THE VALUE OF LATERAL ROOT GROWTH TO EARLY SEASON GROWTH AND DEVELOPMENT OF COTTON PLANTS

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Abstract

Lateral roots are essential to young cotton plants for acquisition of water and nutrients. Lateral root development in the surface soil could be critical for survival of young cotton [*Gossypium hirsutum* (L.)] plants in semi-arid environmental conditions. On the Texas High Plains, where evaporative demand is fairly high, the more root surface area a seedling has, the greater its water absorbing capability and the less chance for growth-reducing tissue water stress to occur. Herbicides, such as trifluralin(Treflan),2,6-dinitro-N,N-dipropyl 4(trifluoromethyl)benzen- amine and pendimethalin(Prowl),N-(1-ethylpropyl)-3,4-dimethyl-2,6 dinitrobezeneamine are commonly used to control the weeds in cotton fields. The objectives of this research were to determine if herbicide source and /or rate will effect lateral root depth and cotton plant growth and development. Four rates of each herbicide were used, and treatments were replicated four times. Overall, application of trifluralin increased depth to first lateral. However, there were no significant adverse effects on cotton growth and development or nutrient acquisition.

Introduction

Incorporation of preplant applied herbicides is an effective form of weed control. Dinitroaniline herbicides reduce roots in susceptible species of plants and cause swelling of root tips (Appleby and Valverde,1988). Jordan et al. (1977) reported that the number of lateral roots produced by cotton seedlings were significantly reduced by trifluralin and pendimethalin except at low rates of pendimethalin. However, the value of this effect is not always apparent in final yield analysis. The presence of a normal, healthy complement of lateral roots on a young cotton plant has the potential to benefit early season plant growth and development which could impact final productivity in some environments. In semi-arid environments, the more root surface area the seedling has, the greater its water absorbing capacity and less its chance for water stress. Nutrients such as zinc and phosphorus are usually concentrated in the top six inches of the soil profile. Lateral root development in this zone could be critical for acquisition of sufficient amounts of these minerals for maximum growth. Furthermore, soil applied systemic insecticides and fungicides that have relatively low water solubility are very dependent upon the presence of sufficient numbers of lateral roots in the topsoil for absorption of sufficient quantities of material for insect and disease control. From a physiological perspective, the number of root tips is directly related to the production of hormones which determine rates of cell division and differentiation in the shoot meristems. The rate of mainstem node production and associated leaf number and size could be altered by effects on lateral root growth and development. All of these conditions could affect the rate of development and even the survival of young cotton seedlings which could effect potential yield.

Objectives

The objectives of this research were to determine if herbicide source and /or rate will effect lateral root depth and cotton plant growth and development.

Materials and Methods

Field plots were established at the Texas Tech University Crop Production Research Center near Brownfield, Texas. HS-26 cotton was planted in plots that were fifty feet long and four rows wide. Treatments were replicated four times in a randomized design. Trifluralin and Pendimethalin were applied at 0.0, 0.56, 0.75, and 1.13 active ingredients per acre on an Amarillo loamy fine sand and were incorporated by listing the rows. Data for population, nodes per plant, plant height, and depth to first lateral root were taken every two weeks until 10 August 1996 when a hail storm damaged the crop. Stand counts were taken in the center ten feet of the middle two rows. The first ten plants in the middle rows were marked off and used repeatedly for plant height and node per plant data counts. Three plants were sampled every two weeks to determine depth to first lateral root. The field was irrigated the day before each sampling. To sample the roots, a spade was used to slice down into the soil and the plant and roots were removed. The soil was gently brushed away and depth to first lateral root was recorded. The plant samples were then dried at 55^{o}C. After drying, the samples were then ground to 1mm. A one-gram sample was digested with a mixture of nitric, perchloric, and sulfuric acids (5:2:1) for 2 hours at 300 ^{o}C. Following digestion, the samples were diluted to 50 mL with deionized water. The resultant solution was analyzed for zinc and iron using an Atomic Absorption Spectrometer, and phosphorous was analyzed colormetrically. Analyses of variance were done using the GLM procedure in SAS (SAS Institute, Inc.,1989).

Results and Discussion

The only significant effect of herbicide over all application rates and all times was that depth to laterals was increased by application of trifluralin.

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The overall effects of herbicide source on final lint yield was not determined due hail damage. Significant differences in some parameters were detected for some treatments at various sampling times.

Trifluralin significantly increased depth to first lateral in some treatments, especially towards the end of the study (Figure 1). No significant differences due to herbicide source for number of nodes per plant(Figure 2) or plant height were detected at any herbicide application rate at any time (Figure 3). Therefore, the effect of herbicide source on lateral root development did not influence above ground growth and development. Final lint yield was not determined due hail damage.

Trifluralin significantly increased the zinc concentration in cotton plants in some treatments(Figure 4). Pendimethalin significantly increased the iron concentration in cotton plants, but only in one treatment (Figure 5). Trifluralin significantly increased the phosphorus concentration in cotton plants, but only in one treatment (Figure 6). Therefore, the effect of trifluralin on lateral root depth did not result in lower concentrations of zinc, iron, and phosphorus.

Summary

Overall, application of trifluralin increased depth to first lateral. However, there were no significant adverse effects on cotton growth and development or nutrient acquisition. Greenhouse studies are being conducted to further evaluate these effects and field studies will be repeated next year.

Acknowledgments

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References

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Jordan, T. N., R. S. Baker, and W. L. Barrentine. 1977. Comparative toxicity of several dinitroaniline herbicides. Weed Science 26:72-75.

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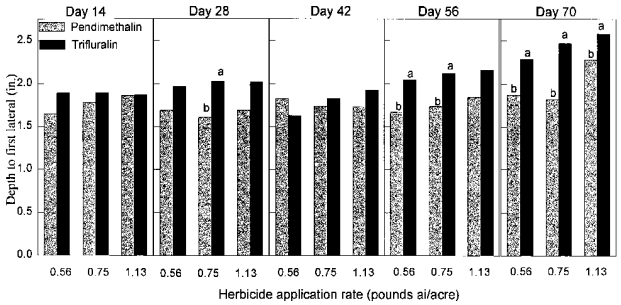

Figure 1. Effects of herbicide source and rate on depth to first lateral of cotton at various times during the growing season.

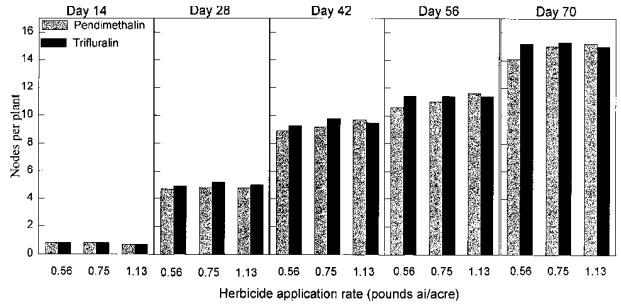

Figure 2. Effects of herbicide source and rate on nodes per plant of cotton at various times during the growing season.

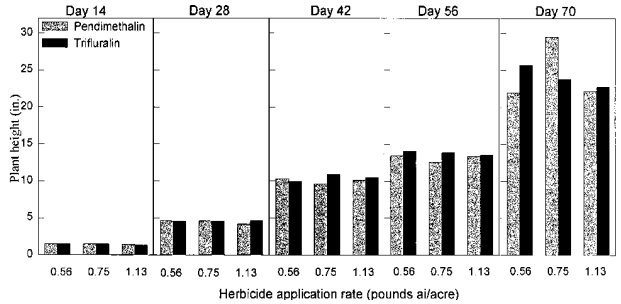

Figure 3. Effects of herbicide source and rate on plant height of cotton at various time during the growing season.

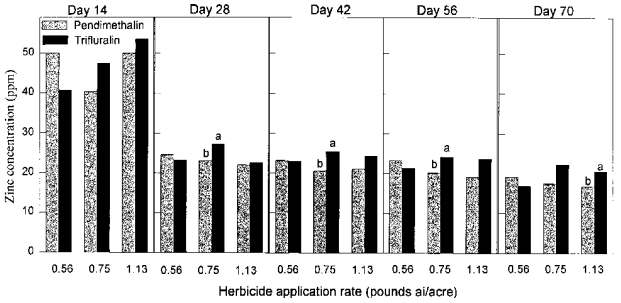

Figure 4. Effects of herbicide source and rate on zinc concentration of cotton at various times during the growing season.

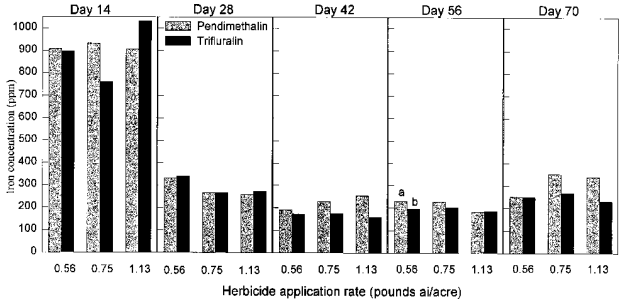

Figure 5. Effects of herbicide source and rate on iron concentration of cotton at various times during the growing season.

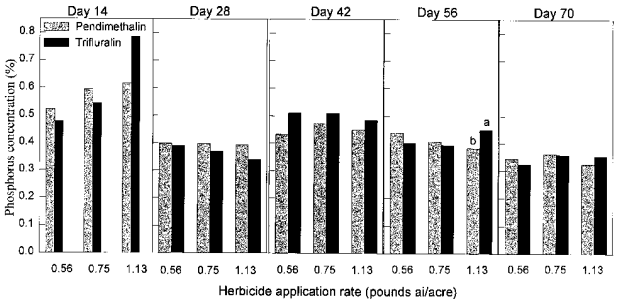

Figure 6. Effects of herbicide source and rate on phosphorous concentration of cotton at various times during the growing season.