PRG's Effect on Root Growth

By Jeffrey S. Beasley and Bruce E. Branham

Plant growth regulators (PGRs) are often applied to highly managed, cool-season turfgrasses every few weeks throughout the growing season to reduce clipping production, increase sward density, reduce seedhead formation and enhance sward color (Lickfeldt et al., 2001). Because PGRs reduce vertical shoot growth, some investigators have theorized that root growth may be enhanced through basal photoassimilate transport (Kaufmann et al., 1983).

Studies evaluating PGR application on turfgrasses have generally focused on shoot growth rather than root or whole plant growth. Extensive research has shown Primo reduces clipping production while increasing sward density for both warm- and cool-season turfgrasses (Ervin and Kioski, 1998; Fagerness and Yelverton, 2000). More detailed investigations of PGR application have found changes in shoot morphology, including increased cell density per leaf, shorter and thicker cells and increased specific leaf weights (Ervin and Kioski, 2001; Gaussoin et al., 1997; Heckman et al., 2001).

Because PGRs alter leaf morphology, the question remains: Do PGRs affect root growth and architecture?

Studies that have measured PGR effects on root growth have reported increased, decreased and no change in root mass (Ervin and Kioski, 2001; Fagerness and Yelverton, 2001; Marcum and Jiang, 1997). Far fewer studies have been conducted to assess PGR effects on turfgrass root characteristics such as surface area, root diameter and root length (Marcum and Jiang, 1997).

Root mass measurement alone does not provide the details necessary to understand the effects of PGR application on plant root growth and structure. More complete information regarding rooting characteristics such as total root length, average root diameter and root surface area provides researchers the insight needed to evaluate the effect of a factor (temperature, water availability, pesticide applications) on root structure. Time again it has been shown root structure plays an integral role in determining a plant's ability to obtain water and nutrients for proper plant growth and development.

Additionally, when considering the effects of PGRs or other growth modifiers, researchers have tended to examine shoot growth without consideration for root growth, or conversely, measured root mass without considering shoot-growth parameters. Particularly when studying compounds that modify plant growth, such as PGRs, it is imperative that both shoot and root responses be examined in order to understand how these compounds affect total plant growth.

The objective of our research was to determine the effect of a single Primo application on root and shoot growth parameters of Kentucky bluegrass over time.

Due to the difficulty in studying root systems under field conditions, we chose a water culture or hydroponic system to measure root growth over time. Kentucky bluegrass plants, variety Moonlight, were grown from seed in the greenhouse and transferred six weeks after germination into the hydroponic system. Individual plants were used in the hydroponic system. Irradiance levels were 800 to 900 micromoles per square meter per second (µmol m-2 s-1) during a 16-hour photoperiod.

Three weeks after plants were transplanted from soil to hydroponics, half of the plants from each container were treated with a single Primo application at the label rate 0.27 kilograms (kg) actual ingredient per hectare, while untreated plants in each container served as controls. For seven weeks following Primo application, one Primo-treated and one untreated plant from each container were harvested weekly.

Shoot height, tiller number and plant color were recorded. Roots were excised as close to the crown as possible and stored at 4 degrees Celsius (C) until image analysis.

Excised roots were analyzed using the WinRhizo system (Regent Instruments Inc., Version 5.0A, Quebec, Canada). The WinRhizo system is an image-analysis system used to

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measure root parameters, including total root length (TRL in cm), root diameter (mm) and root surface area (SA in square centimeters).

On a single plant basis, Primo-treated KBG increased tillering while plant height followed a typical pattern of inhibition and rebound reported in many Primo-treated turfgrass studies (Ervin and Koski, 2001; Fagerness et al., 2002). Root and shoot growth of Primo-treated plants had similar growth patterns: an initial reduction in TRL and SA was followed by a period of increased growth.

Thereafter, root growth slowed for both Primo-treated KBG and controls. Because Primo had no effect on average root diameter, increases in TRL and SA are because of existing vertical growth and/or root initiation.

From this study, root growth (TRL and SA) on a single-plant basis could indicate an increase in rooting for Primo-treated plants. However, because tillers are considered individual plants with individual root systems, it is important to relate root growth to changes in shoot growth. As a result, Primo-induced tillering resulted in reduced TRL and SA per tiller or less roots per tiller.

The increase in tiller number supports past research findings and anecdotal evidence of increased sward density from Primo application. However, increased tiller numbers and reduced TRL and SA per tiller from a Primo application could limit individual tiller development through lowered nutrient and water uptake. In turn, this would create greater competition among KBG plants within the sward.

Changes in root architecture and tillering between Primo-treated and control plants may be the result of altered photosynthetic rates and/or distribution of photoassimilates. Other agronomic commodities treated with PGRs have shown decreased and/or increased photosynthetic rates as well as altered photoassimilate distribution (Huang et al., 1995; Hunter and Proctor, 1994; El-Hodairi et al., 1988).

In our research, changes in photosynthetic rates of Primo-treated KBG were only slightly reduced for a very short period of time, if at all. Rather, changes in photoassimilate distribution in KBG appear to be the major affect of Primo in altering plant growth.

Researchers and turfgrass practitioners often ask how a particular treatment affects root growth or shoot growth. This research illustrates the complexity of plant root growth research.

Both root and shoot growth should be measured in order to obtain an accurate representation of the effects of exogenously-applied PGRs. Though the methods used for this study do not represent field conditions, this research clearly shows how PGRs affect energy (photoassimilate) distribution within the plant. Further research should be conducted to determine Primo effects on turfgrass rooting under field conditions.

However, using a holistic approach provides greater insight into how PGRs affect overall plant growth. Therefore, the next time you hear claims of increased rooting concerning any product, you should ask, "How does this relate to shoot growth and overall plant growth?"

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REFERENCES

El-Hodairi MH, Canham AE, Buckley WR. 1988. "The effects of paclobutrazol on the growth and the movement of 14C-labelled assimilates in Red Delicious apple seedlings." *J Hort Science.* 63(4):575-581.

Ervin EH, Kioski AJ. 2001. "Kentucky bluegrass growth responses to trinexapac-ethyl, traffic and nitrogen." *Crop Sci.* 41:1871-1877.

Ervin EH, Kioski AJ. 2001. "Trinexapac-ethyl increases Kentucky bluegrass leaf cell density and chlorophyll concentration." *J Hort Science.* 36(4):787-789.

Ervin EH, Kioski AJ. 1998. "Growth responses of *Lolium perenne L.* to trinexapac-ethyl." *J Hort Science.* 33(7):1200-1202.

Fagerness MJ, Yelverton FH. 2001. "Plant growth regulator and mowing height effects on seasonal root growth of Penncross creeping bentgrass." *Crop Sci.* 41:1901-1905.

Fagerness MJ, Yelverton FH. 2000. "Tissue production and quality of Tifway bermudagrass as affected by seasonal application patterns of trinexapac-ethyl." *Crop Sci.* 40:493-497.

Gaussoin RE, Branham BE, Flore JA. 1997. "Carbon dioxide exchange rate and chlorophyll content of turfgrasses treated with fluriprimidol or mefluidide." *J Growth Regulation.* 16:73-78.

Heckman N L, Horst GL, Gaussoin RE. 2001. "Heat tolerance of Kentucky bluegrass as affected by trinexapac-ethyl." *J Hort Science.* 36(2):365-367.

Huang W.D., Shen T, Han ZH, Liu S. 1995. "Influence of paclobutrazol on photosynthesis rate and dry matter partitioning in the apple tree." *J Plant Nutr.* 18:901-910.

Hunter DM, Proctor JTA. 1994. "Paclobutrazol reduces photosynthetic carbon uptake rate in grapevines." *J Amer Soc Hortic Sci.* 119:486-491.

Kaufman JE, Sandbrink JJ, Stehling SJ, Thibodeau PS. 1983. "Efficacy of six plant growth regulators on Michigan roadside grasses." P. 128. In Agronomy abstracts. ASA, Madison, WI.

Lickfeldt DW, Gardner DS, Branham BE, Voigt TB. 2001. "Implications of repeated trinexapac-ethyl applications on Kentucky bluegrass." *Agron J.* 93:1164-1168.

Marcum KB, Jiang H. 1997. "Effects of plant growth regulators on tall fescue rooting and water use." *J Turfgrass Manag.* 2:13-27.