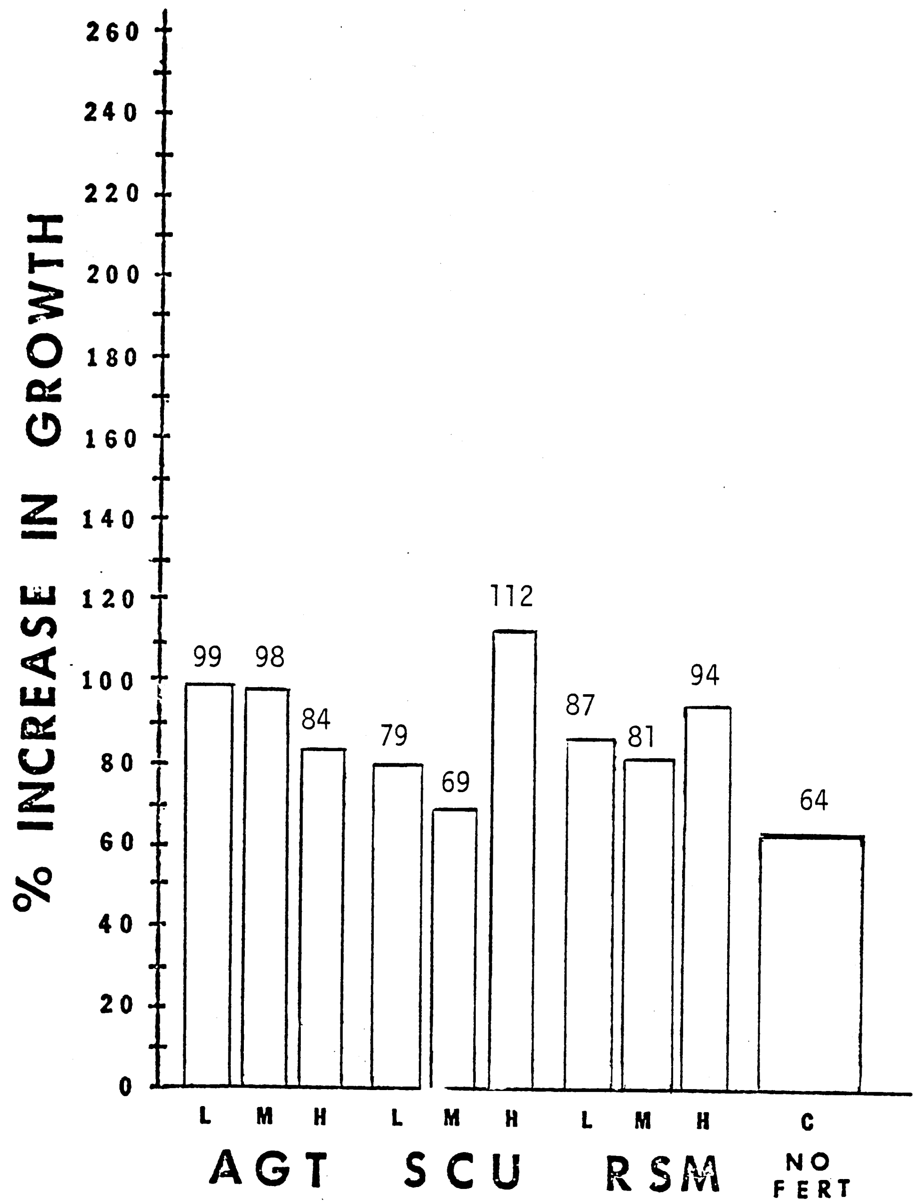

Figure 9. Mean Percent Increase in Diameter by Fertilizer Site 1, Juniper, the First Growing Season After Fertilization

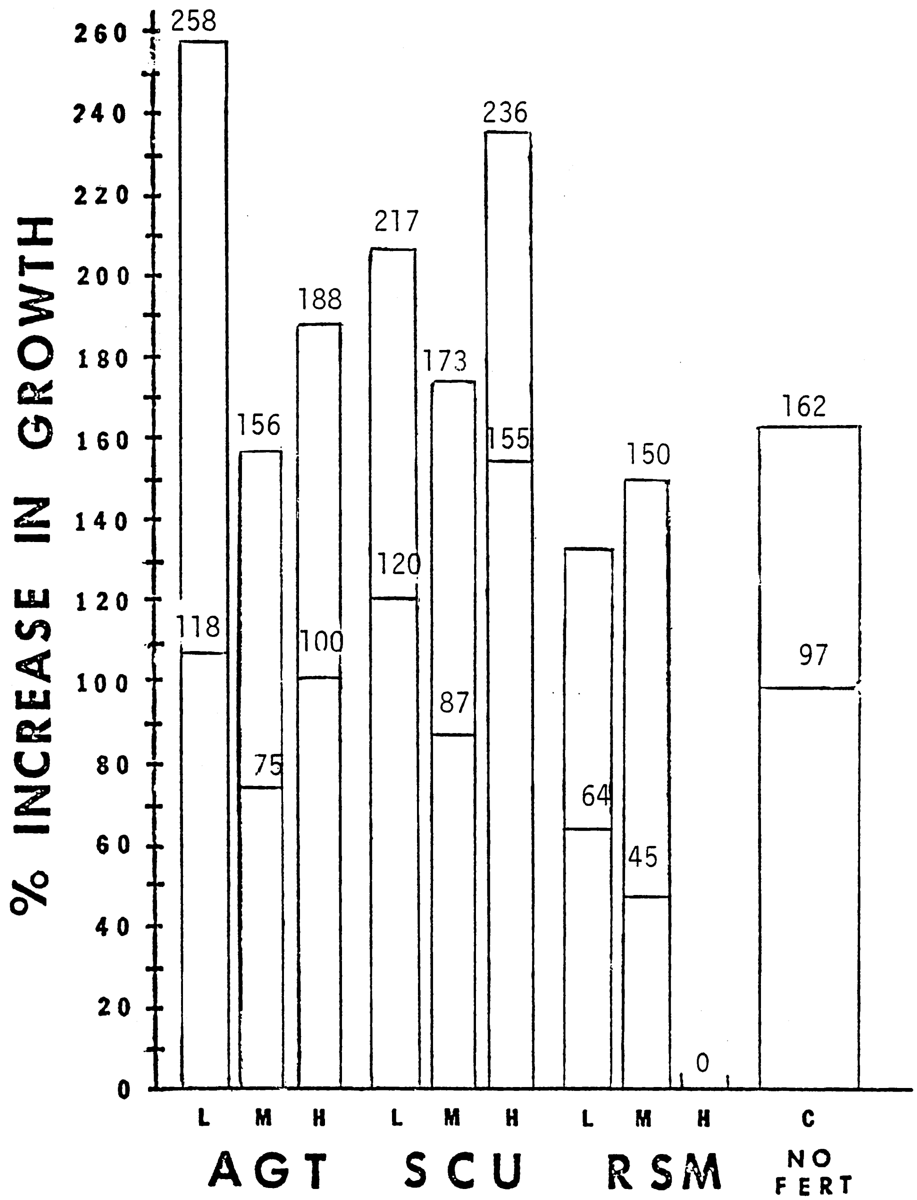

Figure 10. Mean Percent Increase in Height by Fertilizer Site 1, Austrian Pine, the First and Second (Estimate) Growing Season After Fertilization

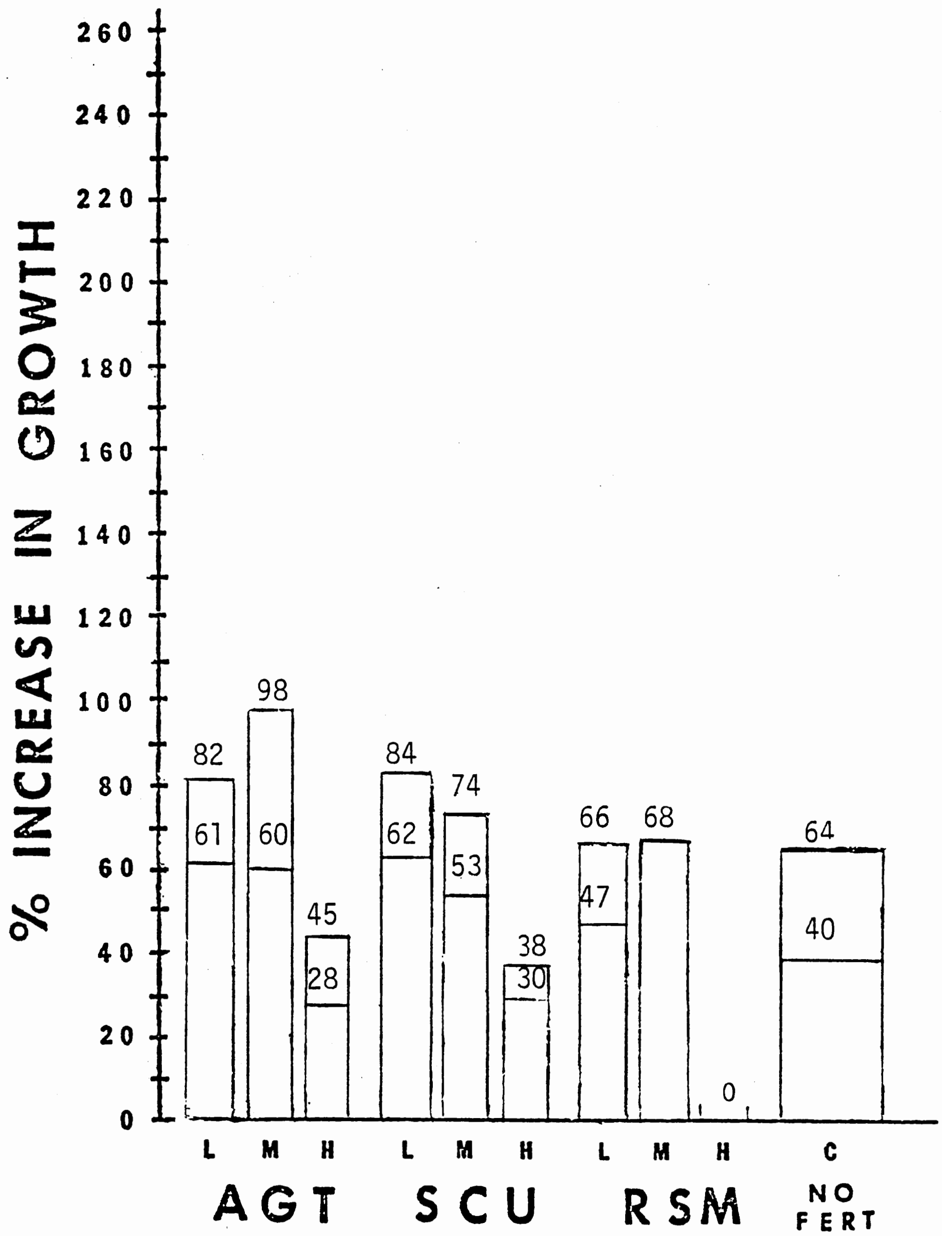

Figure 11. Mean Percent Increase in Diameter by Fertilizer Site 1, Austrian Pine, the First and Second (Estimate) Growing Season After Fertilization

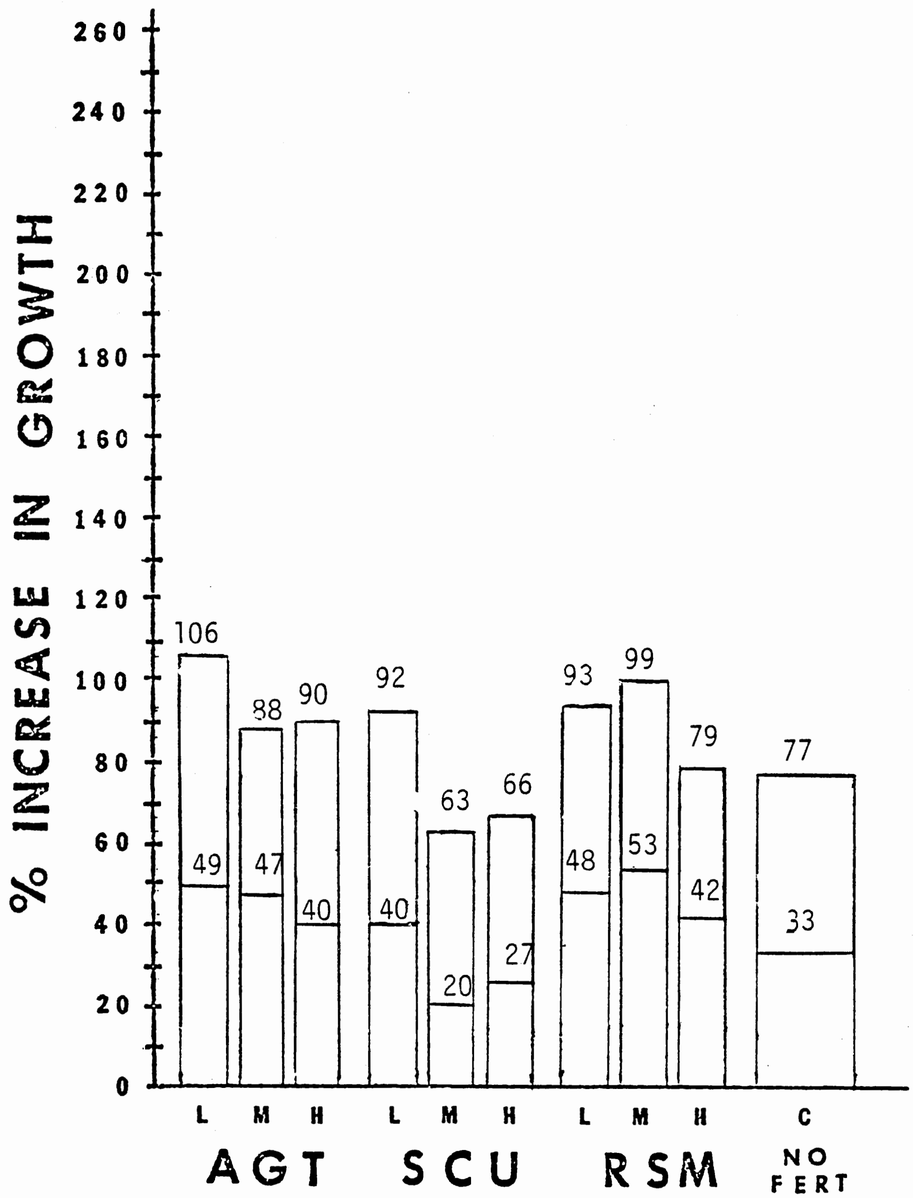

Figure 12. Mean Percent Increase in Height by Fertilizer Site 2, Austrian Pine, the First and Second (Estimate) Growing Season After Fertilization

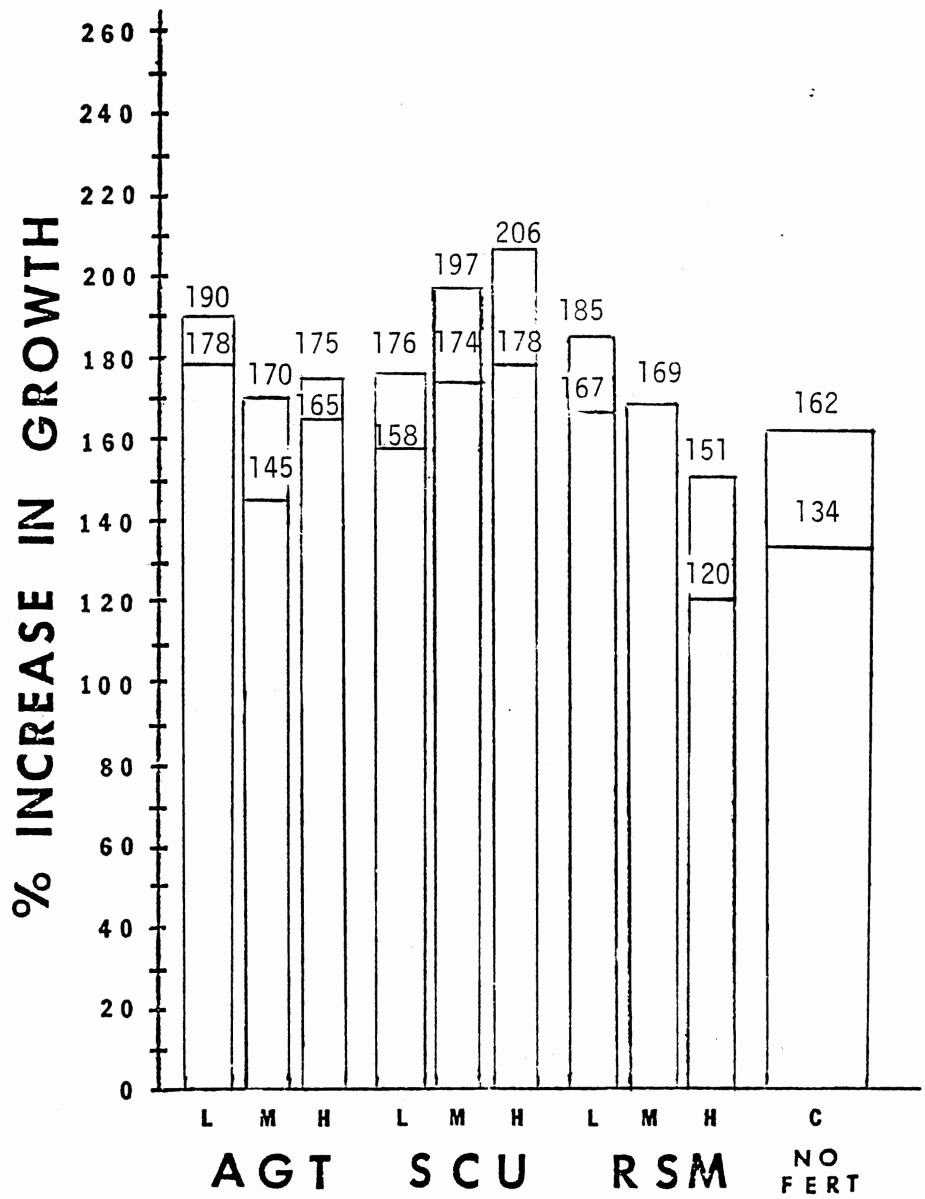

Figure 13. Mean Percent Increase in Diameter by Fertilizer Site 2, Austrian Pine, the First and Second (Estimate) Growing Season After Fertilization

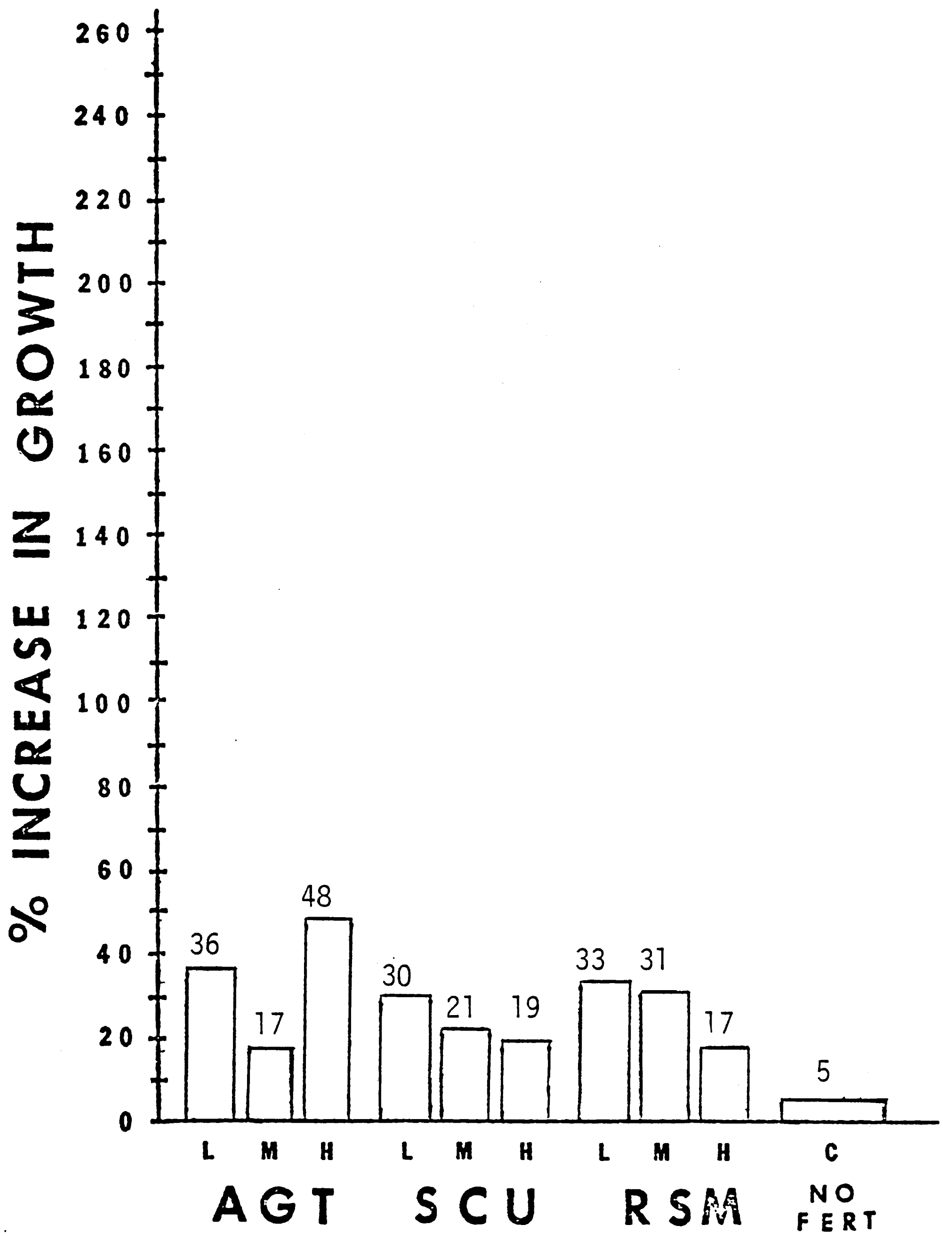

Figure 14. Mean Percent Increase in Height by Fertilizer Site 2, Arborvitae, the First Growing Season After Fertilization

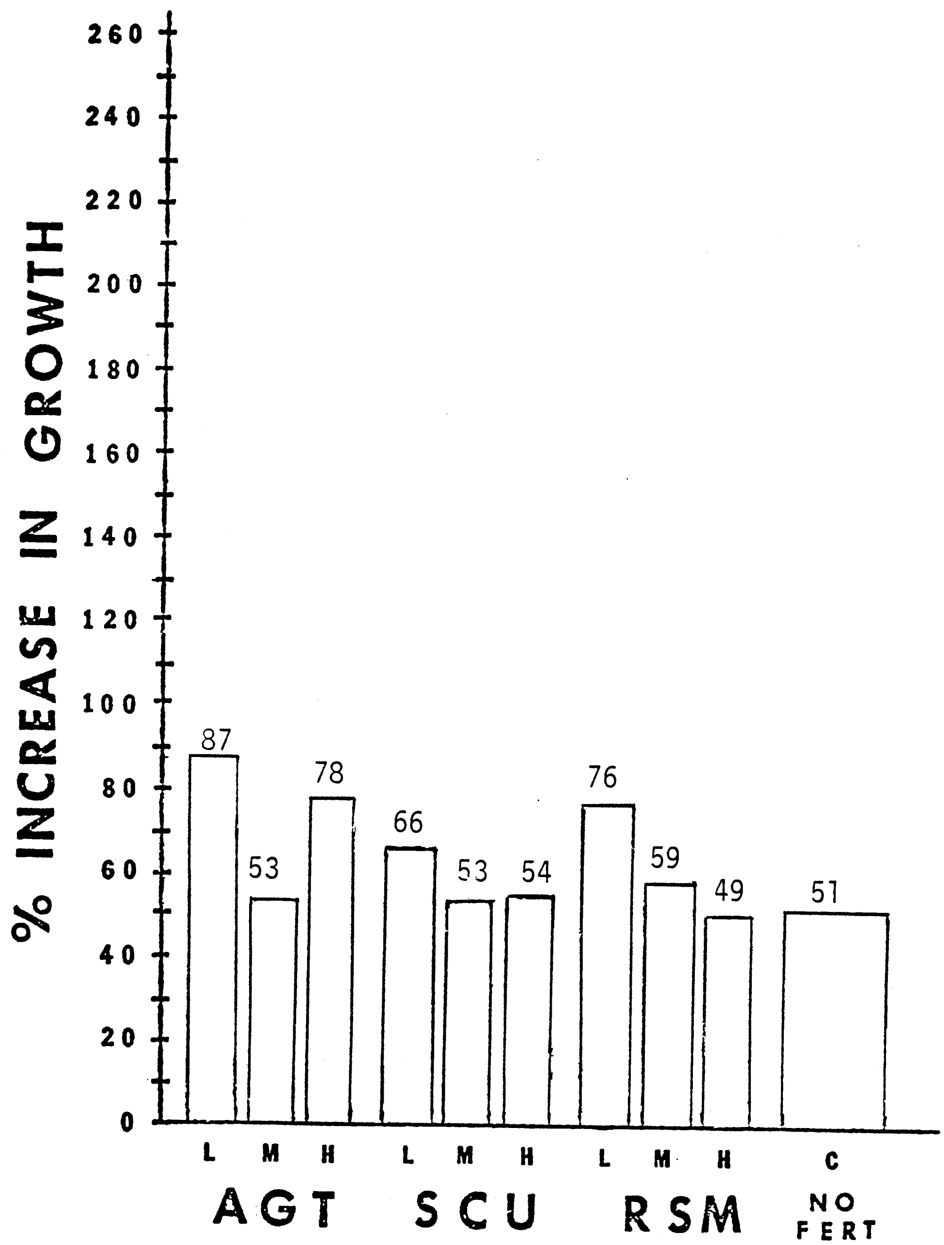

Figure 15. Mean Percent Increase in Diameter by Fertilizer
Site 2, Arborvitae, the First Growing Season
After Fertilization

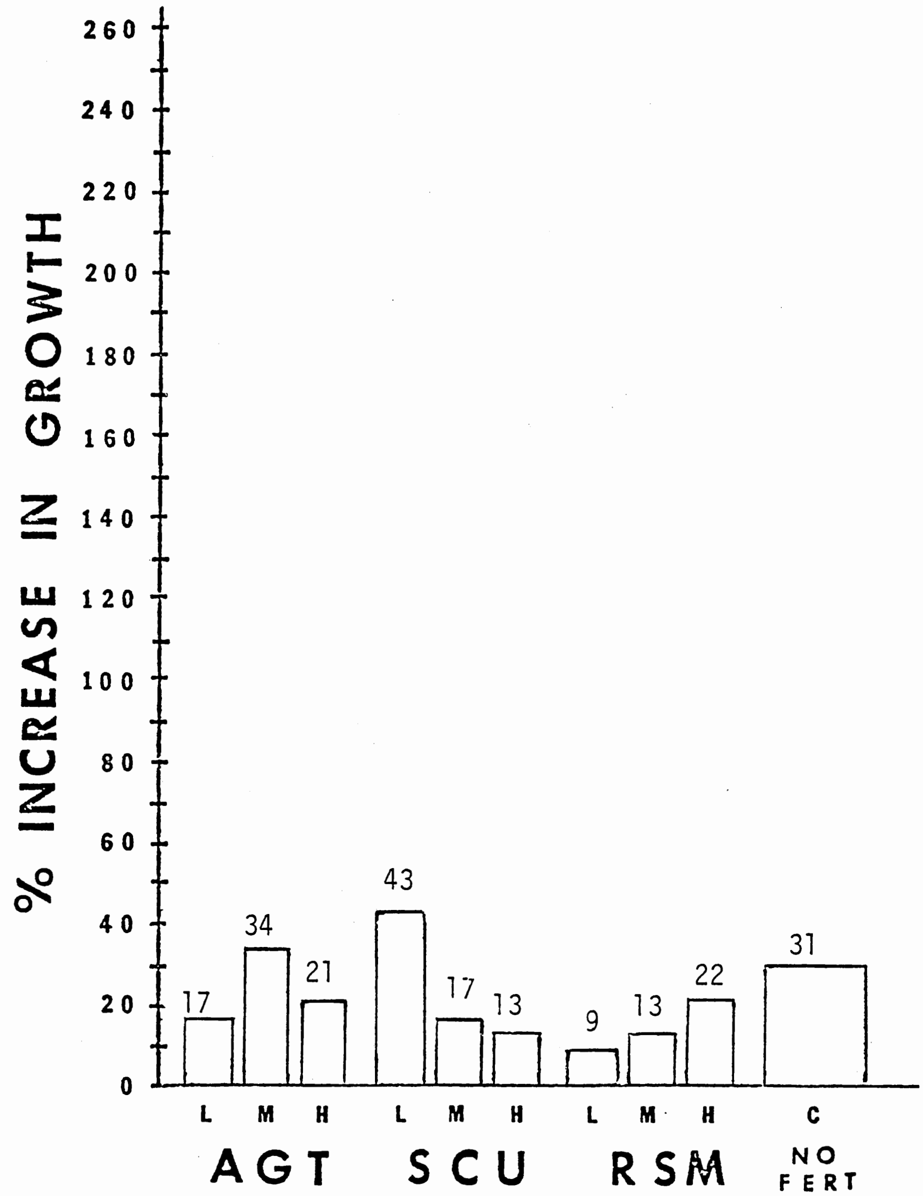

Figure 16. Mean Percent Increase in Height by Fertilizer Site 5, Russian-olive, the First Growing Season After Fertilization

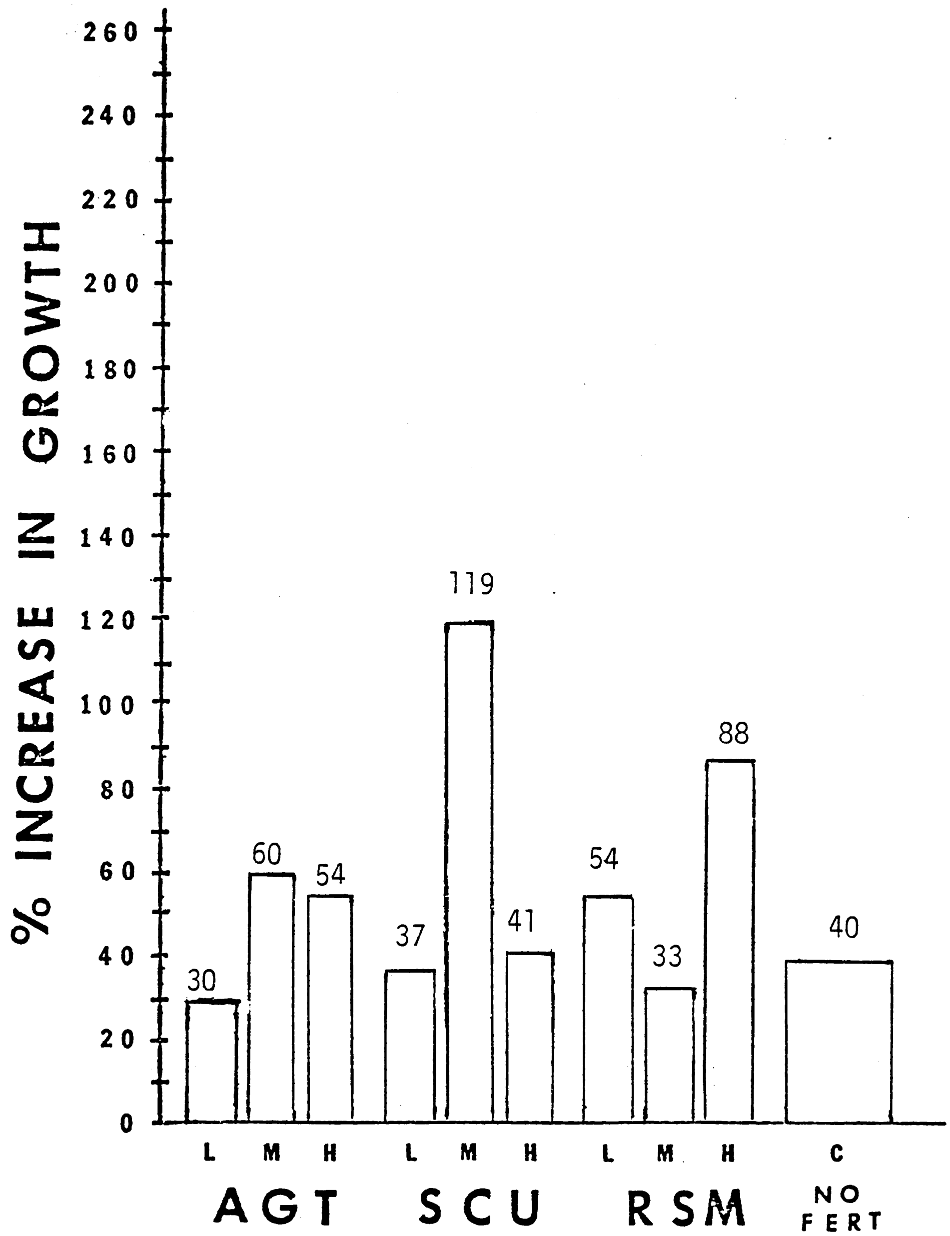

Figure 17. Mean Percent Increase in Diameter by Fertilizer Site 5, Russian-olive, the First Growing Season After Fertilization

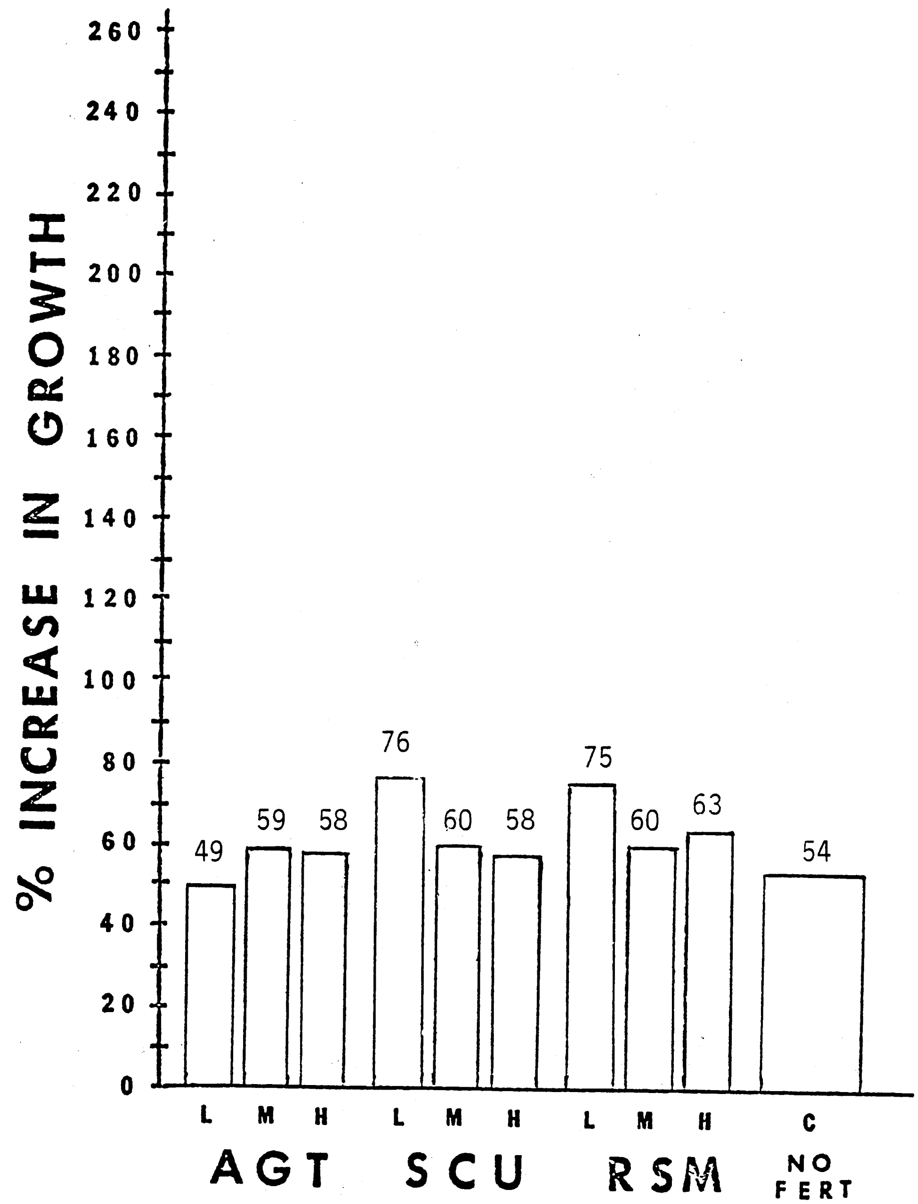

Figure 18. Mean Percent Increase in Height by Fertilization Site 3, Russian-olive, the First Growing Season After Fertilization

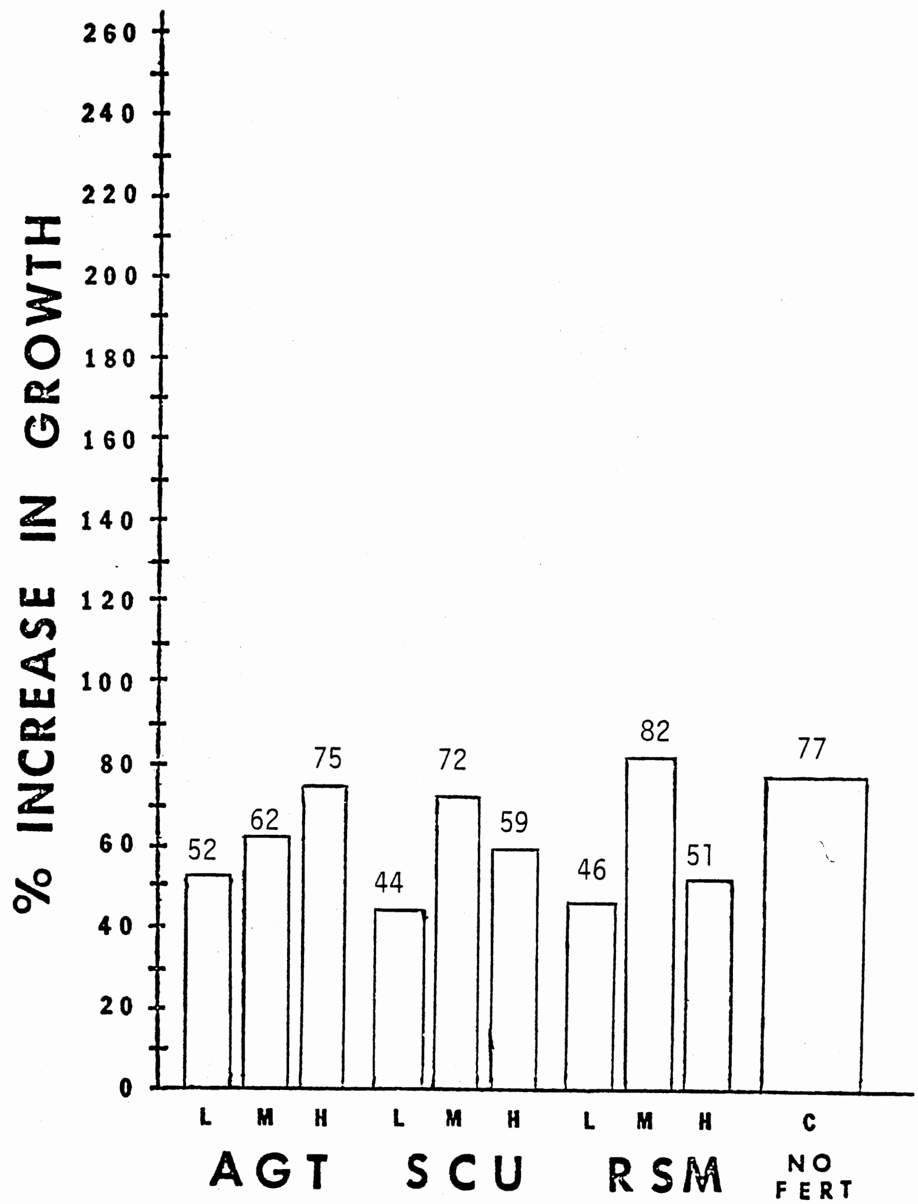

Figure 19. Mean Percent Increase in Diameter by Fertilizer Site 3, Russian-olive, the First Growing Season After Fertilization

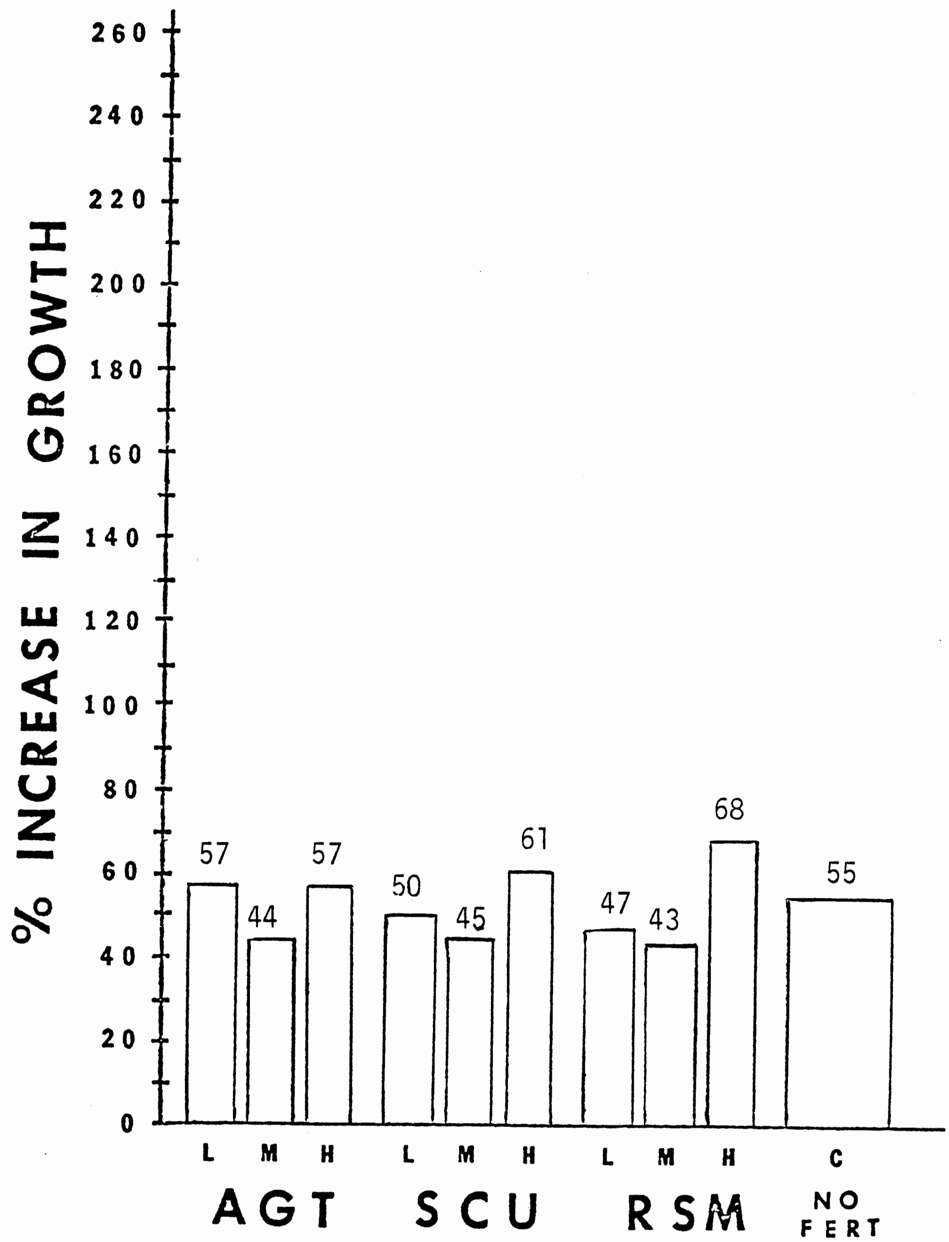

Figure 20. Mean Percent Increase in Height by Fertilizer Site 3, Juniper, the First Growing Season After Fertilization

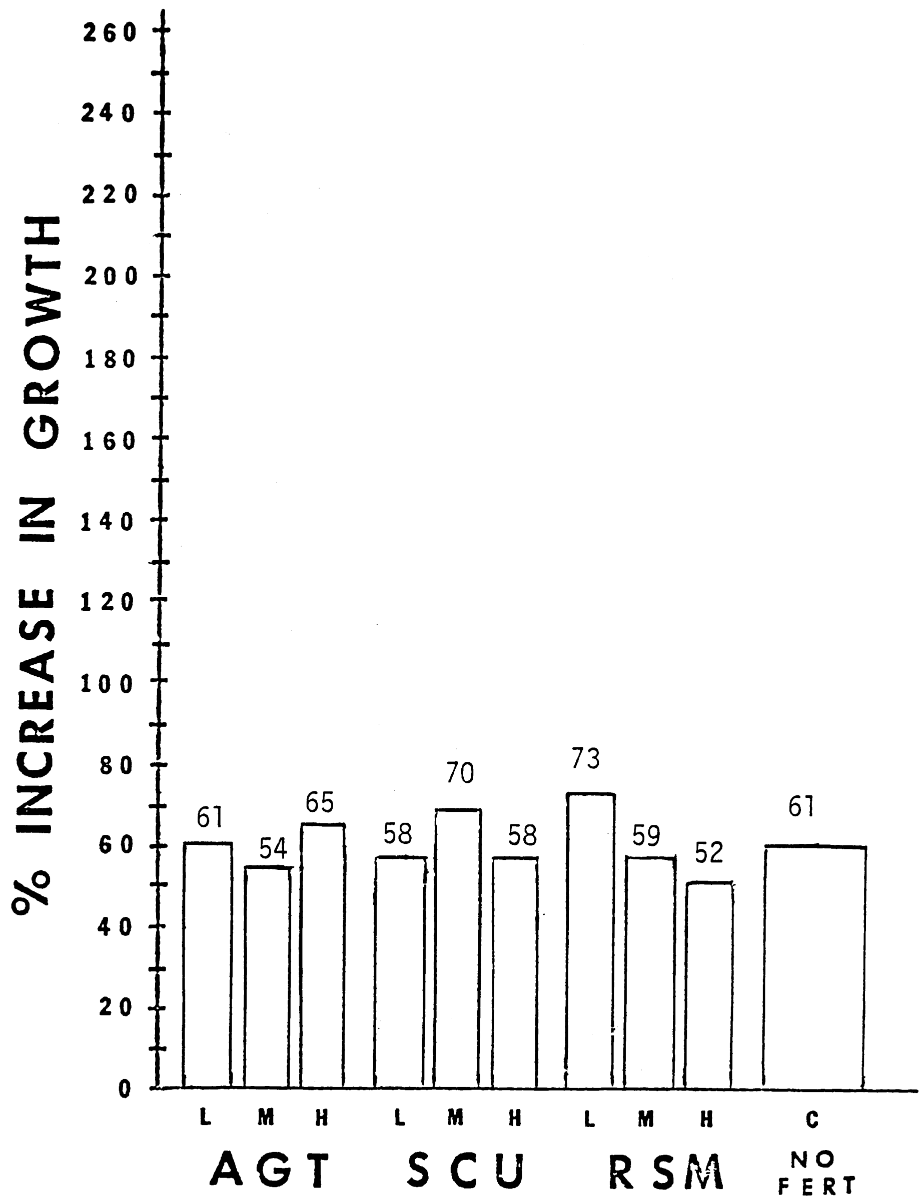

Figure 21. Mean Percent Increase in Diameter by Fertilizer Site 3, Juniper, the First Growing Season After Fertilization

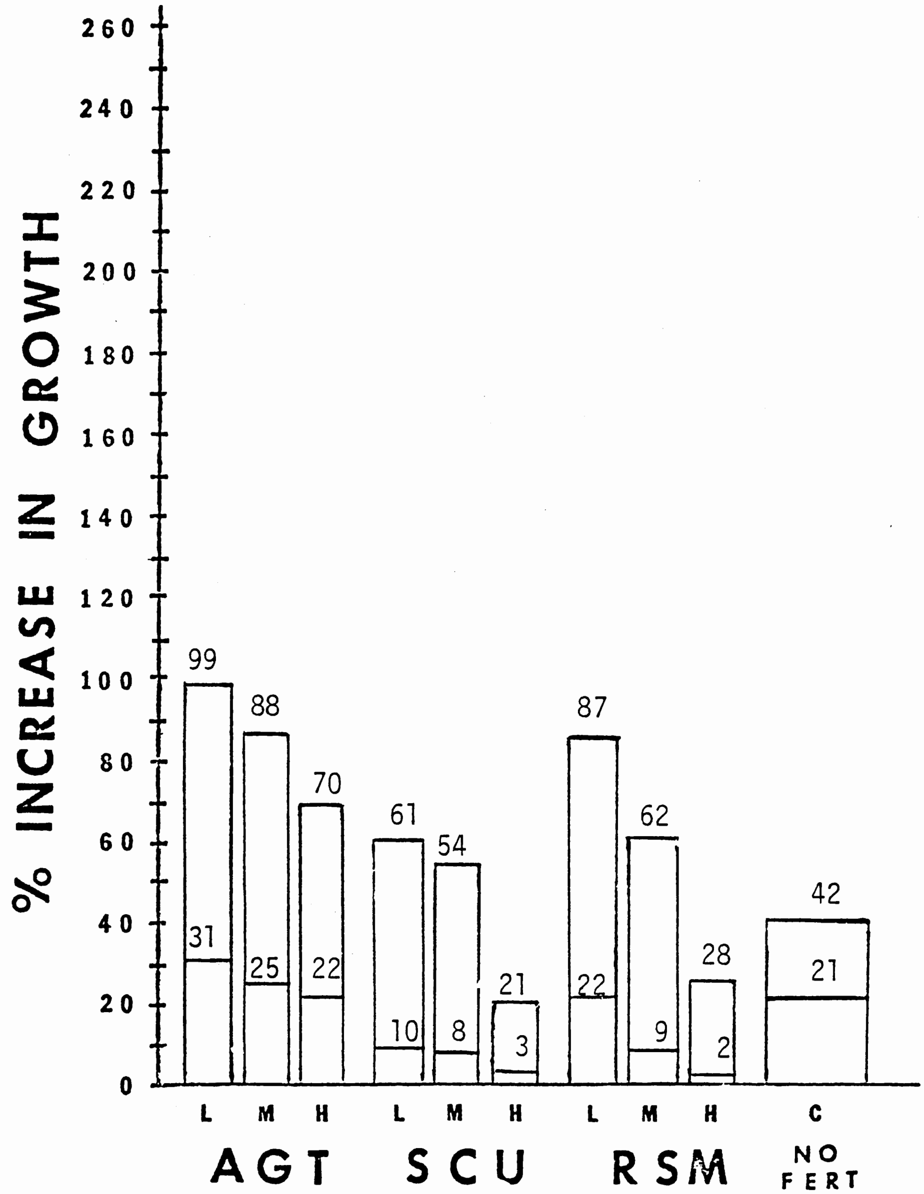

Figure 22. Mean Percent Increase in Height by Fertilizer Site 3, Austrian Pine, the First and Second (Estimate) Growing Season After Fertilization

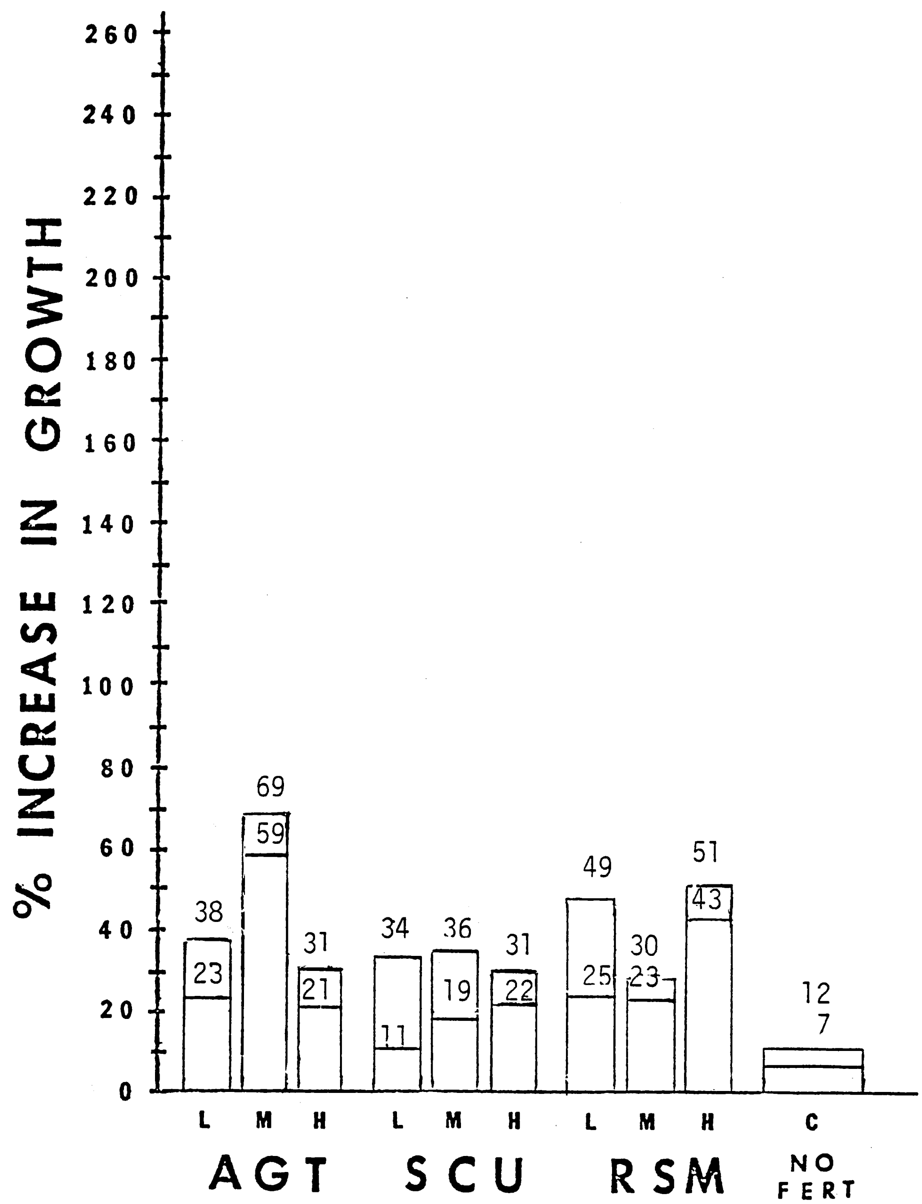

Figure 23. Mean Percent Increase in Diameter by Fertilizer Site 3, Austrian Pine, the First and Second (Estimate) Growing Season After Fertilization

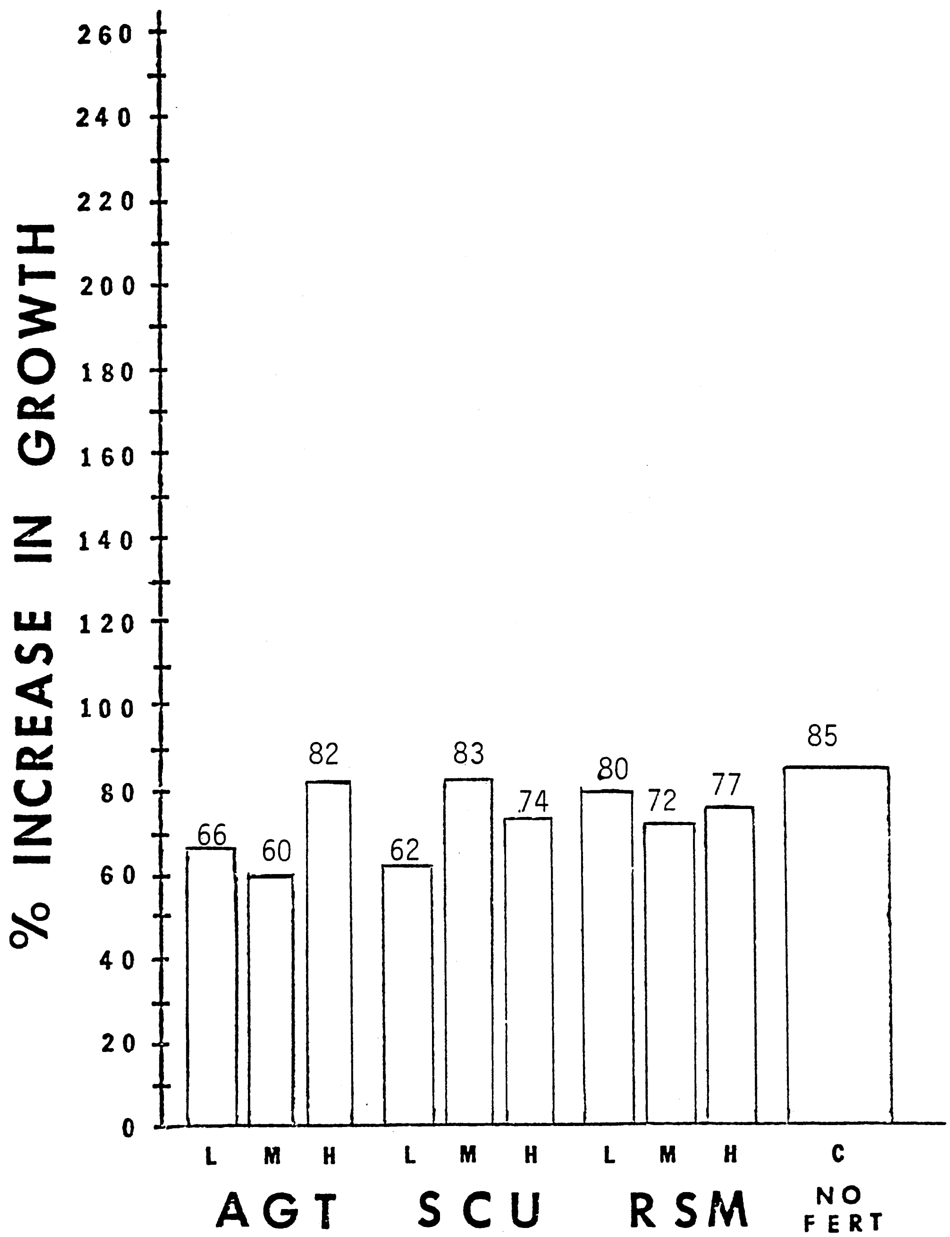

Figure 24. Mean Percent Increase in Height by Fertilizer Site 4, Russian-olive, the First Growing Season After Fertilization

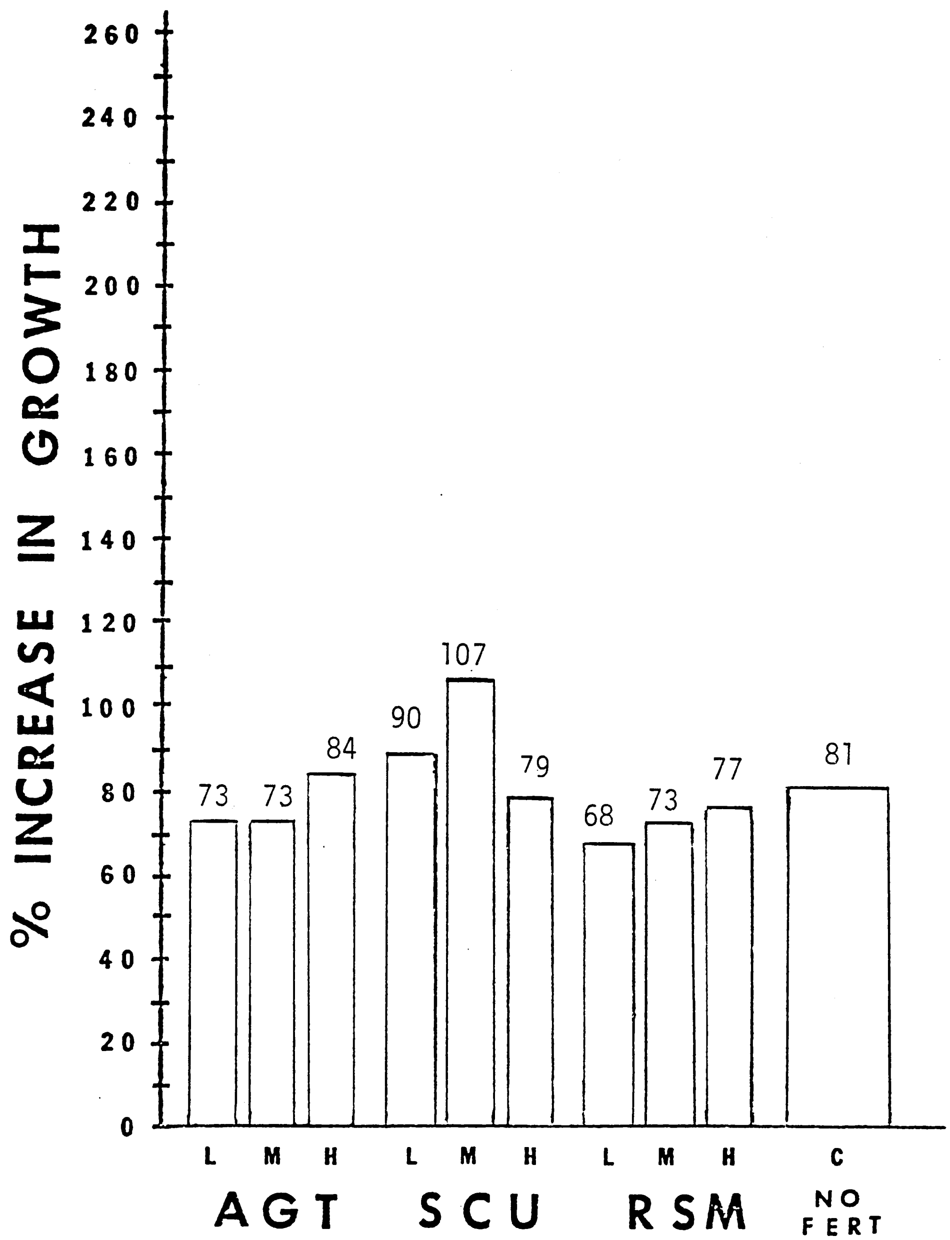

Figure 25. Mean Percent Increase in Diameter by Fertilizer Site 4, Russian-olive, the First Growing Season After Fertilization

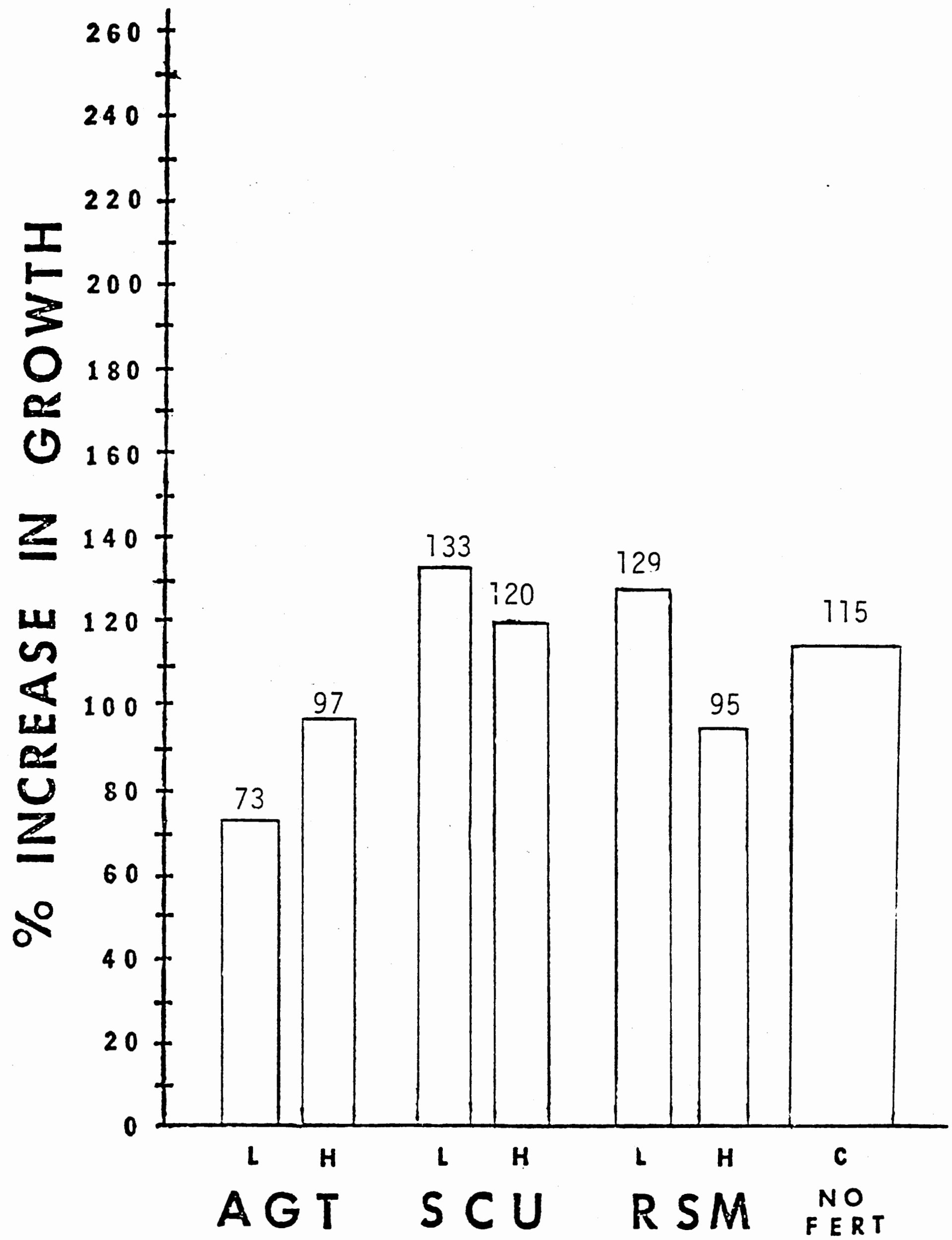

Figure 26. Mean Percent Increase in Height by Fertilizer Site 4, Juniper, the First Growing Season After Fertilization

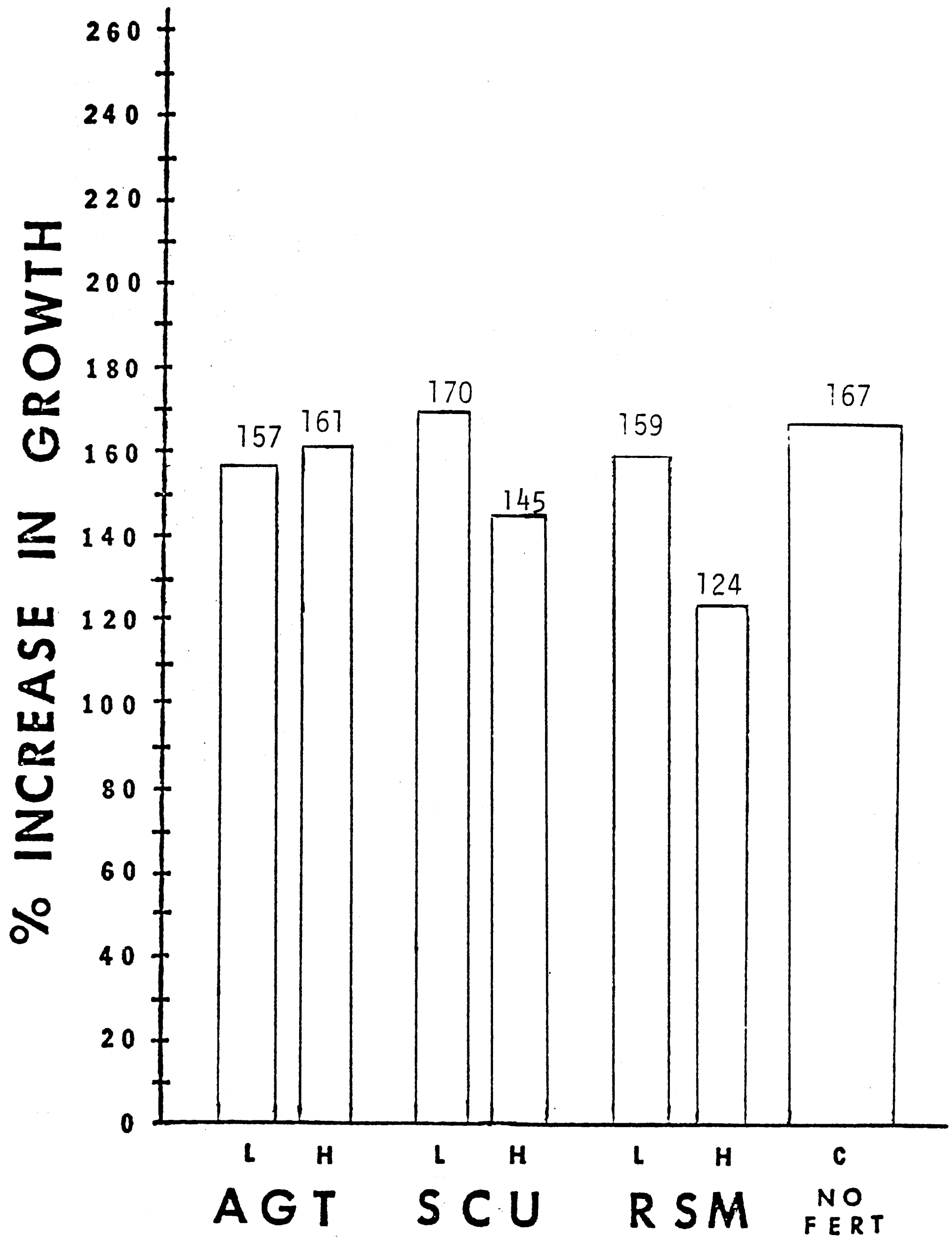

Figure 27. Mean Percent Increase in Diameter by Fertilizer Site 4, Juniper, the First Growing Season After Fertilization

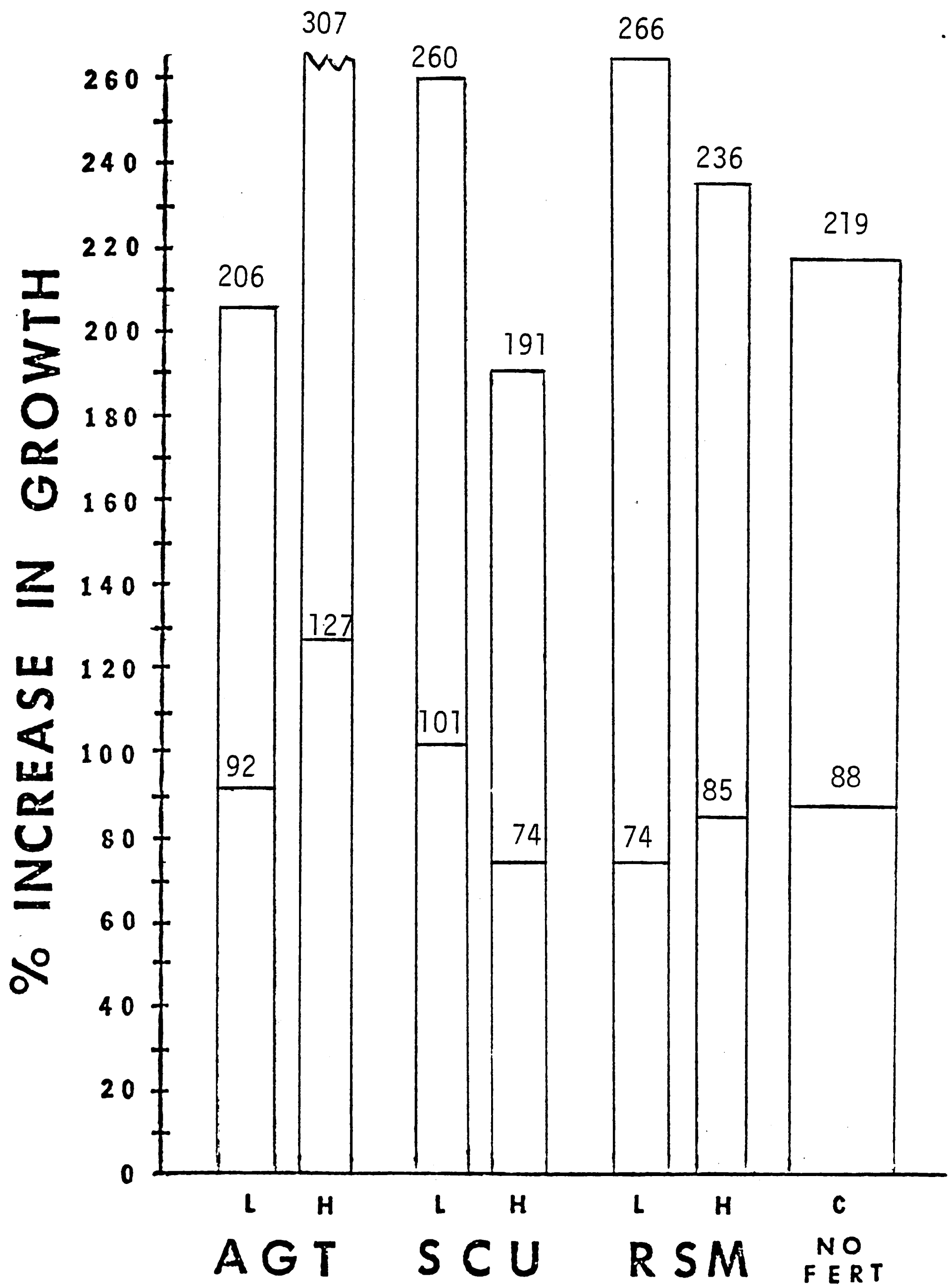

Figure 28. Mean Percent Increase in Height by Fertilizer Site 4, Austrian Pine, the First and Second (Estimate) Growing Season After Fertilization

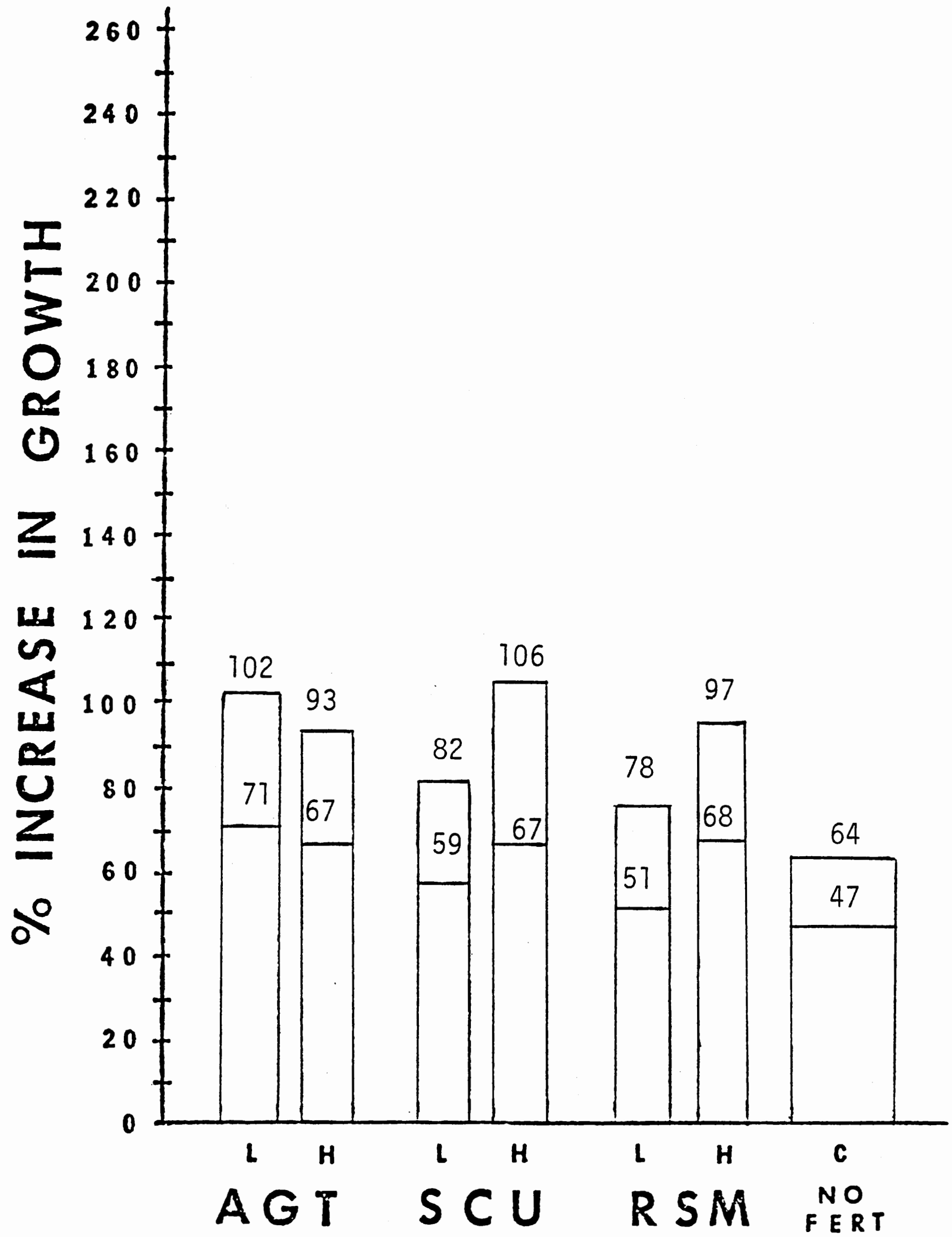

Figure 29. Mean Percent Increase in Diameter by Fertilizer Site 4, Austrian Pine, the First and Second (Estimate) Growing Season After Fertilization

APPENDIX B

TABLES

TABLE I

SOIL CHARACTERISTICS BY SITE

Site 1

Soil Type: Mixed due to construction and leveling. Mainly a Woodward Loam (WoB) 1 to 3% slopes, a reddish-brown loam over granular loam and weathered sandstone or sandy shale

Soil Texture: Coarse

Soil Test: Nov. 1981 (Total Site)

pH: 8.0

Depth	N	P	K	Ca	Mg	Fe	Zn
				Nutrient			
0 cm	20	39	237	4903	182	7.80	0.64
30 cm	18	12	138	5395	191	11.30	0.23
60 cm	19	9	105	4896	208	9.50	5.11
				kg/ha		/ ppm	

May 1983 (High Rate AGT)

pH: 7.55

Depth	N	P	K	Ca	Mg	Fe	Zn
				Nutrient			
0-10 cm	18	166	198	4271	217	14.30	1.62
10-25 cm	3	22	155	4891	219	4.90	0.29
				kg/ha		/ ppm	

(High Rate SCU)

pH: 7.45

Depth	N	P	K	Ca	Mg	Fe	Zn
				Nutrient			
0-10 cm	25	108	254	2827	178	4.40	0.66
10-25 cm	14	46	157	3078	219	8.60	0.44
				kg/ha		/ ppm	

(High Rate RSM)

pH: 7.85

Depth	N	P	K	Ca	Mg	Fe	Zn
				Nutrient			
0-10 cm	5	166	166	4488	250	4.20	0.76
10-25 cm	2	59	145	4150	252	4.40	0.28
				kg/ha		/ ppm	

TABLE I (Continued)

Site 2

Soil Type: Pratt loamy fine sand (PfC)

Soil Texture: Coarse

Soil Test: Nov. 1981 (Total Site)

pH: 7.4

Depth	N	P	K	Ca	Mg	Fe	Zn
0 cm	5	54	158	1945	124	10.5	1.35
30 cm	4	29	147	1770	144	25.9	0.42
60 cm	4	19	135	1872	149	12.6	2.91

Nutrient: kg/ha / ppm

May 1983 (High Rate AGT)

pH: 7.5

Depth	N	P	K	Ca	Mg	Fe	Zn
0-10 cm	4	26	108	1489	81	5.6	3.53
10-25 cm	2	22	90	1279	61	5.2	0.38

Nutrient: kg/ha / ppm

(High Rate SCU)

pH: 7.5

Depth	N	P	K	Ca	Mg	Fe	Zn
0-10 cm	3	35	87	1411	63	4.3	3.49
10-25 cm	3	21	84	1414	63	4.4	0.57

Nutrient: kg/ha / ppm

(High Rate RSM)

pH: 7.9

Depth	N	P	K	Ca	Mg	Fe	Zn
0-10 cm	4	46	106	1242	58	5.2	3.16
10-25 cm	2	24	87	1333	63	5.1	0.42

Nutrient: kg/ha / ppm

TABLE I (Continued)

Site 3

Soil Type: Quinlan--Woodward loam (QwC2) possibly mixed with Woodward loam (WoC) or Pratt fine sandy loam (PbB)

Soil Texture: Fine

Soil Test: Nov. 1981 (Total Site)

pH: 8.1

				Nutrient			
Depth	N	P	K	Ca	Mg	Fe	Zn
0 cm	9	111	485	4394	224	4.8	0.97
30 cm	15	52	340	4974	197	6.8	0.67
60 cm	30	17	251	5096	296	4.4	2.12
				kg/ha		/ ppm	

May 1983 (Not Available)

TABLE I (Continued)

Site 4

Soil Type: Dale silt loam 0 to 1% slope. A fine silt loam, with free salts to 100 cm

Soil Texture: Fine

Soil Test: Nov. 1981 (Total Site)

pH: 6.4

Depth	N	P	K	Nutrient Ca	Mg	Fe	Zn
0 cm	3	157	839	1352	297	40.8	1.48
30 cm	21	81	735	1705	425	40.7	3.37
60 cm	152	70	522	2565	553	14.1	1.51
				kg/ha		/ ppm	

May 1983 (High Rate AGT)

pH: 5.45

Depth	N	P	K	Nutrient Ca	Mg	Fe	Zn
0-10 cm	21	166	463	1177	244	27.2	1.53
10-25 cm	2	137	479	1376	354	13.1	1.10
				kg/ha		/ ppm	

(High Rate SCU)

pH: 5.7

Depth	N	P	K	Nutrient Ca	Mg	Fe	Zn
0-10 cm	9	139	537	996	267	15.8	0.89
10-25 cm	3	99	535	1696	475	11.0	1.00
				kg/ha		/ ppm	

(High Rate RSM)

pH: 5.35

Depth	N	P	K	Nutrient Ca	Mg	Fe	Zn
0-10 cm	6	158	433	1062	251	20.0	1.14
10-25 cm	5	112	528	1331	336	12.2	1.26
				kg/ha		/ ppm	

TABLE II

CHEMICAL FORMULATION OF FERTILIZER TYPES

Agriform Tablet (AGT)	(20-10-5)
Composition	
Total Nitrogen (N)	20.00%
7.0% Soluble Nitrogen 13.0% Water Insoluble Nitrogen	
Available Phosphoric Acid (P_2O_5)	10.00%
Soluble Potash (K_2O)	5.00%
Calcium (Ca)	2.60%
Sulfur (S)	1.60%
Iron (Fe)	0.35%
Derived from: Ureaformaldehyde, Calcium Phosphates, Potassium Sulfate, Ferrous Sulfate	
Sulfur Coated Urea (SCU)	
Composition	(24-4-10)
Total Nitrogen (N)	24.00%
0.80% Ammoniacal Nitrogen 23.20% Urea Nitrogen	
Available Phosphoric Acid (P_2O_5)	4.00%
Soluble Potash (K_2O)	10.00%
Sulfur (S)	16.00%
Derived from: Sulfur Coated Urea, Sulfur Coated Ammonium Phosphate, Sulfur Coated Muriate of Potash	

The nitrogen, phosphorus, and potassium have been coated to provide 20.40% slow release nitrogen, 3.40% slow release phosphorous, and 8.5% slow release potassium.

TABLE II (Continued)

Readily Soluble Mixture (RSM)	(24-8-4)*
(Mixture of 34-0-0 + 10-20-10)	
Composition Mixture	
Total Nitrogen (N)	24.00%
24.00% Ammoniacal Nitrate	
Available Phosphoric Acid (P_2O_5)	8.00%
Soluble Potash (K_2O)	4.00%

*To match the 24% nitrogen in the SCU treatment, a mixture of 58.30 parts of 10-20-10 to 41.70 parts of 34-0-0 were blended together.

TABLE III

1982 DRIP IRRIGATION WATER USAGE BY SITE

Site 1

		Schedule		
	Water Rate	Aug	Sept	Oct
Russian-Olive	1.75 liters/hour	122 hrs	89 hrs	48 hrs
Juniper	3.96 liters/hour			
Austrian Pine	3.50 liters/hour			

Lateral drip lines were 12.7 mm in diameter, the emitters were Submatic dole emitters.

Site 2

		Apr	May	July
Austrian Pine	5.00 liters/hour	133 hrs*	24 hrs	70 hrs
Arborvitae	5.10 liters/hour			
Russian-Olive				

There were no recorded watering times in the months of June, August, September, and October.

Lateral drip lines were 12.7 mm in diameter, the emitters were Submatic dole emitters.

Site 3

		July	Aug	Sept	Oct
Russian-Olive	Not used	12 hrs**	100 hrs	24 hrs	24 hrs
Juniper	2.10 liters/hour				
Austrian Pine	2.40 liters/hour				

Lateral drip lines were 12.7 mm in diameter, the emitters were Submatic dole emitters.

Site 4

Russian-Olive	16.6 liters/hour	Not available
Juniper	16.6 liters/hour	
Austrian Pine	16.6 liters/hour	

Only one lateral line (19 mm in diameter), the emitters were Stuppy emitters connected to the lateral line by microtubing.

*Operational for newly-planted seedlings.

**Pine only.

Note: Schedules were recorded by the landowner.

TABLE IV

PRECIPITATION TOTALS FOR 1978 THROUGH 1982 BY SITE

Year	Site 1	Site 2	Site 3	Site 4
1978	585.22 mm	585.22 mm	545.85 mm	682.24 mm
1979	803.15 mm	803.15 mm	722.12 mm	637.86 mm
1980	636.27 mm	636.27 mm	598.17 mm	530.87 mm
1981	592.33 mm	592.33 mm	588.26 mm	867.41 mm
1982	667.51 mm (300.70 mm in May)	667.51 mm (300.70 mm in May)	710.44 mm (259.84 mm in May)	636.31 mm (297.67 mm in May)
Normal	615.70 mm	615.70 mm	615.95 mm	685.04 mm

TABLE V

SURVIVAL RATES BY SITE, SPECIES, FERTILIZER TREATMENT

Site 1	Russian-Olive		Juniper		Austrian Pine	
Total No. Trees	30		60		65	
Number Dead	2		8		24	
By Treatment	Low SCU	1	Med AGT	1	Med AGT	1
	Control	1	High AGT	1	High AGT	2
			Low SCU	2	High SCU	4
			High SCU	1	Low RSM	5
			High RSM	3	Med RSM	5
					High RSM	6
					Control	1
Survival Rate	93.33%		86.67%		63.08%	
Sites 2 and 5	Russian-Olive (Site 5)		Arborvitae (Site 2)		Austrian Pine (Site 2)	
Total No. Trees	80		97		100	
Number Dead	32		17		7	
By Treatment	Low AGT	3	Med AGT	2	Low AGT	1
	Med AGT	4	High AGT	3	High AGT	1
	High AGT	3	Low SCU	1	Low SCU	1
	Low SCU	3	Med SCU	2	High SCU	1
	Med SCU	3	High SCU	2	High RSM	2
	High SCU	5	Low RSM	3	Control	1
	Low RSM	3	Med RSM	1		
	Med RSM	1	High RSM	2		
	High RSM	4	Control	1		
	Control	3				
Survival Rate	60.00%		82.47%		93.00%	

TABLE V (Continued)

Site 3	Russian-Olive	Juniper	Austrian Pine
Total No. Trees	74	91	80
Number Dead	0	0	10
By Treatment	---	---	Med AGT 1 Low SCU 2 Low RSM 1 Med RSM 2 High RSM 3 Control 1
Survival Rate	100%	100%	87.50%
Site 4	**Russian-Olive**	**Juniper**	**Austrian Pine**
Total No. Trees	62	55	49
Number Dead	1	1	10
By Treatment	Low AGT 1	Low AGT 1	Low SCU 1 High SCU 3 Low RSM 2 High RSM 3 Control 1
Survival Rate	98.39%	98.18%	79.59%

TABLE VI

MEAN FOLIAR NITROGEN CONCENTRATIONS BY SITE

Legend

Fertilizer Treatments

FR = Fertilizer Rate
FT = Fertilizer Type

AGT = Agriform Tablet
SCU = Sulfur Coated Urea
RSM = Readily Soluble Mixture

FR	FT	
1	1	= Low Rate AGT
1	2	= Low Rate SCU
1	3	= Low Rate RSM
3	1	= High Rate AGT
3	2	= High Rate SCU
3	3	= High Rate RSM
4	4	= Control

Species

1 = Russian-Olive
2 = Juniper
3 = Austrian Pine
4 = Arborvitae

Mean Percent Foliar Nitrogen

MNITRC = Mean Nitrogen Concentration

TABLE VI (Continued)

Site = 1 Species = 1

		Means	
FR	FT	N	MNITRC
1	1	3	3.47400000
1	2	2	3.30450000
1	3	3	3.76100000
3	1	3	3.76200000
3	2	3	3.47933333
3	3	3	3.50933333
4	4	2	3.37300000

Site = 1 Species = 2

		Means	
FR	FT	N	MNITRC
1	1	4	1.43050000
1	2	3	1.77866667
1	3	4	1.41225000
3	1	4	1.47400000
3	2	4	1.56000000
3	3	2	1.49900000
4	4	4	1.75850000

Site = 1 Species = 3

		Means	
FR	FT	N	MNITRC
1	1	3	1.30266667
1	2	4	1.28025000
1	3	1	1.46200000
3	1	3	1.14366667
3	2	2	1.03600000
4	4	3	0.68933333

Site = 2 Species = 3

1	1	6	1.37733333
1	2	5	1.50020000
1	3	6	1.40900000
3	1	6	1.45350000
3	2	6	1.42733333
3	3	6	1.18516667
4	4	10	1.31700000

Site = 2 Species = 4

1	1	6	1.90883333
1	2	5	2.03520000
1	3	4	2.03625000
3	1	6	2.07016667
3	2	6	1.94733333
3	3	7	1.99271429
4	4	9	2.04977778

Site = 3 Species = 1

1	1	5	2.76700000
1	2	5	2.81100000
1	3	4	2.67300000
3	1	4	2.90225000
3	2	4	2.67900000
3	3	5	2.71320000
4	4	4	2.96400000

Site = 3 Species = 2

1	1	5	1.58880000
1	2	5	1.69920000
1	3	5	1.46900000
3	1	5	1.61420000
3	2	5	1.66060000
3	3	5	1.72840000
4	4	5	1.56520000

Site = 3 Species = 3

1	1	5	1.04920000
1	2	4	0.94950000
1	3	4	0.96300000
3	1	5	0.85560000
3	2	5	0.86050000
3	3	4	0.96300000
4	4	5	0.89760000

TABLE VI (Continued)

Means				Means				Means			
FR	FT	N	MNITRC	FR	FT	N	MNITRC	FR	FT	N	MNITRC
Site = 4		Species = 1		Site = 4		Species = 2		Site = 4		Species = 3	
1	1	4	3.50750000	1	1	3	1.68333333	1	1	6	1.66716667
1	2	4	3.60775000	1	2	4	1.77525000	1	2	5	1.62000000
1	3	4	3.82575000	1	3	5	1.71160000	1	3	4	1.56075000
3	1	4	4.02900000	3	1	3	1.63066667	3	1	6	1.83550000
3	2	4	3.97025000	3	2	5	1.68160000	3	2	2	1.64800000
3	3	3	3.93533333	3	3	5	1.66940000	3	3	3	1.67366667
4	4	4	3.54025000	4	4	5	1.80940000	4	4	5	1.76500000

TABLE VII

STATISTICAL ANALYSIS OF FOLIAR NITROGEN CONCENTRATIONS BY SITE

Legend

Fertilizer Treatments

FR = Fertilizer Rate
FT = Fertilizer Type

AGT = Agriform Tablet
SCU = Sulfur Coated Urea
RSM = Readily Soluble Mixture

FR	FT	
1	1	= Low Rate AGT
1	2	= Low Rate SCU
1	3	= Low Rate RSM
3	1	= High Rate AGT
3	2	= High Rate SCU
3	3	= High Rate RSM
4	4	= Control

Species

1 = Russian-Olive
2 = Juniper
3 = Austrian Pine
4 = Arborvitae

Mean Percent Foliar Nitrogen

MNITRC = Mean Nitrogen Concentration

TABLE VII (Continued)

SITE=1 SPECIES=1

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	0.58513726	0.07314216	1.68	0.2167	0.573868	5.8838
ERROR	10	0.43450042	0.04345004		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	18	1.01963768			0.20844674		3.54273684

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	2	0.05788618	0.67	0.5351
FR*FT	6	0.52725108	2.02	0.1553

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	3.47400000	0.12034678	0.0001	1		0.3131	0.1226	0.1215	0.9756	0.8397	0.5718
1	2	3.26837529	0.15162799	0.0001	2	0.3131		0.0291	0.0289	0.3014	0.2416	0.6801
1	3	3.76100000	0.12034678	0.0001	3	0.1226	0.0291		0.9954	0.1289	0.1700	0.0656
3	1	3.76200000	0.12034678	0.0001	4	0.1215	0.0289	0.9954		0.1277	0.1685	0.0650
3	2	3.47933333	0.12034678	0.0001	5	0.9756	0.3014	0.1289	0.1277		0.8636	0.5541
3	3	3.50933333	0.12034678	0.0001	6	0.8397	0.2416	0.1700	0.1685	0.8636	.	0.4607
4	4	3.36082984	0.15162799	0.0001	7	0.5718	0.6801	0.0656	0.0650	0.5541	0.4607	

SITE=1 SPECIES=2

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	9	0.57819939	0.06424438	1.60	0.2023	0.489789	12.8864
ERROR	15	0.60230661	0.04015377		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	24	1.18050600			0.20038407		1.55500000

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	3	0.13397679	1.11	0.3752
FR*FT	6	0.44422261	1.84	0.1575

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	1.43050000	0.10019203	0.0001	1		0.0574	0.8992	0.7631	0.3752	0.5573	0.0352
1	2	1.74944626	0.11823184	0.0001	2	0.0574		0.0460	0.0958	0.2404	0.2893	0.9542
1	3	1.41225000	0.10019203	0.0001	3	0.8992	0.0460		0.6692	0.3136	0.4931	0.0274
3	1	1.47400000	0.10019203	0.0001	4	0.7631	0.0958	0.6692		0.5530	0.7262	0.0630
3	2	1.56000000	0.10019203	0.0001	5	0.3752	0.2404	0.3136	0.5530		0.9024	0.1816
3	3	1.53771729	0.14784930	0.0001	6	0.5573	0.2893	0.4931	0.7262	0.9024		0.2354
4	4	1.75850000	0.10019203	0.0001	7	0.0352	0.9542	0.0274	0.0630	0.1816	0.2354	

SITE=1 SPECIES=3

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	8	1.31839458	0.16479932	1.38	0.3437	0.611162	30.6644
ERROR	7	0.83879917	0.11982845		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	15	2.15719375			0.34616247		1.12887500

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	3	0.46286305	1.29	0.3511
FR*FT	5	0.85553153	1.43	0.3219

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6
1	1	1.33151282	0.21288432	0.0004	1		0.8571	0.9734	0.3615	0.2401	0.0666
1	2	1.28025000	0.17308123	0.0001	2	0.8571		0.8784	0.3922	0.2838	0.0797
1	3	1.34607885	0.37706905	0.0091	3	0.9734	0.8784		0.4857	0.3553	0.1806
3	1	1.03267308	0.20924501	0.0017	4	0.3615	0.3922	0.4857		0.7278	0.3384
3	2	0.91277885	0.26511129	0.0108	5	0.2401	0.2838	0.3553	0.7278		0.5695
4	4	0.71817949	0.21288432	0.0119	6	0.0666	0.0797	0.1806	0.3384	0.5695	

TABLE VII (Continued)

SITE=2 SPECIES=3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	16	1.22931181	0.07683199	2.52	0.0157	0.590038	12.7208
ERROR	28	0.85413419	0.03050479		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	44	2.08344600			0.17465621		1.37300000

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	10	0.73776208	2.42	0.0321
FR*FT	6	0.49154973	2.69	0.0347

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	1.46568581	0.08286104	0.0001	1		0.2117	0.7558	0.9773	0.9474	0.0267	0.2396
1	2	1.60211281	0.08989844	0.0001	2	0.2117		0.3347	0.2318	0.2454	0.0015	0.0226
1	3	1.49735248	0.08286104	0.0001	3	0.7558	0.3347		0.7828	0.8117	0.0132	0.1408
3	1	1.46864128	0.08342049	0.0001	4	0.9773	0.2318	0.7828		0.9697	0.0240	0.2389
3	2	1.47255556	0.08342049	0.0001	5	0.9474	0.2454	0.8117	0.9697		0.0221	0.2247
3	3	1.22422876	0.08356354	0.0001	6	0.0267	0.0015	0.0132	0.0240	0.0221		0.2539
4	4	1.34451915	0.05628855	0.0001	7	0.2396	0.0226	0.1408	0.2389	0.2247	0.2539	

SITE=2 SPECIES=4

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	18	3.54411694	0.19689539	3.03	0.0060	0.694606	12.6995
ERROR	24	1.55822353	0.06492598		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	42	5.10234047			0.25480577		2.00641860

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	12	3.06274017	3.93	0.0021
FR*FT	6	0.48137677	1.24	0.3233

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	1.86632030	0.12776322	0.0001	1		0.2345	0.3745	0.8238	0.7856	0.9191	0.0631
1	2	2.06124155	0.13601823	0.0001	2	0.2345		0.8162	0.3263	0.1512	0.2600	0.4279
1	3	2.01832831	0.15229413	0.0001	3	0.3745	0.8162		0.5004	0.2864	0.4278	0.3434
3	1	1.90025158	0.12967995	0.0001	4	0.8238	0.3263	0.5004		0.6236	0.8985	0.0998
3	2	1.82365947	0.12525172	0.0001	5	0.7856	0.1512	0.2864	0.6236		0.6905	0.0335
3	3	1.88139732	0.11830873	0.0001	6	0.9191	0.2600	0.4278	0.8985	0.6905		0.0624
4	4	2.20453667	0.09420444	0.0001	7	0.0631	0.4279	0.3434	0.0998	0.0335	0.0624	

TABLE VII (Continued)

SITE=3 SPECIES=1

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	10	0.95886770	0.09588677	1.53	0.1994	0.433911	8.9807
ERROR	20	1.25095714	0.06254786		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	30	2.20982484			0.25009570		2.78480645

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	4	0.63896908	2.55	0.0707
FR*FT	6	0.31989863	0.85	0.5455

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	2.76700000	0.11184620	0.0001	1		0.7837	0.5117	0.4925	0.5004	0.7373	0.2670
1	2	2.81100000	0.11184620	0.0001	2	0.7837		0.3645	0.6651	0.3554	0.5434	0.3882
1	3	2.65384283	0.12718421	0.0001	3	0.5117	0.3645		0.2146	0.9865	0.7297	0.1052
3	1	2.88540805	0.12718421	0.0001	4	0.4925	0.6651	0.2146		0.2087	0.3214	0.6824
3	2	2.65075588	0.12718421	0.0001	5	0.5004	0.3554	0.9865	0.2087		0.7162	0.1020
3	3	2.71320000	0.11184620	0.0001	6	0.7373	0.5434	0.7297	0.3214	0.7162		0.1599
4	4	2.96040805	0.12718421	0.0001	7	0.2670	0.3882	0.1052	0.6824	0.1020	0.1599	

SITE=3 SPECIES=2

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	10	0.41795960	0.04179596	1.49	0.2047	0.382504	10.3635
ERROR	24	0.67473514	0.02811396		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	34	1.09269474			0.16767219		1.61791429

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	4	0.18569846	1.65	0.1941
FR*FT	6	0.23226114	1.38	0.2640

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	1.58880000	0.07498528	0.0001	1		0.3082	0.2698	0.8127	0.5048	0.2005	0.8258
1	2	1.69920000	0.07498528	0.0001	2	0.3082		0.0401	0.4307	0.7190	0.7854	0.2185
1	3	1.46900000	0.07498528	0.0001	3	0.2698	0.0401		0.1836	0.0834	0.0221	0.3733
3	1	1.61420000	0.07498528	0.0001	4	0.8127	0.4307	0.1836		0.6656	0.2922	0.6482
3	2	1.66060000	0.07498528	0.0001	5	0.5048	0.7190	0.0834	0.6656		0.5287	0.3773
3	3	1.72840000	0.07498528	0.0001	6	0.2005	0.7854	0.0221	0.2922	0.5287		0.1369
4	4	1.56520000	0.07498528	0.0001	7	0.8258	0.2185	0.3733	0.6482	0.3773	0.1369	

SITE=3 SPECIES=3

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	10	0.23182145	0.02318215	1.16	0.3658	0.356739	15.1418
ERROR	21	0.41801304	0.01990538		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	31	0.64983449			0.14108644		0.93176562

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	4	0.09941650	1.25	0.3211
FR*FT	6	0.13240495	1.11	0.3904

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	1.04920000	0.06309577	0.0001	1		0.2502	0.3342	0.0416	0.0466	0.3210	0.1041
1	2	0.93621873	0.07173637	0.0001	2	0.2502		0.8574	0.4083	0.4369	0.8777	0.6901
1	3	0.95476221	0.07173637	0.0001	3	0.3342	0.8574		0.3111	0.3350	0.9793	0.5560
3	1	0.85560000	0.06309577	0.0001	4	0.0416	0.4083	0.3111		0.9567	0.3240	0.6427
3	2	0.86050000	0.06309577	0.0001	5	0.0466	0.4369	0.3350	0.9567		0.3486	0.6818
3	3	0.95208829	0.07173637	0.0001	6	0.3210	0.8777	0.9793	0.3240	0.3486		0.5745
4	4	0.89760000	0.06309577	0.0001	7	0.1041	0.6901	0.5560	0.6427	0.6818	0.5745	

TABLE VII (Continued)

SITE=4 SPECIES=1

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	9	3.82594302	0.42510478	2.43	0.0547	0.562926	11.0948
ERROR	17	2.97058861	0.17474051		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	26	6.79653163			0.41801974		3.76770370

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	3	2.72789165	5.20	0.0099
FR*FT	6	1.09805137	1.05	0.4302

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	3.50750000	0.20900987	0.0001	1		0.7386	0.2967	0.0956	0.1359	0.2181	0.9131
1	2	3.60775000	0.20900987	0.0001	2	0.7386		0.4709	0.1722	0.2368	0.3463	0.8221
1	3	3.82575000	0.20900987	0.0001	3	0.2967	0.4709		0.5010	0.6312	0.7724	0.3476
3	1	4.02900000	0.20900987	0.0001	4	0.0956	0.1722	0.5010		0.8448	0.7415	0.1166
3	2	3.97025000	0.20900987	0.0001	5	0.1359	0.2368	0.6312	0.8448		0.8799	0.1640
3	3	3.92069444	0.24632050	0.0001	6	0.2181	0.3463	0.7724	0.7415	0.8799		0.2551
4	4	3.54025000	0.20900987	0.0001	7	0.9131	0.8221	0.3476	0.1166	0.1640	0.2551	

SITE=4 SPECIES=2

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	10	0.20635413	0.02063541	1.66	0.1638	0.466414	6.4428
ERROR	19	0.23607257	0.01242487		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	29	0.44242670			0.11146691		1.73010000

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	4	0.09440933	1.90	0.1520
FR*FT	6	0.11194480	1.50	0.2308

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	1.64408378	0.06688230	0.0001	1		0.1685	0.4283	0.9960	0.1157	0.7648	0.0622
1	2	1.76743750	0.05710980	0.0001	2	0.1685		0.4704	0.1700	0.8538	0.2114	0.5863
1	3	1.71160000	0.04984952	0.0001	3	0.4283	0.4704		0.4315	0.3332	0.5565	0.1814
3	1	1.64455437	0.06688230	0.0001	4	0.9960	0.1700	0.4315		0.1168	0.7690	0.0628
3	2	1.78160000	0.04984952	0.0001	5	0.1157	0.8538	0.3332	0.1168		0.1280	0.6977
3	3	1.66940000	0.04984952	0.0001	6	0.7648	0.2114	0.5565	0.7690	0.1280		0.0617
4	4	1.80940000	0.04984952	0.0001	7	0.0622	0.5863	0.1814	0.0628	0.6977	0.0617	

SITE=4 SPECIES=3

DEPENDENT VARIABLE: MNITRC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	11	0.60362963	0.05487542	1.98	0.0928	0.533510	9.8413
ERROR	19	0.52780192	0.02777905		ROOT MSE		MNITRC MEAN
CORRECTED TOTAL	30	1.13143155			0.16667048		1.69358065

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	5	0.34815142	2.51	0.0664
FR*FT	6	0.25547821	1.53	0.2211

LEAST SQUARES MEANS

FR	FT	MNITRC LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	1.66716667	0.06804294	0.0001	1		0.4979	0.3222	0.0964	0.6404	0.7892	0.4079
1	2	1.59668439	0.07597516	0.0001	2	0.4979		0.7186	0.0303	0.3699	0.4323	0.1613
1	3	1.55530188	0.08650632	0.0001	3	0.3222	0.7186		0.0197	0.2627	0.3068	0.1029
3	1	1.83550000	0.06804294	0.0001	4	0.0964	0.0303	0.0197		0.4957	0.2843	0.4295
3	2	1.73550252	0.12686625	0.0001	5	0.6404	0.3699	0.2627	0.4957		0.8237	0.9070
3	3	1.70040649	0.10198364	0.0001	6	0.7892	0.4323	0.3068	0.2843	0.8237		0.6854
4	4	1.75331460	0.07571626	0.0001	7	0.4079	0.1613	0.1029	0.4295	0.9070	0.6854	

TABLE VIII

MEAN PERCENT INCREASE IN HEIGHT AND DIAMETER
BY SITE, SPECIES AND FERTILIZER TREATMENT

Legend

Fertilizer Treatments

FR = Fertilizer Rate
FT = Fertilizer Type

AGT = Agriform Tablet
SCU = Sulfur Coated Urea
RSM = Readily Soluble Mixture

FR	FT	
1	1	= Low Rate AGT
1	2	= Low Rate SCU
1	3	= Low Rate RSM
2	1	= Medium Rate AGT
2	2	= Medium Rate SCU
2	3	= Medium Rate RSM
3	1	= High Rate AGT
3	2	= High Rate SCU
3	3	= High Rate RSM
4	4	= Control

Species

1 = Russian-Olive
2 = Juniper
3 = Austrian Pine
4 = Arborvitae

Mean Percent Height Growth

PCTH1M = One Growing Season After Fertilization
PCTH2M = Second Growing Season After Fertilization Estimate

Mean Percent Diameter Growth

PCTD1M = One Growing Season After Fertilization
PCTD2M = Second Growing Season After Fertilization Estimate

TABLE VIII (Continued)

SITE=1 SPECIES=1

MEANS

FR	FT	N	PCTH1M	PCTD1M
1	1	4	157.336921	140.781574
1	2	3	145.588419	188.382752
1	3	4	210.678720	230.337809
3	1	4	139.624541	172.446396
3	2	4	168.042747	210.946383
3	3	4	165.088352	224.785895
4	4	4	167.596068	192.272006

SITE=1 SPECIES=2

MEANS

FR	FT	N	PCTH1M	PCTD1M
1	1	5	93.286576	99.097462
1	2	3	100.498575	78.768881
1	3	6	102.456708	86.874841
2	1	5	95.933449	97.944957
2	2	6	141.787212	69.287412
2	3	4	102.097068	81.116394
3	1	4	133.970730	83.615545
3	2	5	133.042064	112.266413
3	3	3	144.102313	94.426046
4	4	5	77.574892	63.543150

SITE=1 SPECIES=3

MEANS

FR	FT	N	PCTH1M	PCTH2M	PCTD1M	PCTD2M
1	1	6	117.541847	258.528139	60.9419284	81.6412923
1	2	6	120.485732	216.561584	62.3466944	83.7981811
1	3	1	64.285714	135.714286	46.7532468	66.2337662
2	1	6	74.881925	156.326620	59.5089321	97.8616926
2	2	6	87.340368	173.164983	53.4853625	73.6399765
2	3	1	45.000000	150.000000	67.5000000	65.0000000
3	1	4	100.378709	187.782954	27.5546218	44.6013072
3	2	3	154.694264	235.863095	29.7509413	38.4924919
4	4	7	96.911719	162.243094	39.5842146	63.6775948

TABLE VIII (Continued)

SITE=2 SPECIES=3

MEANS

FR	FT	N	PCTH1M	PCTH2M	PCTD1M	PCTD2M
1	1	4	49.1149889	106.249305	178.457677	189.945154
1	2	5	39.8099839	92.450886	157.520593	175.641637
1	3	6	48.2889895	92.785162	167.458536	184.908391
2	1	5	46.7855750	87.504033	144.954979	169.742253
2	2	3	19.9404762	62.688492	173.737374	197.087542
2	3	7	52.9947090	99.079365	185.765617	168.808779
3	1	4	40.0518341	90.437742	165.432432	174.815034
3	2	6	26.9535862	66.313797	178.498606	206.139976
3	3	6	42.0515572	78.804714	119.783362	150.895910
4	4	8	32.5773278	76.849150	133.920354	162.155628

SITE=2 SPECIES=4

MEANS

FR	FT	N	PCTH1M	PCTD1M
1	1	9	36.4407922	87.1591300
1	2	8	29.6239765	65.9024162
1	3	6	33.2498542	76.2730388
2	1	8	17.3309091	52.8169952
2	2	7	21.1882161	52.8072611
2	3	9	30.7015636	58.8252855
3	1	6	47.5813847	77.7613208
3	2	7	19.2296484	54.0072929
3	3	8	17.2821648	48.6320677
4	4	13	4.7845638	50.8845913

SITE=5 SPECIES=1

MEANS

FR	FT	N	PCTH1M	PCTD1M
1	1	4	16.6553209	29.755264
1	2	4	42.7015203	36.566660
1	3	4	9.0883970	53.625962
2	1	4	34.2374511	59.899613
2	2	4	16.5166869	119.340861
2	3	6	12.9108559	33.035335
3	1	3	20.5647694	53.669799
3	2	2	13.2593213	41.009125
3	3	2	22.0354809	88.299320
4	4	3	31.2413624	40.193071

TABLE VIII (Continued)

SITE=3 SPECIES=1

MEANS

FR	FT	N	PCTH1M	PCTD1M
1	1	7	48.8093156	51.8171845
1	2	7	76.1492482	43.5113100
1	3	7	74.9811021	45.9455150
2	1	7	58.8719312	61.7414029
2	2	7	59.6118787	72.0792509
2	3	7	59.6837028	82.3108736
3	1	7	58.4221954	75.4329739
3	2	7	58.3729401	59.3404061
3	3	7	63.1221796	50.9061951
4	4	8	53.6637251	77.4767675

SITE=3 SPECIES=2

MEANS

FR	FT	N	PCTH1M	PCTD1M
1	1	9	56.6471806	61.1489056
1	2	9	50.2808117	57.5594597
1	3	9	47.4635842	73.4045403
2	1	9	43.6850622	54.1159125
2	2	9	45.4783761	70.4977954
2	3	9	43.2888223	58.7718790
3	1	9	57.3219043	64.7081409
3	2	9	61.4502825	57.9611295
3	3	9	67.7779311	51.9525678
4	4	9	55.2863693	60.8059800

SITE=3 SPECIES=3

MEANS

FR	FT	N	PCTH1M	PCTH2M	PCTD1M	PCTD2M
1	1	8	30.6498089	99.3415026	23.0178879	37.8975177
1	2	6	10.1600810	61.0068370	10.7171673	33.6929599
1	3	6	21.9797178	87.2039014	24.6270352	48.6123574
2	1	6	25.1558851	88.3224507	58.9473672	69.1904675
2	2	7	7.8278743	53.7343126	19.3266279	36.3588075
2	3	5	8.7105039	61.6226104	22.9930324	30.3416643
3	1	6	21.6734908	69.8345544	21.0412503	30.8234158
3	2	5	2.9149476	20.7863258	22.3877945	30.8584606
3	3	4	2.3711188	28.5087218	43.2233971	50.5267070
4	4	5	20.7983778	42.3413105	7.3649036	11.6859893

TABLE VIII (Continued)

SITE=4 SPECIES=1

MEANS

FR	FT	N	PCTH1M	PCTD1M
1	1	6	65.7860018	72.743999
1	2	5	62.3442959	89.764816
1	3	6	79.5842158	67.897436
2	1	5	59.9508117	72.652367
2	2	6	83.3612264	107.392078
2	3	6	71.6652868	72.727890
3	1	6	81.9532600	83.756334
3	2	6	74.1190254	79.022235
3	3	5	77.4774550	77.332081
4	4	6	84.5372569	80.978262

SITE=4 SPECIES=2

MEANS

FR	FT	N	PCTH1M	PCTD1M
1	1	6	72.751776	157.218846
1	2	8	133.301097	170.217109
1	3	6	129.188121	159.158286
3	1	8	97.110298	161.201834
3	2	8	119.964326	145.039257
3	3	5	95.293055	124.256974
4	4	6	115.456434	167.228071

SITE=4 SPECIES=3

MEANS

FR	FT	N	PCTH1M	PCTH2M	PCTD1M	PCTD2M
1	1	7	92.449619	205.523362	71.1699306	101.766145
1	2	6	101.111111	260.015263	58.5149578	81.552581
1	3	4	73.674242	265.882035	50.9170275	78.105548
3	1	7	126.514706	306.769957	66.5411332	92.501569
3	2	4	74.018322	191.098733	66.6496159	106.004552
3	3	4	84.721592	236.413591	68.2524027	96.999592
4	4	6	88.087290	218.816620	46.6587927	63.959429

TABLE IX

STATISTICAL ANALYSIS OF MEAN PERCENT INCREASE IN HEIGHT AND DIAMETER BY SITE, SPECIES AND FERTILIZER TREATMENT

Legend

Fertilizer Treatments

FR = Fertilizer Rate
FT = Fertilizer Type

AGT = Agriform Tablet
SCU = Sulfur Coated Urea
RSM = Readily Soluble Mixture

FR	FT	
1	1	= Low Rate AGT
1	2	= Low Rate SCU
1	3	= Low Rate RSM
2	1	= Medium Rate AGT
2	2	= Medium Rate SCU
2	3	= Medium Rate RSM
3	1	= High Rate AGT
3	2	= High Rate SCU
3	3	= High Rate RSM
4	4	= Control

Species

1 = Russian-Olive
2 = Juniper
3 = Austrian Pine
4 = Arborvitae

Mean Percent Height Growth

PCTH1M = One Growing Season After Fertilization
PCTH2M = Second Growing Season After Fertilization Estimate

Mean Percent Diameter Growth

PCTD1M = One Growing Season After Fertilization
PCTD2M = Second Growing Season After Fertilization Estimate

TABLE IX (Continued)

SITE=1 SPECIES=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	9	85922.19988700	9546.91109856	1.53	0.2161	0.447058	47.7551
ERROR	17	106272.48842986	6251.32284882		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	26	192194.68831686			79.06530749		165.56424653

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	3	74867.58881959	3.99	0.0254
FR*FT	6	11054.61106741	0.29	0.9811

LEAST SQUARES MEANS

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	157.336921	39.532654	0.0010	1		0.9236	0.3534	0.7552	0.8504	0.8914	0.8566
1	2	163.280703	46.589679	0.0027	2	0.9236		0.4486	0.7034	0.9388	0.9767	0.9445
1	3	210.678720	39.532654	0.0001	3	0.3534	0.4486		0.2209	0.4561	0.4261	0.4515
3	1	139.624541	39.532654	0.0026	4	0.7552	0.7034	0.2209		0.6178	0.6545	0.6233
3	2	168.042747	39.532654	0.0005	5	0.8504	0.9388	0.4561	0.6178		0.9585	0.9937
3	3	165.088352	39.532654	0.0006	6	0.8914	0.9767	0.4261	0.6545	0.9585		0.9647
4	4	167.596068	39.532654	0.0006	7	0.8566	0.9445	0.4515	0.6233	0.9937	0.9647	

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	9	86600.82244256	9622.31360473	1.60	0.1946	0.457824	39.9341
ERROR	17	102556.73444255	6032.74908486		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	26	189157.55688512			77.67077369		194.49735205

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	3	62291.72384946	3.44	0.0404
FR*FT	6	24309.09859310	0.67	0.6741

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	140.781574	38.835387	0.0021	1		0.2377	0.1214	0.5718	0.2186	0.1445	0.3616
1	2	214.246194	45.767942	0.0002	2	0.2377		0.7919	0.4956	0.9568	0.8627	0.7188
1	3	230.337809	38.835387	0.0001	3	0.1214	0.7919		0.3066	0.7284	0.9207	0.4976
3	1	172.446396	38.835387	0.0004	4	0.5718	0.4956	0.3066		0.4928	0.3540	0.7226
3	2	210.946383	38.835387	0.0001	5	0.2186	0.9568	0.7284	0.4928		0.8041	0.7380
3	3	224.785895	38.835387	0.0001	6	0.1445	0.8627	0.9207	0.3540	0.8041		0.5616
4	4	192.272006	38.835387	0.0001	7	0.3616	0.7188	0.4976	0.7226	0.7380	0.5616	

SITE=1 SPECIES=2

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	14	50951.52076462	3639.39434033	1.77	0.0920	0.443574	40.6147
ERROR	31	63914.32510901	2061.75242287		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	45	114865.84587364			45.40652401		111.79831058

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	5	24001.05338765	2.33	0.0661
FR*FT	9	26950.46737698	1.45	0.2094

LEAST SQUARES MEANS

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9	10
1	1	90.447909	20.544374	0.0001	1		0.9843	0.6673	0.7522	0.0731	0.7181	0.1124	0.1247	0.0673	0.7627
1	2	91.122148	27.279910	0.0022	2	0.9843		0.7334	0.7977	0.1346	0.7641	0.1642	0.1836	0.1033	0.7765
1	3	102.456708	18.537136	0.0001	3	0.6673	0.7334		0.9257	0.1437	0.9857	0.1978	0.2260	0.1150	0.4579
2	1	99.832430	20.871212	0.0001	4	0.7522	0.7977	0.9257		0.1430	0.9462	0.1806	0.2058	0.1055	0.5273
2	2	141.787212	18.537136	0.0001	5	0.0731	0.1346	0.1437	0.1430		0.1926	0.9990	0.8633	0.6698	0.0386
2	3	101.917585	23.506189	0.0001	6	0.7181	0.7641	0.9857	0.9462	0.1926		0.2301	0.2624	0.1321	0.5101
3	1	141.825708	23.476031	0.0001	7	0.1124	0.1642	0.1978	0.1806	0.9990	0.2301		0.8744	0.6931	0.0580
3	2	136.941045	20.871212	0.0001	8	0.1247	0.1836	0.2260	0.2058	0.8633	0.2624	0.8744		0.5756	0.0626
3	3	156.002038	27.327950	0.0001	9	0.0673	0.1033	0.1150	0.1055	0.6698	0.1321	0.6931	0.5756		0.0344
4	4	81.473873	20.871212	0.0005	10	0.7627	0.7765	0.4579	0.5273	0.0386	0.5101	0.0580	0.0626	0.0344	

TABLE IX (Continued)

SITE=1 SPECIES=2

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	14	14098.89120483	1007.06365749	0.79	0.6713	0.263172	41.2455
ERROR	31	39473.95211332	1273.35329398		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	45	53572.84331815			35.68407620		86.51621670

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	5	3593.05259110	0.56	0.7265
FR*FT	9	10505.83861373	0.92	0.5238

LEAST SQUARES MEANS

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	I/J	1	2	3	4	5	6	7	8	9	10
1	1	99.725271	16.145411	0.0001	1		0.4944	0.5589	0.9362	0.1715	0.5896	0.5438	0.4897	0.9097	0.1699
1	2	81.268253	21.438734	0.0007	2	0.4944		0.8302	0.4485	0.6471	0.8604	0.9072	0.2003	0.4830	0.5987
1	3	86.874841	14.567963	0.0001	3	0.5589	0.8302		0.5073	0.3998	0.9785	0.9220	0.1953	0.5431	0.3765
2	1	101.592634	16.402267	0.0001	4	0.9362	0.4485	0.5073		0.1509	0.5288	0.4847	0.5304	0.9629	0.1376
2	2	69.287412	14.567963	0.0001	5	0.1715	0.6471	0.3998	0.1509		0.4767	0.5208	0.0416	0.2057	0.9245
2	3	86.235888	18.473042	0.0001	6	0.5896	0.8604	0.9785	0.5288	0.4767		0.9481	0.2276	0.5503	0.4356
3	1	84.554351	18.449342	0.0001	7	0.5438	0.9072	0.9220	0.4847	0.5208	0.9481		0.2026	0.5181	0.4765
3	2	115.914089	16.402267	0.0001	8	0.4897	0.2003	0.1953	0.5304	0.0416	0.2276	0.2026		0.6247	0.0387
3	3	102.833856	21.476488	0.0001	9	0.9097	0.4830	0.5431	0.9629	0.2057	0.5503	0.5181	0.6247		0.1880
4	4	67.190826	16.402267	0.0003	10	0.1699	0.5987	0.3765	0.1376	0.9245	0.4356	0.4765	0.0387	0.1880	

SITE=1 SPECIES=3

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	14	44689.50490889	3192.10749349	1.26	0.2959	0.414110	49.6109
ERROR	25	63227.41850045	2529.09674002		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	39	107916.92340934			50.29012567		101.36911530

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	17981.62810084	1.18	0.3461
FR*FT	8	26707.87680806	1.32	0.2791

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	I/J	1	2	3	4	5	6	7	8	9
1	1	118.056561	21.948410	0.0001	1		0.9200	0.7302	0.1542	0.3082	0.2806	0.5370	0.1320	0.4732
1	2	121.000446	21.948410	0.0001	2	0.9200		0.6924	0.1288	0.2645	0.2594	0.4812	0.1522	0.4146
1	3	98.124554	53.903919	0.0807	3	0.7302	0.6924		0.6943	0.8589	0.5742	0.9898	0.2129	0.9832
2	1	75.396638	21.948410	0.0021	4	0.1542	0.1288	0.6943		0.6715	0.7204	0.5123	0.0116	0.4656
2	2	87.855081	21.948410	0.0005	5	0.3082	0.2645	0.8589	0.6715		0.5682	0.7759	0.0251	0.7577
2	3	54.548844	54.354079	0.3252	6	0.2806	0.2594	0.5742	0.7204	0.5682		0.4883	0.0570	0.4688
3	1	97.366832	27.039109	0.0014	7	0.5370	0.4812	0.9898	0.5123	0.7759	0.4883		0.0625	0.9891
3	2	175.052255	31.275253	0.0001	8	0.1320	0.1522	0.2129	0.0116	0.0251	0.0570	0.0625		0.0427
4	4	96.911719	19.007881	0.0001	9	0.4732	0.4146	0.9832	0.4656	0.7577	0.4688	0.9891	0.0427	

DEPENDENT VARIABLE: PCTH2M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	14	165560.96994519	11825.78356751	1.32	0.2622	0.425578	49.0653
ERROR	25	223465.54847300	8938.62193892		ROOT MSE		PCTH2M MEAN
CORRECTED TOTAL	39	389026.51841819			94.54428560		192.69062499

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	95270.73750225	1.78	0.1450
FR*FT	8	70290.23244295	0.98	0.4720

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

FR	FT	PCTH2M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	I/J	1	2	3	4	5	6	7	8	9
1	1	268.524660	41.262509	0.0001	1		0.4492	0.5634	0.0729	0.1304	0.5797	0.1750	0.7938	0.0628
1	2	226.558105	41.262509	0.0001	2	0.4492		0.8470	0.2803	0.4341	0.8637	0.4778	0.3904	0.2498
1	3	205.603102	101.338134	0.0532	3	0.5634	0.8470		0.7178	0.8363	0.9880	0.8308	0.4801	0.6900
2	1	166.323142	41.262509	0.0005	4	0.0729	0.2803	0.7178		0.7603	0.7049	0.8056	0.0925	0.9410
2	2	183.161505	41.262509	0.0002	5	0.1304	0.4341	0.8363	0.7603		0.8219	0.9824	0.1449	0.7048
2	3	207.786363	102.184425	0.0528	6	0.5797	0.8637	0.9880	0.7049	0.8219		0.8221	0.4934	0.6776
3	1	181.776334	50.832906	0.0015	7	0.1750	0.4778	0.8308	0.8056	0.9824	0.8221		0.1736	0.7559
3	2	286.700115	58.796761	0.0001	8	0.7938	0.3904	0.4801	0.0925	0.1449	0.4934	0.1736		0.0825
4	4	162.243094	35.734381	0.0001	9	0.0628	0.2498	0.6900	0.9410	0.7048	0.6776	0.7559	0.0825	

TABLE IX (Continued)

SITE=1 SPECIES=3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	14	8003.76711520	571.69765109	0.71	0.7411	0.285671	56.3480
ERROR	25	20013.63067302	800.54522692		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	39	28017.39778822			28.29390795		50.21278912

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	971.31195777	0.20	0.9729
FR*FT	8	7032.45515744	1.10	0.3971

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
1	1	60.4670083	12.3484738	0.0001	1		0.9322	0.4236	0.9308	0.6520	0.8402	0.0767	0.0918	0.2129
1	2	61:8717742	12.3484738	0.0001	2	0.9322		0.3994	0.8635	0.5923	0.8739	0.0660	0.0805	0.1846
1	3	34.3046701	30.3270771	0.2687	3	0.4236	0.3994		0.4491	0.5660	0.4538	0.8064	0.7715	0.8709
2	1	59.0340120	12.3484738	0.0001	4	0.9308	0.8635	0.4491		0.7154	0.8062	0.0890	0.1047	0.2450
2	2	53.0104424	12.3484738	0.0002	5	0.6520	0.5923	0.5660	0.7154		0.6681	0.1607	0.1764	0.4189
2	3	67.0666985	30.5803433	0.0378	6	0.8402	0.8739	0.4538	0.8062	0.6681	.	0.2431	0.2204	0.4043
3	1	26.1268544	15.2125701	0.0983	7	0.0767	0.0660	0.8064	0.0890	0.1607	0.2431		0.9379	0.4760
3	2	24.3635257	17.5958824	0.1784	8	0.0918	0.0805	0.7715	0.1047	0.1764	0.2204	0.9379		0.4667
4	4	39.5842146	10.6940920	0.0011	9	0.2129	0.1846	0.8709	0.2450	0.4189	0.4043	0.4760	0.4667	

DEPENDENT VARIABLE: PCTD2M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	14	14978.57322815	1069.89808772	0.64	0.8098	0.262724	56.7043
ERROR	25	42034.01301843	1681.36052074		ROOT MSE		PCTD2M MEAN
CORRECTED TOTAL	39	57012.58624658			41.00439636		72.31266224

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	1765.28730244	0.17	0.9812
FR*FT	8	13213.28592571	0.98	0.4724

FR	FT	PCTD2M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
1	1	81.2324415	17.8957857	0.0001	1		0.9281	0.5498	0.4995	0.7382	0.6178	0.1965	0.1055	0.4653
1	2	83.3893302	17.8957857	0.0001	2	0.9281		0.5200	0.5578	0.6715	0.5864	0.1717	0.0920	0.4129
1	3	52.9788539	43.9509273	0.2393	3	0.5498	0.5200		0.3491	0.6676	0.9427	0.8766	0.6596	0.8203
2	1	97.4528417	17.8957857	0.0001	4	0.4995	0.5578	0.3491		0.3160	0.4030	0.0652	0.0355	0.1660
2	2	73.2311257	17.8957857	0.0004	5	0.7382	0.6715	0.6676	0.3160		0.7406	0.3128	0.1704	0.6900
2	3	57.5122094	44.3179683	0.2062	6	0.6178	0.5864	0.9427	0.4030	0.7406		0.8103	0.5965	0.8966
3	1	45.4722598	22.0465216	0.0497	7	0.1965	0.1717	0.8766	0.0652	0.3128	0.8103		0.6622	0.5055
3	2	31.1086318	25.5004907	0.2339	8	0.1055	0.0920	0.6596	0.0355	0.1704	0.5965	0.6622		0.2855
4	4	63.6775948	15.4982051	0.0004	9	0.4653	0.4129	0.8203	0.1660	0.6900	0.8966	0.5055	0.2855	

SITE=2 SPECIES=3

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	21	15756.45825626	750.30753601	0.81	0.6932	0.346014	75.4000
ERROR	32	29780.63235333	930.64476104		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	53	45537.09060959			30.50647081		40.45949812

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	12	8881.28554652	0.80	0.6521
FR*FT	9	6875.17270974	0.82	0.6015

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9	10
1	1	41.5895860	17.0232183	0.0203	1		0.8399	0.9041	0.8315	0.1456	0.5667	0.5086	0.3908	0.7180	0.7035
1	2	37.2108709	15.5215866	0.0225	2	0.8399		0.7208	0.6622	0.1888	0.4131	0.6346	0.5108	0.5553	0.8535
1	3	44.1486935	14.3870581	0.0044	3	0.9041	0.7208		0.9141	0.1001	0.6124	0.4392	0.2856	0.7938	0.5878
2	1	46.2305144	15.4306666	0.0053	4	0.8315	0.6622	0.9141		0.0909	0.7030	0.4008	0.2521	0.8799	0.5222
2	2	5.5425254	19.5568606	0.7787	5	0.1456	0.1888	0.1001	0.0909		0.0378	0.4353	0.4184	0.0713	0.2386
2	3	53.2785148	13.3465332	0.0004	6	0.5667	0.4131	0.6124	0.7030	0.0378		0.2313	0.1063	0.8137	0.2960
3	1	25.8560614	18.2947172	0.1672	7	0.5086	0.6346	0.4392	0.4008	0.4353	0.2313		0.9381	0.3188	0.7457
3	2	24.1128393	14.1682020	0.0985	8	0.3908	0.5108	0.2856	0.2521	0.4184	0.1063	0.9381		0.1778	0.6245
3	3	49.1562867	14.3050567	0.0017	9	0.7180	0.5553	0.7938	0.8799	0.0713	0.8137	0.3188	0.1778		0.4215
4	4	33.4809741	12.1036902	0.0093	10	0.7035	0.8535	0.5878	0.5222	0.2386	0.2960	0.7457	0.6245	0.4215	

TABLE IX (Continued)

SITE=2 SPECIES=3

DEPENDENT VARIABLE: PCTH2M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	21	23365.90312006	1112.66205334	0.84	0.6573	0.348344	42.6091
ERROR	33	43711.28371378	1324.58435496		ROOT MSE		PCTH2M MEAN
CORRECTED TOTAL	54	67077.18683384			36.39483967		85.41569241

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	12	14638.60819919	0.92	0.5378
FR*FT	9	8727.29492087	0.73	0.6768

LEAST SQUARES MEANS

PROB > \|T\| HO: LSMEAN(I)=LSMEAN(J)

FR	FT	PCTH2M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	I/J	1	2	3	4	5	6	7	8	9	10
1	1	113.363848	20.274165	0.0001	1		0.5269	0.4808	0.3746	0.1217	0.7474	0.1661	0.0895	0.2851	0.2239
1	2	96.999348	18.511071	0.0001	2	0.5269		0.9469	0.8123	0.3020	0.7138	0.4116	0.2846	0.6640	0.5409
1	3	95.458744	17.163465	0.0001	3	0.4808	0.9469		0.8516	0.3121	0.6386	0.4375	0.2834	0.6957	0.5730
2	1	91.379181	16.960086	0.0001	4	0.3746	0.8123	0.8516		0.3752	0.4972	0.5161	0.3575	0.8266	0.6884
2	2	67.568539	23.287392	0.0066	5	0.1217	0.3020	0.3121	0.3752		0.1572	0.8451	0.8865	0.5003	0.5996
2	3	105.548845	15.922656	0.0001	6	0.7474	0.7138	0.6386	0.4972	0.1572		0.2409	0.1129	0.3643	0.3016
3	1	73.608148	21.743529	0.0019	7	0.1661	0.4116	0.4375	0.5161	0.8451	0.2409		0.9357	0.6396	0.7573
3	2	71.454150	16.899892	0.0002	8	0.0895	0.2846	0.2834	0.3575	0.8865	0.1129	0.9357		0.4915	0.6363
3	3	86.522095	17.050993	0.0001	9	0.2851	0.6640	0.6957	0.8266	0.5003	0.3643	0.6396	0.4915		0.8530
4	4	82.233845	14.421683	0.0001	10	0.2239	0.5409	0.5730	0.6884	0.5996	0.3016	0.7573	0.6363	0.8530	

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	21	65418.90720922	3115.18605758	0.75	0.7478	0.331113	40.4677
ERROR	32	132153.92628969	4129.81019655		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL.	53	197572.83349891			64.26359931		158.80214074

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	12	47597.18137930	0.96	0.5040
FR*FT	9	17821.72582992	0.48	0.8775

LEAST SQUARES MEANS

PROB > \|T\| HO: LSMEAN(I)=LSMEAN(J)

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	I/J	1	2	3	4	5	6	7	8	9	10
1	1	155.726842	35.860368	0.0001	1		0.6548	0.8116	0.3912	0.6534	0.7953	0.8752	0.9965	0.2988	0.5106
1	2	135.289710	32.697096	0.0002	2	0.6548		0.8110	0.6593	0.9580	0.4450	0.5743	0.6225	0.5459	0.8297
1	3	145.064138	30.307148	0.0001	3	0.8116	0.8110		0.4780	0.7978	0.5662	0.7091	0.7820	0.3812	0.6478
2	1	116.113149	32.505568	0.0011	4	0.3912	0.6593	0.4780		0.7388	0.1980	0.3534	0.3266	0.8716	0.8106
2	2	132.655254	41.197629	0.0029	5	0.6534	0.9580	0.7978	0.7388		0.4665	0.5720	0.6293	0.6417	0.8951
2	3	166.852304	28.115224	0.0001	6	0.7953	0.4450	0.5662	0.1980	0.4665		0.9453	0.7692	0.1266	0.3074
3	1	163.578895	38.538852	0.0002	7	0.8752	0.5743	0.7091	0.3534	0.5720	0.9453		0.8712	0.2730	0.4513
3	2	155.913048	29.846116	0.0001	8	0.9965	0.6225	0.7820	0.3266	0.6293	0.7692	0.8712		0.2345	0.4613
3	3	109.519634	30.134408	0.0010	9	0.2988	0.5459	0.3812	0.8716	0.6417	0.1266	0.2730	0.2345		0.6847
4	4	126.139248	25.497105	0.0001	10	0.5106	0.8297	0.6478	0.8106	0.8951	0.3074	0.4513	0.4613	0.6847	

DEPENDENT VARIABLE: PCTD2M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	21	75336.21893691	3587.43899700	0.88	0.6176	0.358095	36.3562
ERROR	33	135044.15621152	4092.24715792		ROOT MSE		PCTD2M MEAN
CORRECTED TOTAL	54	210380.37514843			63.97067420		175.95522207

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	12	62778.92082753	1.28	0.2766
FR*FT	9	12557.29810938	0.34	0.9542

PROB > \|T\| HO: LSMEAN(I)=LSMEAN(J)

FR	FT	PCTD2M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	I/J	1	2	3	4	5	6	7	8	9	10
1	1	182.976272	35.635601	0.0001	1		0.4860	0.6044	0.3574	0.8026	0.4834	0.9839	0.9022	0.3220	0.5162
1	2	151.281079	32.536636	0.0001	2	0.4860		0.8323	0.8404	0.7037	0.9665	0.5129	0.3777	0.7777	0.9486
1	3	159.890476	30.167969	0.0001	3	0.6044	0.8323		0.6581	0.8303	0.8550	0.6253	0.4697	0.6089	0.8863
2	1	142.903959	29.810494	0.0001	4	0.3574	0.8404	0.6581		0.5616	0.7825	0.3942	0.2362	0.9267	0.7816
2	2	170.207776	40.931906	0.0002	5	0.8026	0.7037	0.8303	0.5616		0.7115	0.7999	0.7072	0.5318	0.7412
2	3	152.999907	27.987019	0.0001	6	0.4834	0.9665	0.8550	0.7825	0.7115		0.5144	0.3459	0.7092	0.9795
3	1	183.981430	38.218282	0.0001	7	0.9839	0.5129	0.6253	0.3942	0.7999	0.5144		0.9286	0.3591	0.5421
3	2	188.188924	29.704691	0.0001	8	0.9022	0.3777	0.4697	0.2362	0.7072	0.3459	0.9286		0.2082	0.3955
3	3	139.321948	29.970279	0.0001	9	0.3220	0.7777	0.6089	0.9267	0.5318	0.7092	0.3591	0.2082		0.7183
4	4	154.008651	25.348781	0.0001	10	0.5162	0.9486	0.8863	0.7816	0.7412	0.9795	0.5421	0.3955	0.7183	

TABLE IX (Continued)

SITE=2 SPECIES=4

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	22	41689.28518736	1894.96750852	2.82	0.0008	0.516849	107.7678
ERROR	58	38971.15896325	671.91653385		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	80	80660.44415061			25.92135286		24.05295579

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	13	31944.49055052	3.66	0.0003
FR*FT	9	9744.79463684	1.61	0.1329

LEAST SQUARES MEANS

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	28.9117090	9.7598223	0.0044
1	2	18.5351691	10.2915970	0.0769
1	3	33.1242451	11.7497073	0.0066
2	1	12.3802137	10.3201675	0.2352
2	2	9.6832564	10.9793008	0.3814
2	3	24.5221056	9.7971748	0.0152
3	1	42.7720577	11.7475616	0.0006
3	2	6.1359916	10.9748657	0.5782
3	3	8.6782117	10.3176090	0.4037
4	4	4.8029575	7.2520869	0.5104

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.4154	0.7622	0.2010	0.1547	0.7236	0.3214	0.0929	0.1188	0.0533
2	0.4154		0.3118	0.6433	0.5190	0.6415	0.0954	0.3669	0.4537	0.2822
3	0.7622	0.3118		0.1525	0.1196	0.5376	0.5258	0.0776	0.0962	0.0455
4	0.2010	0.6433	0.1525		0.8451	0.3454	0.0380	0.6509	0.7781	0.5556
5	0.1547	0.5190	0.1196	0.8451		0.2646	0.0297	0.8027	0.9419	0.7157
6	0.7236	0.6415	0.5376	0.3454	0.2646		0.1935	0.1725	0.2195	0.1158
7	0.3214	0.0954	0.5258	0.0380	0.0297	0.1935		0.0168	0.0218	0.0082
8	0.0929	0.3669	0.0776	0.6509	0.8027	0.1725	0.0168		0.8524	0.9207
9	0.1188	0.4587	0.0962	0.7781	0.9419	0.2195	0.0218	0.8524		0.7628
10	0.0533	0.2822	0.0455	0.5556	0.7157	0.1158	0.0082	0.9207	0.7628	

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	21	93004.93491030	4428.80642430	2.24	0.0084	0.452286	71.8969
ERROR	57	112628.18931607	1975.93314590		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	78	205633.12422637			44.45146956		61.82671029

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	12	75460.68046630	3.18	0.0016
FR*FT	9	17544.25444400	0.99	0.4616

LEAST SQUARES MEANS

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	84.9989670	16.4549094	0.0001
1	2	58.6614894	17.3376011	0.0013
1	3	82.2013370	19.9558762	0.0001
2	1	55.7266371	17.4315786	0.0023
2	2	42.3588979	18.5203299	0.0259
2	3	58.5840940	16.5117889	0.0008
3	1	83.0265047	19.9518416	0.0001
3	2	47.9122034	18.5114277	0.0122
3	3	43.4648167	17.4227688	0.0155
4	4	45.2897278	13.6600245	0.0016

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.2301	0.9067	0.1870	0.0675	0.2174	0.9342	0.1105	0.0632	0.0726
2	0.2301		0.3418	0.8976	0.4888	0.9972	0.3253	0.6475	0.5056	0.5498
3	0.9067	0.3418		0.2852	0.1234	0.3251	0.9747	0.1891	0.1238	0.1383
4	0.1870	0.8976	0.2852		0.5730	0.8966	0.2707	0.7414	0.5866	0.6474
5	0.0675	0.4888	0.1234	0.5730		0.4759	0.1160	0.8195	0.9627	0.9008
6	0.2174	0.9972	0.3251	0.8966	0.4759		0.3086	0.6422	0.4925	0.5472
7	0.9342	0.3253	0.9747	0.2707	0.1160	0.3086		0.1748	0.1161	0.1299
8	0.1105	0.6475	0.1891	0.7414	0.8195	0.6422	0.1748		0.8495	0.9111
9	0.0632	0.5056	0.1238	0.5866	0.9627	0.4925	0.1161	0.8495		0.9362
0	0.0726	0.5498	0.1383	0.6474	0.9008	0.5472	0.1299	0.9111	0.9362	

SITE=5 SPECIES=1

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	15	6772.76208369	451.51747225	1.53	0.1852	0.534238	79.2757
ERROR	20	5904.66777209	295.23338860		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	35	12677.42985578			17.18235690		21.67418444

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	3623.45315876	2.05	0.1066
FR*FT	9	3149.30892493	1.19	0.3559

LEAST SQUARES MEANS

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	18.8539287	9.2675255	0.0554
1	2	41.4321806	9.3117072	0.0002
1	3	9.8201379	9.2955343	0.3034
2	1	26.7014155	9.2922248	0.0094
2	2	11.9083925	9.3280508	0.2164
2	3	15.4762810	7.1329543	0.0423
3	1	20.0995116	10.7415886	0.0760
3	2	15.4090565	13.2696363	0.2592
3	3	9.5766638	13.2762631	0.4791
4	4	27.5436689	10.8151933	0.0192

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.0852	0.4751	0.5461	0.5843	0.7755	0.9286	0.8320	0.5655	0.5458
2	0.0852		0.0194	0.2623	0.0283	0.0419	0.1354	0.1194	0.0513	0.3247
3	0.4751	0.0194		0.2003	0.8683	0.6399	0.4729	0.7309	0.9879	0.2139
4	0.5461	0.2623	0.2003		0.2487	0.3573	0.6362	0.4841	0.2793	0.3514
5	0.5843	0.0283	0.8683	0.2487		0.7686	0.5687	0.8292	0.8808	0.2690
6	0.7755	0.0419	0.6399	0.3573	0.7686		0.7231	0.9965	0.7060	0.3714
7	0.9286	0.1354	0.4729	0.6362	0.5687	0.7231		0.7800	0.5363	0.6232
8	0.8320	0.1194	0.7309	0.4841	0.8292	0.9965	0.7800		0.7608	0.4573
9	0.5655	0.0513	0.9879	0.2793	0.8808	0.7060	0.5363	0.7608		0.2918
10	0.5458	0.3247	0.2139	0.9514	0.2690	0.3714	0.6232	0.4573	0.2918	

TABLE IX (Continued)

SITE=5 SPECIES=1

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	15	44938.17341671	2995.87822778	0.58	0.8550	0.304207	133.3617
ERROR	20	102784.15811043	5139.20790552		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	35	147722.33152714			71.68826895		53.75474863

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	16045.44440585	0.52	0.7861
FR*FT	9	28892.72901087	0.62	0.7627

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	27.276513	38.665991	0.4887
1	2	31.603770	38.850326	0.4255
1	3	58.317499	38.782849	0.1483
2	1	65.568975	38.769041	0.1063
2	2	118.228664	38.918515	0.0065
2	3	29.941639	29.760128	0.3264
3	1	49.907301	44.816081	0.2787
3	2	13.181518	55.363607	0.8142
3	3	92.520921	55.391255	0.1104
4	4	27.828725	45.123174	0.5444

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.9345	0.5556	0.4809	0.0962	0.9569	0.6970	0.8352	0.3364	0.9926
2	0.9345		0.6123	0.5311	0.1119	0.9737	0.7523	0.7853	0.3533	0.9482
3	0.5556	0.6123		0.8929	0.2619	0.5742	0.8874	0.5073	0.6095	0.6024
4	0.4809	0.5311	0.8929		0.3228	0.4818	0.7876	0.4372	0.6793	0.5149
5	0.0962	0.1119	0.2619	0.3228		0.0921	0.2603	0.1315	0.6924	0.1308
6	0.9569	0.9737	0.5742	0.4818	0.0921		0.7138	0.7922	0.3422	0.9698
7	0.6970	0.7523	0.8874	0.7876	0.2603	0.7138		0.6010	0.5482	0.7265
8	0.8352	0.7853	0.5073	0.4372	0.1315	0.7922	0.6010		0.3263	0.8286
9	0.3364	0.3533	0.6095	0.6793	0.6924	0.3422	0.5482	0.3263		0.3612
10	0.9926	0.9482	0.6024	0.5149	0.1308	0.9698	0.7265	0.8286	0.3612	

SITE=3 SPECIES=1

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	16	9304.04394810	581.50274676	0.81	0.6684	0.193572	43.8755
ERROR	54	38761.00867412	717.79645693		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	70	48065.05262222			26.79172366		61.06311630

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	7	4364.31820083	0.87	0.5382
FR*FT	9	4939.72574727	0.76	0.6500

LEAST SQUARES MEANS

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	51.7693886	10.7405840	0.0001
1	2	79.1093213	10.7405840	0.0001
1	3	77.9411752	10.7405840	0.0001
2	1	61.8320042	10.7405840	0.0001
2	2	62.5719518	10.7405840	0.0001
2	3	62.6437758	10.7405840	0.0001
3	1	61.3822684	10.7405840	0.0001
3	2	61.3330132	10.7405840	0.0001
3	3	66.0822526	10.7405840	0.0001
4	4	53.6637251	9.4723047	0.0001

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.0616	0.0731	0.4853	0.4539	0.4509	0.5049	0.5071	0.3220	0.8953
2	0.0616		0.9353	0.2329	0.2533	0.2553	0.2211	0.2199	0.3670	0.0812
3	0.0731	0.9353		0.2656	0.2879	0.2902	0.2527	0.2513	0.4113	0.0958
4	0.4853	0.2329	0.2656		0.9590	0.9550	0.9751	0.9723	0.7678	0.5708
5	0.4539	0.2533	0.2879	0.9590		0.9960	0.9341	0.9314	0.8073	0.5365
6	0.4509	0.2553	0.2902	0.9550	0.9960		0.9301	0.9274	0.8112	0.5333
7	0.5049	0.2211	0.2527	0.9751	0.9341	0.9301		0.9973	0.7440	0.5921
8	0.5071	0.2199	0.2513	0.9723	0.9314	0.9274	0.9973		0.7415	0.5945
9	0.3220	0.3670	0.4113	0.7678	0.8073	0.8112	0.7440	0.7415		0.3897
10	0.8953	0.0812	0.0958	0.5708	0.5365	0.5333	0.5921	0.5945	0.3897	

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	16	29218.61444341	1826.16340271	1.31	0.2258	0.279498	59.9734
ERROR	54	75321.02396254	1394.83377708		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	70	104539.63840595			37.34747350		62.27337921

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	7	16336.15212326	1.67	0.1347
FR*FT	9	12882.46232015	1.03	0.4318

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	49.6000066	14.9722982	0.0017
1	2	41.2941321	14.9722982	0.0079
1	3	43.7283370	14.9722982	0.0051
2	1	59.5242249	14.9722982	0.0002
2	2	69.8620729	14.9722982	0.0001
2	3	80.0936956	14.9722982	0.0001
3	1	73.2157960	14.9722982	0.0001
3	2	57.1232281	14.9722982	0.0004
3	3	48.6890171	14.9722982	0.0020
4	4	77.4767675	13.2043259	0.0001

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.6790	0.7698	0.6211	0.3146	0.1325	0.2420	0.7078	0.9638	0.1683
2	0.6790		0.9034	0.3652	0.1582	0.0572	0.1156	0.4313	0.7125	0.0755
3	0.7698	0.9034		0.4323	0.1960	0.0741	0.1455	0.5051	0.8047	0.0967
4	0.6211	0.3652	0.4323		0.6067	0.3074	0.4957	0.9047	0.5895	0.3725
5	0.3146	0.1582	0.1960	0.6067		0.6104	0.8672	0.5261	0.2936	0.7044
6	0.1325	0.0572	0.0741	0.3074	0.6104		0.7318	0.2549	0.1215	0.8962
7	0.2420	0.1156	0.1455	0.4957	0.8672	0.7318		0.4237	0.2245	0.8318
8	0.7078	0.4313	0.5051	0.9047	0.5261	0.2549	0.4237		0.6743	0.3125
9	0.9638	0.7125	0.8047	0.5895	0.2936	0.1215	0.2245	0.6743		0.1551
10	0.1683	0.0755	0.0967	0.3725	0.7044	0.8962	0.8318	0.3125	0.1551	

TABLE IX (Continued)

SITE=3 SPECIES=2

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	17	14970.08004997	880.59294412	3.27	0.0002	0.435535	31.0499
ERROR	72	19401.61333491	269.46685187		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	89	34371.69338488			16.41544553		52.86803245

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	8	9547.36058838	4.43	0.0002
FR*FT	9	5422.71946159	2.24	0.0290

LEAST SQUARES MEANS

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	56.6471806	5.4718152	0.0001
1	2	50.2808117	5.4718152	0.0001
1	3	47.4635842	5.4718152	0.0001
2	1	43.6850622	5.4718152	0.0001
2	2	45.4783761	5.4718152	0.0001
2	3	43.2888223	5.4718152	0.0001
3	1	57.3219043	5.4718152	0.0001
3	2	61.4502825	5.4718152	0.0001
3	3	67.7779311	5.4718152	0.0001
4	4	55.2863693	5.4718152	0.0001

LEAST SQUARES MEANS FOR EFFECT FR*FT
PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.4134	0.2392	0.0983	0.1533	0.0886	0.9308	0.5368	0.1547	0.8609
2	0.4134		0.7169	0.3968	0.5368	0.3692	0.3659	0.1532	0.0268	0.5198
3	0.2392	0.7169		0.6268	0.7983	0.5912	0.2068	0.0749	0.0106	0.3154
4	0.0983	0.3968	0.6268		0.8174	0.9593	0.0823	0.0246	0.0027	0.1382
5	0.1533	0.5368	0.7983	0.8174		0.7780	0.1303	0.0426	0.0052	0.2091
6	0.0886	0.3692	0.5912	0.9593	0.7780		0.0739	0.0217	0.0023	0.1254
7	0.9308	0.3659	0.2068	0.0823	0.1303	0.0739		0.5953	0.1809	0.7933
8	0.5368	0.1532	0.0749	0.0246	0.0426	0.0217	0.5953		0.4162	0.4283
9	0.1547	0.0268	0.0106	0.0027	0.0052	0.0023	0.1809	0.4162		0.1108
10	0.8609	0.5198	0.3154	0.1382	0.2091	0.1254	0.7933	0.4283	0.1108	

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	17	15122.05166087	889.53245064	2.01	0.0213	0.322248	34.4025
ERROR	72	31804.67033199	441.73153239		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	89	46926.72199286			21.01741022		61.09263107

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	8	11404.25676238	3.23	0.0034
FR*FT	9	3717.79489849	0.94	0.5010

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	61.1489056	7.0058034	0.0001
1	2	57.5594597	7.0058034	0.0001
1	3	73.4045403	7.0058034	0.0001
2	1	54.1159125	7.0058034	0.0001
2	2	70.4977954	7.0058034	0.0001
2	3	58.7718790	7.0058034	0.0001
3	1	64.7081409	7.0058034	0.0001
3	2	57.9611295	7.0058034	0.0001
3	3	51.9525678	7.0058034	0.0001
4	4	60.8059800	7.0058034	0.0001

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.7182	0.2201	0.4801	0.3485	0.8111	0.7205	0.7486	0.3564	0.9725
2	0.7182		0.1141	0.7292	0.1957	0.9029	0.4729	0.9678	0.5732	0.7441
3	0.2201	0.1141		0.0555	0.7701	0.1441	0.3830	0.1234	0.0337	0.2076
4	0.4801	0.7292	0.0555		0.1026	0.6398	0.2886	0.6991	0.8278	0.5017
5	0.3485	0.1957	0.7701	0.1026		0.2405	0.5608	0.2098	0.0653	0.3312
6	0.8111	0.9029	0.1441	0.6398	0.2405		0.5509	0.9350	0.4935	0.8379
7	0.7205	0.4729	0.3830	0.2886	0.5608	0.5509		0.4981	0.2021	0.6949
8	0.7486	0.9678	0.1234	0.6991	0.2098	0.9350	0.4981		0.5461	0.7748
9	0.3564	0.5732	0.0337	0.8278	0.0653	0.4935	0.2021	0.5461		0.3745
10	0.9725	0.7441	0.2076	0.5017	0.3312	0.8379	0.6949	0.7748	0.3745	

SITE=3 SPECIES=3

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	16	9939.63546911	621.22721682	1.69	0.0874	0.397962	117.4875
ERROR	41	15036.73090642	366.74953430		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	57	24976.36637552			19.15070584		16.30021141

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	7	4225.71741879	1.65	0.1499
FR*FT	9	5713.91805032	1.73	0.1127

LEAST SQUARES MEANS

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	30.6498089	6.7707970	0.0001
1	2	5.2704073	8.3056445	0.5292
1	3	19.8481630	8.2957881	0.0214
2	1	20.2662114	8.3056445	0.0191
2	2	4.1296023	7.6773621	0.5936
2	3	5.4968489	9.1062489	0.5494
3	1	18.9508077	8.2956589	0.0276
3	2	1.6238348	9.0933934	0.8592
3	3	-0.6535082	10.1730727	0.9491
4	4	20.1851115	9.0990897	0.0321

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.0227	0.3190	0.3382	0.0132	0.0323	0.2810	0.0142	0.0142	0.3616
2	0.0227		0.1998	0.1824	0.9157	0.9846	0.2284	0.7592	0.6435	0.2143
3	0.3190	0.1938		0.9704	0.1498	0.2317	0.9364	0.1259	0.1138	0.9774
4	0.3382	0.1824	0.9704		0.1398	0.2129	0.9070	0.1224	0.1073	0.9946
5	0.0132	0.9157	0.1498	0.1398		0.9047	0.1738	0.8262	0.6975	0.1644
6	0.0323	0.9846	0.2317	0.2129	0.9047		0.2616	0.7575	0.6422	0.2387
7	0.2810	0.2284	0.9364	0.9070	0.1738	0.2616		0.1498	0.1300	0.9163
8	0.0142	0.7592	0.1259	0.1224	0.8262	0.7575	0.1498		0.8632	0.1435
9	0.0142	0.6435	0.1138	0.1073	0.6975	0.6422	0.1300	0.8632		0.1199
10	0.3616	0.2143	0.9774	0.9946	0.1644	0.2387	0.9163	0.1435	0.1199	

TABLE IX (Continued)

SITE=3 SPECIES=3

DEPENDENT VARIABLE: PCTH2M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	16	45124.62549198	2820.28909325	1.58	0.1176	0.381976	65.3220
ERROR	41	73010.08379098	1780.73375100		ROOT MSE		PCTH2M MEAN
CORRECTED TOTAL	57	118134.70928295			42.19874111		64.60111707

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	7	13464.14291483	1.08	0.3940
FR*FT	9	31670.48257714	1.98	0.0675

FR	FT	PCTH2M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	99.3415026	14.9195080	0.0001
1	2	58.1465891	18.3015575	0.0028
1	3	87.9464754	18.2798387	0.0001
2	1	85.4622027	18.3015575	0.0001
2	2	52.4678395	16.9171319	0.0035
2	3	62.5383924	20.0656960	0.0033
3	1	69.9196426	18.2795540	0.0004
3	2	19.3444009	20.0373688	0.3400
3	3	29.6961468	22.4164512	0.1926
4	4	46.7914959	20.0499206	0.0246

LEAST SQUARES MEANS FOR EFFECT FR*FT
PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.0885	0.6317	0.5599	0.0440	0.1487	0.2195	0:0026	0.0133	0.0417
2	0.0885		0.2336	0.2687	0.8111	0.8653	0.6355	0.1439	0.3155	0.6653
3	0.6317	0.2336		0.9202	0.1403	0.3351	0.4684	0.0109	0.0435	0.1216
4	0.5599	0.2687	0.9202		0.1698	0.3780	0.5319	0.0150	0.0531	0.1454
5	0.0440	0.8111	0.1403	0.1698		0.6892	0.4637	0.1922	0.4026	0.8215
6	0.1487	0.8653	0.3351	0.3780	0.6892		0.7783	0.1233	0.2632	0.5639
7	0.2195	0.6355	0.4684	0.5319	0.4637	0.7783		0.0587	0.1578	0.3738
8	0.0026	0.1439	0.0109	0.0150	0.1922	0.1233	0.0587		0.7224	0.3227
9	0.0133	0.3155	0.0435	0.0531	0.4026	0.2632	0.1578	0.7224		0.5575
10	0.0417	0.6653	0.1216	0.1454	0.8215	0.5639	0.3738	0.3227	0.5575	

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	16	18190.85803604	1136.92862725	1.47	0.1603	0.363873	111.5519
ERROR	41	31801.51099176	775.64660956		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	57	49992.36902780			27.85043284		24.96635619

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	7	7919.03725217	1.46	0.2091
FR*FT	9	10271.82078388	1.47	0.1910

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	23.0178879	9.8466150	0.0244
1	2	12.2483168	12.0787086	0.3165
1	3	29.1526682	12.0613746	0.0202
2	1	60.4785167	12.0787086	0.0001
2	2	20.8002630	11.1650119	0.0696
2	3	25.3734935	13.2430092	0.0624
3	1	23.4544804	12.0641867	0.0588
3	2	25.6085291	13.2243138	0.0597
3	3	38.7188015	14.7944666	0.0124
4	4	10.8038615	13.2325978	0.4190

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.4934	0.6957	0.0208	0.8823	0.8872	0.9778	0.8759	0.3821	0.4632
2	0.4934		0.3049	0.0046	0.5861	0.4439	0.4948	0.4415	0.1596	0.9335
3	0.6957	0.3049		0.0611	0.5946	0.8271	0.7277	0.8355	0.6069	0.2918
4	0.0208	0.0046	0.0611		0.0147	0.0450	0.0282	0.0490	0.2458	0.0062
5	0.8823	0.5861	0.5946	0.0147		0.7831	0.8655	0.7720	0.3192	0.5478
6	0.8872	0.4439	0.8271	0.0450	0.7831		0.9116	0.9897	0.4888	0.4194
7	0.9778	0.4948	0.7277	0.0282	0.8655	0.9116		0.9008	0.4129	0.4604
8	0.8759	0.4415	0.8355	0.0490	0.7720	0.9897	0.9008		0.4963	0.4181
9	0.3821	0.1596	0.6069	0.2458	0.3192	0.4888	0.4129	0.4963		0.1510
10	0.4632	0.9335	0.2918	0.0062	0.5478	0.4194	0.4604	0.4181	0.1510	

DEPENDENT VARIABLE: PCTD2M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	16	21312.59322215	1332.03707638	1.32	0.2310	0.340181	83.0275
ERROR	41	41338.21603750	1008.24917165		ROOT MSE		PCTD2M MEAN
CORRECTED TOTAL	57	62650.80925965			31.75293957		38.24386891

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	7	11719.32618527	1.66	0.1461
FR*FT	9	9593.26703688	1.06	0.4137

FR	FT	PCTD2M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	37,8975177	11.2263594	0.0016
1	2	34.1462359	13.7712224	0.0174
1	3	54.2418281	13.7548799	0.0003
2	1	69.6437435	13.7712224	0.0001
2	2	38.7370842	12.7294951	0.0041
2	3	32.2380981	15.0986692	0.0388
3	1	35.5515369	13.7546656	0.0134
3	2	35.5291947	15.0773540	0.0233
3	3	48.7959466	16.8675226	0.0061
4	4	18.7122373	15.0867988	0.2219

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.8338	0.3627	0.0814	0.9608	0.7651	0.8955	0.9004	0.5936	0.3136
2	0.8338		0.2850	0.0597	0.7974	0.9219	0.9400	0.9441	0.4908	0.4357
3	0.3627	0.2850		0.4112	0.3876	0.2682	0.3191	0.3390	0.7970	0.0770
4	0.0814	0.0597	0.4112		0.0894	0.0602	0.0733	0.0892	0.3282	0.0130
5	0.9608	0.7974	0.3876	0.0894		0.7315	0.8585	0.8653	0.6222	0.2932
6	0.7651	0.9219	0.2682	0.0602	0.7315		0.8666	0.8742	0.4516	0.5103
7	0.8955	0.9400	0.3191	0.0733	0.8585	0.8666		0.9991	0.5325	0.3894
8	0.9004	0.9441	0.3390	0.0892	0.8653	0.8742	0.9991		0.5457	0.4198
9	0.5936	0.4908	0.7970	0.3282	0.6222	0.4516	0.5325	0.5457		0.1741
10	0.3136	0.4357	0.0770	0.0130	0.2932	0.5103	0.3894	0.4198	0.1741	

TABLE IX (Continued)

SITE=4 SPECIES=1

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	14	14305.38778847	1021.81341346	1.53	0.1417	0.338016	34.6807
ERROR	42	28016.23723840	667.05326758		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	56	42321.62502688			25.82737438		74.47193776

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	5	10378.21728401	3.11	0.0177
FR*FT	9	3927.17050446	0.65	0.7445

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	65.7860018	10.5439814	0.0001
1	2	59.7129352	11.6578349	0.0001
1	3	79.5842158	10.5439814	0.0001
2	1	61.8773646	11.6578349	0.0001
2	2	83.3612264	10.5439814	0.0001
2	3	71.6652868	10.5439814	0.0001
3	1	81.9532600	10.5439814	0.0001
3	2	74.1190254	10.5439814	0.0001
3	3	73.5552657	11.6578349	0.0001
4	4	84.5372569	10.5439814	0.0001

LEAST SQUARES MEANS FOR EFFECT FR*FT
PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.7012	0.3601	0.8048	0.2452	0.6954	0.2845	0.5792	0.6237	0.2155
2	0.7012		0.2131	0.8964	0.1399	0.4513	0.1645	0.3646	0.4068	0.1218
3	0.3601	0.2131		0.2664	0.8013	0.5982	0.8745	0.7158	0.7032	0.7414
4	0.8048	0.8964	0.2664		0.1790	0.5369	0.2086	0.4405	0.4835	0.1568
5	0.2452	0.1399	0.8013	0.1790		0.4372	0.9252	0.5387	0.5361	0.9375
6	0.6954	0.4513	0.5982	0.5369	0.4372		0.4940	0.8701	0.9049	0.3929
7	0.2845	0.1645	0.8745	0.2086	0.9252	0.4940		0.6021	0.5960	0.8633
8	0.5792	0.3646	0.7158	0.4405	0.5387	0.8701	0.6021		0.9716	0.4886
9	0.6237	0.4068	0.7032	0.4835	0.5361	0.9049	0.5960	0.9716		0.4886
10	0.2155	0.1218	0.7414	0.1568	0.9375	0.3929	0.8633	0.4886	0.4886	

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	14	20182.84184110	1441.63156008	1.66	0.1013	0.356844	36.5797
ERROR	42	36376.48050712	866.10667874		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	56	56559.32234821			29.42969043		80.45360925

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	5	13755.84313899	3.18	0.0160
FR*FT	9	6426.99870210	0.82	0.5973

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	72.743999	12.014621	0.0001
1	2	85.567084	13.283831	0.0001
1	3	67.897436	12.014621	0.0001
2	1	75.818854	13.283831	0.0001
2	2	107.392078	12.014621	0.0001
2	3	72.727890	12.014621	0.0001
3	1	83.756334	12.014621	0.0001
3	2	79.022235	12.014621	0.0001
3	3	75.879955	13.283831	0.0001
4	4	80.978262	12.014621	0.0001

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7	8	9	10
1		0.4780	0.7769	0.8645	0.0478	0.9992	0.5204	0.7136	0.8619	0.6305
2	0.4780		0.3295	0.6073	0.2298	0.4774	0.9200	0.7166	0.6095	0.7990
3	0.7769	0.3295		0.6606	0.0250	0.7776	0.3560	0.5162	0.6581	0.4457
4	0.8645	0.6073	0.6606		0.0852	0.8638	0.6599	0.8589	0.9974	0.7747
5	0.0478	0.2298	0.0250	0.0852		0.0477	0.1715	0.1024	0.0858	0.1276
6	0.9992	0.4774	0.7776	0.8638	0.0477		0.5198	0.7129	0.8612	0.6298
7	0.5204	0.9200	0.3560	0.6599	0.1715	0.5198		0.7819	0.6624	0.8709
8	0.7136	0.7166	0.5162	0.8589	0.1024	0.7129	0.7819		0.8616	0.9089
9	0.8619	0.6095	0.6581	0.9974	0.0858	0.8612	0.6624	0.8616		0.7773
10	0.6305	0.7990	0.4457	0.7747	0.1276	0.6298	0.8709	0.9089	0.7773	

SITE=4 SPECIES=2

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	13	34351.48763750	2642.42212596	1.50	0.1695	0.371426	38.0543
ERROR	33	58133.96191145	1761.63520944		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	46	92485.44954895			41.97183829		110.29466009

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	7	14252.78576839	1.16	0.3540
FR*FT	6	20098.70186910	1.90	0.1100

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0
1	1	64.360376	17.585821	0.0009
1	2	133.301097	14.839286	0.0001
1	3	123.224094	17.585821	0.0001
3	1	97.110298	14.839286	0.0001
3	2	119.964326	14.839286	0.0001
3	3	98.762867	19.442222	0.0001
4	4	110.413607	17.596370	0.0001

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

I/J	1	2	3	4	5	6	7
1		0.0052	0.0224	0.1640	0.0214	0.2052	0.0703
2	0.0052		0.6643	0.0940	0.5295	0.1673	0.3273
3	0.0224	0.6643		0.2646	0.8882	0.3648	0.6063
4	0.1640	0.0940	0.2646		0.2840	0.9465	0.5672
5	0.0214	0.5295	0.8882	0.2840		0.3923	0.6809
6	0.2052	0.1673	0.3648	0.9465	0.3923		0.6590
7	0.0703	0.3273	0.6063	0.5672	0.6809	0.6590	

TABLE IX (Continued)

SITE=4 SPECIES=2

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	13	17701.91999362	1361.68615336	0.61	0.8294	0.193388	30.3106
ERROR	33	73834.08211190	2237.39642763		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	46	91536.00210551			47.30112501		156.05492968

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	7	11641.47333698	0.74	0.6374
FR*FT	6	6060.44665664	0.45	0.8387

LEAST SQUARES MEANS FOR EFFECT FR*FT
PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	I/J	1	2	3	4	5	6	7
1	1	152.798942	19.818744	0.0001	1	.	0.5065	0.9877	0.7480	0.7666	0.4948	0.6717
1	2	170.217109	16.723473	0.0001	2	0.5065	.	0.4961	0.7055	0.2948	0.1759	0.8317
1	3	152.370072	19.818744	0.0001	3	0.9877	0.4961	.	0.7356	0.7792	0.5038	0.6606
3	1	161.201834	16.723473	0.0001	4	0.7480	0.7055	0.7356	.	0.4991	0.2986	0.8947
3	2	145.039257	16.723473	0.0001	5	0.7666	0.2948	0.7792	0.4991	.	0.6416	0.4548
3	3	132.089898	21.910857	0.0001	6	0.4948	0.1759	0.5038	0.2986	0.6416	.	0.2773
4	4	164.661335	19.830632	0.0001	7	0.6717	0.8317	0.6606	0.8947	0.4548	0.2773	.

SITE=4 SPECIES=3

DEPENDENT VARIABLE: PCTH1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	12	59691.67291043	4974.30607587	2.79	0.0146	0.572707	44.5815
ERROR	25	44535.55461725	1781.42218469		ROOT MSE		PCTH1M MEAN
CORRECTED TOTAL	37	104227.22752768			42.20689736		94.67361333

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	45441.24005680	4.25	0.0044
FR*FT	6	14250.43285363	1.33	0.2796

FR	FT	PCTH1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	92.449619	15.952708	0.0001	1	.	0.5628	0.2336	0.1436	0.9446	0.5143	0.7802
1	2	106.333911	17.492966	0.0001	2	0.5628	.	0.1025	0.4021	0.5842	0.2726	0.7738
1	3	59.203930	22.077313	0.0128	3	0.2336	0.1025	.	0.0206	0.3420	0.6325	0.1727
3	1	126.514706	15.952708	0.0001	4	0.1436	0.4021	0.0206	.	0.1988	0.0672	0.2582
3	2	90.537294	22.097952	0.0004	5	0.9446	0.5842	0.3420	0.1988	.	0.6043	0.7603
3	3	74.447981	22.042342	0.0024	6	0.5143	0.2726	0.6325	0.0672	0.6043	.	0.3930
4	4	99.126493	17.491262	0.0001	7	0.7802	0.7738	0.1727	0.2582	0.7603	0.3930	.

DEPENDENT VARIABLE: PCTH2M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	12	243853.72003606	20321.14333634	2.11	0.0554	0.503567	40.3603
ERROR	25	240398.88893228	9615.95555729		ROOT MSE		PCTH2M MEAN
CORRECTED TOTAL	37	484252.60896834			98.06097877		242.96373582

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	198882.39424472	3.45	0.0128
FR*FT	6	44971.32579134	0.78	0.5938

FR	FT	PCTH2M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	205.523362	37.063566	0.0001	1	.	0.2563	0.5762	0.0648	0.7375	0.8718	0.5026
1	2	269.421780	40.642111	0.0001	2	0.2563	.	0.6678	0.5034	0.5273	0.4247	0.6499
1	3	241.368163	51.293108	0.0001	3	0.5762	0.6678	.	0.3113	0.8497	0.7299	0.9812
3	1	306.769957	37.063566	0.0001	4	0.0648	0.5034	0.3113	.	0.2193	0.1627	0.2568
3	2	226.983693	51.341059	0.0002	5	0.7375	0.5273	0.8497	0.2193	.	0.8768	0.8072
3	3	215.826330	51.211859	0.0003	6	0.8718	0.4247	0.7299	0.1627	0.8768	.	0.6845
4	4	242.941952	40.638151	0.0001	7	0.5026	0.6499	0.9812	0.2568	0.8072	0.6845	.

TABLE IX (Continued)

SITE=4 SPECIES=3

DEPENDENT VARIABLE: PCTD1M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	12	11226.60256038	935.55021336	1.30	0.2777	0.384566	43.5656
ERROR	25	17966.33991090	718.65359644		ROOT MSE		PCTD1M MEAN
CORRECTED TOTAL	37	29192.94247128			26.80771524		61.53410879

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	8409.21864978	1.95	0.1117
FR*FT	6	2817.38391060	0.65	0.6872

FR	FT	PCTD1M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	71.1699306	10.1323640	0.0001	1		0.4895	0.3405	0.7494	0.6358	0.9564	0.1058
1	2	60.6211692	11.1106593	0.0001	2	0.4895		0.7258	0.6971	0.9021	0.5298	0.3604
1	3	54.3576185	14.0224077	0.0007	3	0.3405	0.7258		0.4878	0.6821	0.3829	0.6453
3	1	66.5411332	10.1323640	0.0001	4	0.7494	0.6971	0.4878		0.8338	0.7494	0.1829
3	2	62.8700166	14.0355165	0.0001	5	0.6358	0.9021	0.6821	0.8338		0.6387	0.3477
3	3	72.1238992	14.0001961	0.0001	6	0.9564	0.5298	0.3829	0.7494	0.6387		0.1589
4	4	45.9408215	11.1095768	0.0004	7	0.1058	0.3604	0.6453	0.1829	0.3477	0.1589	

DEPENDENT VARIABLE: PCTD2M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	12	23630.20851757	1969.18404313	1.97	0.0734	0.486457	35.7530
ERROR	25	24945.97291948	997.83891678		ROOT MSE		PCTD2M MEAN
CORRECTED TOTAL	37	48576.18143705			31.58858839		88.35223218

SOURCE	DF	TYPE I SS	F VALUE	PR > F
PLOT	6	16956.06025108	2.83	0.0304
FR*FT	6	6674.14826650	1.11	0.3820

FR	FT	PCTD2M LSMEAN	STD ERR LSMEAN	PROB > |T| HO:LSMEAN=0	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7
1	1	101.766145	11.939364	0.0001	1		0.4105	0.2633	0.5881	0.8362	0.9144	0.0435
1	2	86.935463	13.092128	0.0001	2	0.4105		0.6865	0.7560	0.3791	0.5584	0.2299
1	3	78.438549	16.523156	0.0001	3	0.2633	0.6865		0.4966	0.2652	0.3788	0.5063
3	1	92.501569	11.939364	0.0001	4	0.5881	0.7560	0.4966		0.5133	0.7320	0.1213
3	2	106.026926	16.538603	0.0001	5	0.8362	0.3791	0.2652	0.5133		0.7802	0.0551
3	3	99.555182	16.496983	0.0001	6	0.9144	0.5584	0.3788	0.7320	0.7802		0.1075
4	4	64.084910	13.090853	0.0001	7	0.0435	0.2299	0.5063	0.1213	0.0551	0.1075	

TABLE X

STATISTICAL ANALYSIS--DUNCAN MULTIPLE RANGE TEST OF MEAN PERCENT INCREASE IN HEIGHT AND DIAMETER BY SITE, SPECIES AND FERTILIZER TREATMENT

Legend

Fertilizer Treatments

FR = Fertilizer Rate
FT = Fertilizer Type

FR

1 = Low
2 = Medium
3 = High
4 = No Fertilizer

FT

1 = Agriform Tablet
2 = Sulfur Coated Urea
3 = Readily Soluble Mixture
4 = No Fertilizer

Mean Percent Height Growth

PCTH1M = One Growing Season After Fertilization
PCTH2M = Second Growing Season After Fertilization Estimate

Mean Percent Diameter Growth

PCTD1M = One Growing Season After Fertilization
PCTD2M = Second Growing Season After Fertilization Estimate

Statistical Information

Alpha Level = 0.05

Means with the same letter are not significantly different

TABLE X (Continued)

FR	Mean	FT	Mean	FR	Mean	FT	Mean
			Site 1, Russian-Olive				
	PCTH1M				PCTD1M		
1	173.53a	1	148.48a	1	186.33a	1	156.61a
3	157.59a	2	158.42a	3	202.73a	2	201.28a
4	167.60a	3	187.88a	4	192.27a	3	227.56a
	MSE = 6251.32				MSE = 6032.75		
			Site 1, Juniper				
	PCTH1M				PCTD1M		
1	98.76ab	1	105.86ab	1	89.50a	1	94.26a
2	115.92ab	2	129.82a	2	81.99a	2	86.67a
3	136.12a	3	111.96ab	3	98.26a	3	86.85a
4	77.56b	4	77.57b	4	63.54a	4	63.54a
	MSE = 2061.75				MSE = 1273.35		
			Site 1, A. Pine				
	PCTH1M				PCTD1M		
1	114.80a	1	97.25a	1	60.50a	1	52.06a
2	78.33a	2	114.07a	2	57.34a	2	52.28a
3	123.66a	3	54.64a	3	28.47b	3	57.13a
4	96.91a	4	96.91a	4	39.58ab	4	39.58a
	MSE = 2529.1				MSE = 800.54		
	PCTH2M				PCTD2M		
1	229.71a	1	202.52a	1	81.45a	1	78.46a
2	163.61a	2	203.06a	2	84.16a	2	70.67a
3	208.39a	3	142.86a	3	41.98a	3	65.62a
4	162.24a	4	162.24a	4	63.68a	4	63.68a
	MSE = 8938.62				MSE = 1681.36		
			Site 2, A. Pine				
	PCTH1M				PCTD1M		
1	45.68a	1	45.43a	1	167.08a	1	161.56a
2	44.31a	2	30.04a	2	196.76a	2	169.99a
3	35.89a	3	48.05a	3	153.21a	3	159.15a
4	32.58a	4	32.58a	4	133.92a	4	133.92a
	MSE = 930.65				MSE = 4129.81		

TABLE X (Continued)

FR	Mean	FT	Mean	FR	Mean	FT	Mean
			Site 2, A. Pine				
	PCTH2M				PCTD2M		
1	96.26a	1	93.70a	1	183.16a	1	176.96a
2	87.92a	2	74.87a	2	174.46a	2	193.31a
3	77.03a	3	90.69a	3	177.59a	3	168.24a
4	76.85a	4	76.85a	4	162.16a	4	162.16a
	MSE = 1324.58				MSE = 4092.25		
			Site 2, Arborvitae				
	PCTH1M				PCTD1M		
1	33.24a	1	32.70a	1	76.93a	1	72.76a
2	23.47a	2	23.63a	2	55.07a	2	57.95a
3	26.59a	3	26.70a	3	58.75a	3	59.83a
4	4.78b	4	4.78b	4	50.86a	4	50.86a
	MSE = 671.92				MSE = 1975.93		
			Site 3, Russian-Olive				
	PCTH1M				PCTD1M		
1	66.65a	1	55.37a	1	47.09b	1	63.00a
2	59.39a	2	64.71a	2	72.04ab	2	58.31a
3	59.97a	3	65.93a	3	61.89ab	3	59.72a
4	53.66a	4	53.66a	4	77.48a	4	77.48a
	MSE = 717.80				MSE = 1394.83		
			Site 3, Juniper				
	PCTH1M				PCTD1M		
1	51.46ab	1	52.55a	1	64.04a	1	59.99a
2	44.15b	2	52.40a	2	61.13a	2	62.01a
3	62.18a	3	52.84a	3	58.21a	3	61.38a
4	55.29ab	4	55.28a	4	60.81a	4	60.81a
	MSE = 269.47				MSE = 441.73		
			Site 3, A. Pine				
	PCTH1M				PCTD1M		
1	21.90a	1	26.31a	1	19.81a	1	33.20a
2	13.85a	2	7.24b	2	33.55a	2	17.31a
3	10.27a	3	13.33ab	3	27.40a	3	29.04a
4	20.80a	4	20.80ab	4	7.36a	4	7.36a
	MSE = 366.75				MSE = 775.65		

TABLE X (Continued)

FR	Mean	FT	Mean	FR	Mean	FT	Mean
			Site 3, A. Pine				
	PCTH2M				PCTD2M		
1	84.20a	1	87.18a	1	39.85ab	1	45.16a
2	67.46ab	2	47.01b	2	45.63a	2	33.94ab
3	42.46b	3	63.02ab	3	36.09ab	3	43.03a
4	42.34b	4	42.34b	4	11.69b	4	11.69b
	MSE = 1780.73				MSE = 1008.25		
			Site 4, Russian-Olive				
	PCTH1M				PCTD1M		
1	69.64a	1	69.78a	1	76.04a	1	76.60a
2	72.35a	2	73.92a	2	84.94a	2	92.20a
3	77.87a	3	76.17a	3	80.20a	3	72.38a
4	84.54a	4	84.54a	4	80.98a	4	80.98a
	MSE = 667.05				MSE = 866.11		
			Site 4, Juniper				
	PCTH1M				PCTD1M		
1	113.90a	1	86.67a	1	163.00a	1	159.49a
3	105.38a	2	126.63a	3	146.25a	2	157.63a
4	115.46a	3	113.78a	4	167.23a	3	143.29a
		4	115.46a			4	167.23a
	MSE = 1761.64				MSE = 2237.40		
			Site 4, A. Pine				
	PCTH1M				PCTD1M		
1	91.09a	1	109.48a	1	61.48a	1	68.86a
3	101.37a	2	90.27a	3	67.03a	2	61.77a
4	88.09a	3	79.20a	4	46.66a	3	59.59a
		4	88.09a			4	46.66a
	MSE = 1781.42				MSE = 718.654		
			Site 4, A. Pine				
	PCTH2M				PCTD2M		
1	238.96a	1	256.15a	1	89.06ab	1	97.13a
3	257.13a	2	232.45a	3	97.30a	2	91.33a
4	218.82a	3	251.15a	4	63.60b	3	87.55a
		4	218.82a			4	63.60a
	MSE = 9615.96				MSE = 997.84		

TABLE X (Continued)

FR	Mean	FT	Mean	FR	Mean	FT	Mean
			Site 5, Russian-Olive				
	PCTHIM				PCTDIM		
1	22.82a	1	24.12a	1	39.98a	1	47.24a
2	20.03a	2	26.34a	2	65.37a	2	70.56a
3	18.90a	3	13.16a	3	59.95a	3	49.11a
4	31.24a	4	31.24a	4	40.19a	4	40.19a
	MSE = 295.23				MSE = 5193.21		

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VITA

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