Creeping Bentgrass Responses to a Tryptophan-Containing Organic Byproduct

RFR-A1713

Isaac Mertz, research associate
Nick Christians, university professor
Adam Thoms, assistant professor
Benjamin Pease, research associate
Erik Ervin, university professor (VT)
Xunzhong Zhang, research associate (VT)
Department of Horticulture

Introduction

Tryptophan is one of the 22 essential amino acids and serves as a building block for protein synthesis. Tryptophan also is a known precursor for auxin in plants. Previous research has shown that applying fertilizers amended with auxin coming from tryptophan may enhance plant defense chemical responses during limited soil moisture conditions. This occurs through increases in root production, as well as changes in endogenous hormone levels, resulting in plant growth regulating activity. Tryptophan is produced industrially through fermentation, and following that process, a byproduct remains. Tryptophan byproduct (TRP-B) is currently considered a waste product. However, the trace amounts of tryptophan and nitrogen containing compounds remaining in the byproduct following fermentation make it an intriguing subject for use as a growth promoter for turfgrasses. The objective of this research was to determine whether applications of TRP-B improve Penn A-4 creeping bentgrass (*Agrostis stolonifera* L.) performance more than applications of pure tryptophan and/or urea.

Materials and Methods

A collaborative study was initiated June 2013 at both Virginia Polytechnic Institute and State University (VT), and Iowa State University (ISU). Mature Penn A-4 creeping bentgrass plugs (11-cm dia.) were taken from similar United States Golf Association (USGA) specification putting green field plots at the VT Turfgrass Research Center (Blacksburg, VA) and the ISU Horticulture Research Station (Ames, IA). Following collection, bentgrass plugs were separated from their roots by cutting just below the crown (~1 cm) and transplanted into plastic containers (13 cm diameter, 14 cm deep) containing USGA specification sand mixes.

Plants were irrigated every other day at 50 percent of gravimetrically measured evapotranspiration (ET) loss throughout the study. Soil moisture capacity of each container was determined gravimetrically prior to initial treatments. Prior to each subsequent irrigation, containers were weighed, and the recorded weight for each container was subtracted from its 100 percent container capacity weight. Dividing this number in half allowed the team to maintain the amount of water each sample was receiving at 50 percent of its gravimetrically measured ET loss.

Prior to initial treatments, the plants were placed in a growth chamber at each site and allowed to become acclimated to the conditions for one week. Growth chambers at each site had average day/night temperatures of 20/16°C and an average 14-h photoperiod of 400 µmol $m^{-2}s^{-1}$ photosynthetic photon flux (PPF).

This trial included four replications at two locations. Treatments included TRP-B, urea, and pure tryptophan + urea, and were applied every 14 days at three different rates. Application rates were based on the amount of nitrogen applied and were 2.5 (low N-rate), 12.25 (medium N-rate), and 24.5 kg N ha^{-1} (high N-rate). Treatments were applied by hand using a pipette and watered in with an amount of water equal to 50 percent of gravimetrically measured ET loss, as described above.

Results and Discussion

Leaf total free amino acids. Across N sources, leaf total amino acid content increased over time at medium and high N rates, but not at the low N rate (Table 1). TRP-B, urea, or TRP + urea at the same N rate resulted in similar total amino acid contents. The results indicate TRP-B or TRP + urea had similar effects on leaf amino acid content when compared with urea alone.

Leaf and root IAA. TRP-B and TRP + urea increased IAA content by 227 percent and 255 percent, respectively, relative to urea at the high N rate as measured at day 42 (Table 2). TRP-B and TRP + urea at the high N rate also increased root IAA content by 242 percent and 374 percent, respectively, relative to urea (Table 2). Similarly, greatest root IAA was found with TRP-B at high N rate and TRP + urea at medium and high N rates. This is consistent with previous studies, where a tryptophan-dosed organic fertilizer amendment increased tall fescue leaf IAA content.

Tryptophan is a primary precursor for bacterial and plant-based IAA biosynthesis and may be used for IAA synthesis after being taken up by the plant. As the tryptophan application rate increased, leaf and root IAA content increased. This suggests tryptophan or TRP-B may be directly involved in IAA biosynthesis.

Rooting biomass. TRP-B and tryptophan + urea increased root biomass by 22.3 percent and 19.5 percent, respectively, relative to urea only at the high N rate (Figure 1). This is in agreement with previous studies where a tryptophan-containing organic fertilizer increased root biomass in tall fescue. A higher level of leaf and root IAA in the plants treated with TRP-B and TRP + urea relative to urea was associated with greater root growth.

In summary, TRP-B and TRP + urea treatments increased leaf and root IAA content, and root biomass relative to urea only, especially at the high N rate.

The tested tryptophan-based organic byproduct may be used to improve root growth and overall creeping bentgrass performance, especially in situations where synthetic nitrogen sources, such as urea, are the majority and/or only fertilizer source being used.

For more information, see the full article published in 2017 International Turfgrass Research Journal, or the summary in Golf Course Management.

Table 1. Leaf total amino acids response to tryptophan byproduct, tryptophan + urea, or urea-alone in creeping bentgrass: pooled across sites.

No.	Treatment	Rate (N kg ha^{-1})	Total amino acids (µg g^{-1} FW) 0[x]	14[x]	28[x]	42[x]
1	TRP-B[z]	2.5	51.6a[y]	58.4bc	58.0dc	71.2cd
2	TRP-B	12.25	50.7a	64.8abc	67.0abc	82.3ab
3	TRP-B	24.5	51.3a	63.8abc	70.7ab	87.1a
4	Urea	2.5	53.2a	56.0c	55.7d	62.4d
5	Urea	12.25	51.3a	62.7bc	58.7cd	72.7bc
6	Urea	24.5	51.1a	60.9bc	67.2abc	80.1abc
7	TRP+Urea	1.0+1.5	51.8a	61.2bc	56.2d	62d
8	TRP+Urea	4.0+8.25	53.3a	68.5ab	62.3bcd	73.8bc
9	TRP+Urea	8.0+16.5	52.7a	74.0a	74.9a	77.6abc

[z]TRP-B = tryptophan-containing byproduct; TRP = lab-grade tryptophan.
[y]Means followed by same letters within each column are not significantly different at P = 0.05.
[x]Day of application.

Table 2. Leaf and root indole-3-acetic acid (IAA) response to tryptophan byproduct, tryptophan + urea, or urea-alone in creeping bentgrass: Virginia Tech site.

No.	Treatment	Rate (N kg ha^{-1})	Leaf IAA (ng g^{-1} FW) 0[x]	14[x]	28[x]	42[x]	Root IAA (µg g^{-1} FW)
1	TRP-B[z]	2.5	110.2ab[y]	134.4c	69.0c	57.2c	2.09de
2	TRP-B	12.25	112.9ab	140.2bc	80.2c	92.7b	2.84cd
3	TRP-B	24.5	110.4ab	142.5bc	123.6ab	117.6a	3.52bc
4	Urea	2.5	106.5ab	113.5d	68.3c	34.3d	1.15e
5	Urea	12.25	107.6ab	132.4c	73.2c	45.8cd	1.29e
6	Urea	24.5	113ab	146.7abc	97.5bc	36d	1.03e
7	TRP+Urea	1.0+1.5	113.7a	141.46c	80.6c	48.6cd	1.25e
8	TRP+Urea	4.0+8.25	111.3ab	151.4ab	133.1ab	115.4a	4.67ab
9	TRP+Urea	8.0+16.5	104.2b	160.3a	136.3a	127.7a	4.88a

[z]TRP-B = tryptophan-containing byproduct; TRP = lab-grade tryptophan.
[y]Means followed by same letters within each column are not significantly different at P = 0.05.
[x]Day of application.

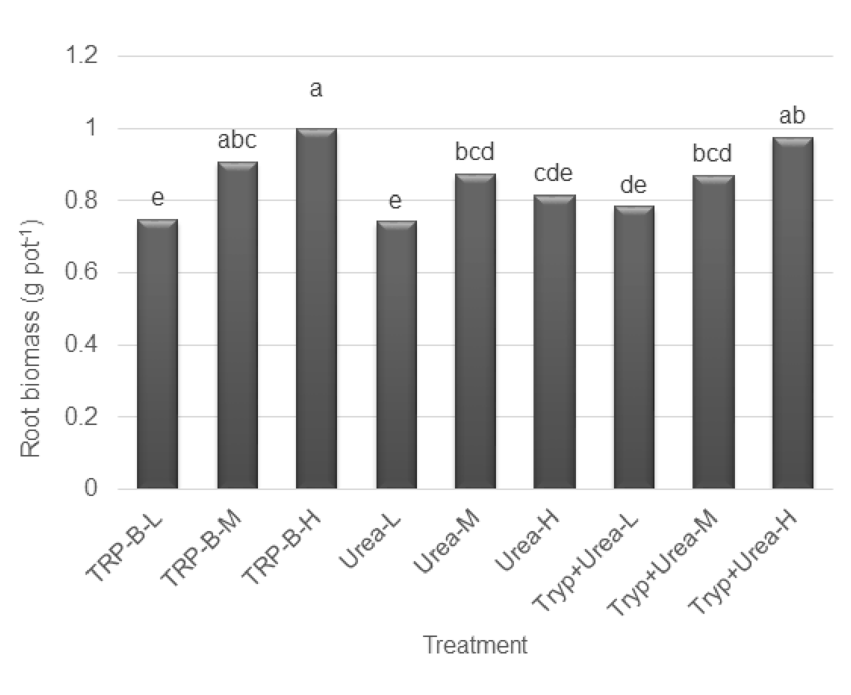

Figure 1. Root biomass response (pooled across sites) to application of a tryptophan-containing byproduct (TRP-B), TRP + urea, and urea at low rate (L; 2.5 kg N ha^{-1}), medium (M; 12.25 kg N ha^{-1}), and high rate (H; 24.5 kg N ha^{-1}) in creeping bentgrass. Treatments marked with same letters are not significantly different at P = 0.05.