Evaluation of Creeping Bentgrass (*Agrostis stolonifera* L.) Responses to a Tryptophan-Containing Byproduct

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Abstract

Tryptophan is one of the 22 essential amino acid and acts as a building block in protein synthesis, as well as a biochemical precursor for serotonin, niacin, and auxin in most organisms. Previous research has shown that applying biosolids boosted 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 endogenous hormone levels that can result in plant growth regulating activity. Tryptophan is produced industrially, which results in a significant amount of byproducts. Tryptophan byproduct (TRP-B) is currently considered a waste product, however, its amino acid and nutrient contents make it an intriguing subject for the use as a growth promoter for turfgrasses. The objective of this research was to determine whether applications of TRP-B improve 'Penn-A4' creeping bentgrass (*Agrostis stolonifera* L.) performance more than applications of pure tryptophan and/or urea. Creeping bentgrass plugs taken from sand-based putting greens at both the Virginia Tech Turfgrass Research Center (Blacksburg, VA) and the Iowa State Horticulture Research Station (Ames, IA) were transplanted into pots and allowed to reestablish in a growth chamber at both respective universities before being treated. 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 being applied and were 2.5, 12.2, and 24.5 kg N ha^{-1}. At trial end (42 days), plant parts were harvested and used for analysis. At 24.5 kg N ha^{-1}, TRP-B and pure tryptophan + urea increased root mass by 18.2% and 16.3% respectively compared to urea only. Creeping bentgrass treated with TRP-B can result in increased root production, but the response is rate dependent.

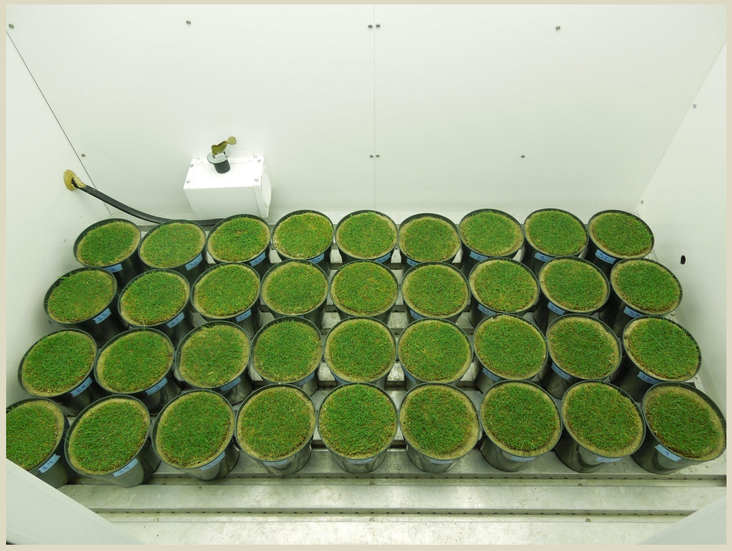
Materials & Methods

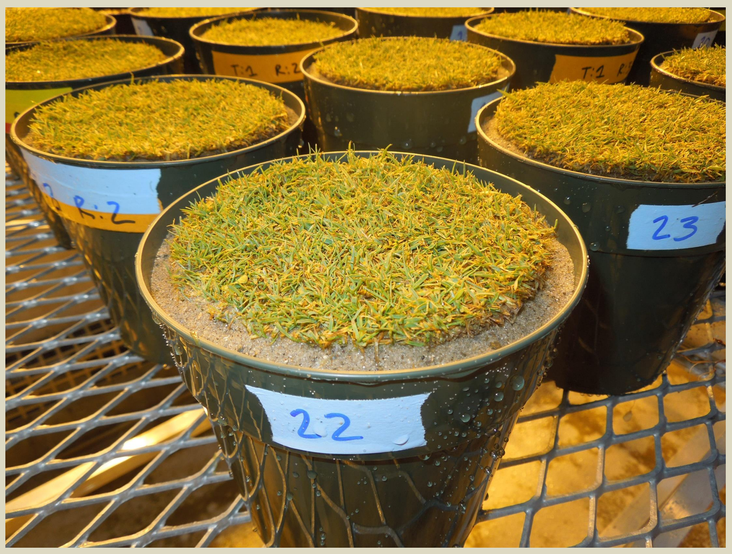
- Completely randomized design with 4 replications
- 2 locations; Virginia Tech and Iowa State
- 'Penn A4' Creeping bentgrass plugs
- Growth Chamber Experiment
- Day/Night Temp. = 26.5/20°C
- Photoperiod = 14-h @ 400 µmol $m^{-2}s^{-1}$ PAR
- Relative Humidity averaged around 50%
- Sand-based growing medium
- Irrigated to 50% field capacity every other day
- Treatments applied on 14-day intervals
- Foliar applications, watered in to 50% field capacity
- Measurements included rooting biomass (g), total leaf free amino acids (µmol g^{-1} FW), total leaf chlorophyll (mg g^{-1} FW), and photochemical efficiency (ISU = NDVI, VT = F_V/F_M)

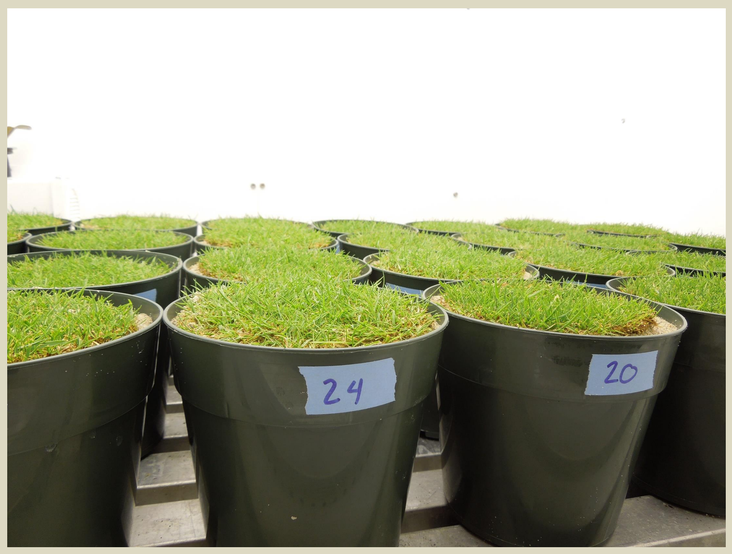
Treatment List

Treatment	Product	Rate (kg Product/ha)	Rate (kg N/ha)
1	TRP-B	406	2.45
2	TRP-B	2030	12.23
3	TRP-B	4060	24.46
4	Urea	5.4	2.45
5	Urea	26.9	12.23
6	Urea	53.8	24.46
7	Tryptophan + Urea	7.24 + 3.42	0.98 + 1.47
8	Tryptophan + Urea	30.04 + 17.86	4.04 + 8.19
9	Tryptophan + Urea	60.08 + 35.08	8.07 + 16.39

**TRP-B is a byproduct of pure tryptophan production and contains 0.6% nitrogen and 1.4% pure tryptophan by weight*







(Top): ***Samples were arranged in a completely randomized design (CRD) inside a growth chamber at each respective research site.*** **(Middle):** ***Plugs were initially saturated and allowed to drain for two days before field capacity weights were established.*** **These allowed us to irrigate back to 50% field capacity in order to simulate drought stress.** **(Bottom):** ***Samples showing tissue growth following treatment applications.***

Results/Conclusions

Plants treated with TRP-B and pure tryptophan + urea produced average root biomasses that ranged from 0.747 to 0.997 and 0.783 to 0.974 grams respectively (Table 1). Urea only treatments produced average root biomasses that ranged from 0.741 to 0.974 grams. When applied at 4060 kg ha^{-1}, TRP-B increased creeping bentgrass root production by 18.2% compared to an application of urea containing an identical amount of nitrogen (P = <0.05). Applications of pure tryptophan + urea at 60.08 + 35.08 kg ha^{-1} also increased root production by 16.3% compared to urea only treatments. Total leaf free amino acids content varied by treatment (P= <0.05). On average, applications of TRP-B and pure tryptophan + urea increased total leaf free amino acids content by 5.9% and 4.8% respectively compared to that of urea only treatments (Table 2).

Treatment	Rooting Biomass (g)		% Change vs Urea Only Equivalent
1	0.747	e	0.8
2	0.908	abc	3.9
3	0.997	a	18.2
4	0.741	e	-
5	0.873	bcd	-
6	0.815	cde	-
7	0.783	de	5.4
8	0.87	bcd	-0.3
9	0.974	ab	16.3
LSD = 0.1224			
Contrasts:			
TRP-B vs Urea			*
TRP-B vs Tryptophan + Urea			NS
Tryptophan + Urea vs Urea			*

TABLE-1: ***Dry root weight of 'Penn A4' creeping bentgrass receiving applications of TRP-B, Urea, and Tryptophan + Urea.***

Treatment	Total Leaf Free Amino Acids (µmol g^{-1} FW)		% Change vs Urea Only Equivalent
1	59.8	cd	5
2	66.2	ab	7.4
3	68.3	a	5.1
4	56.8	d	-
5	61.3	bcd	-
6	64.8	abc	-
7	57.8	d	1.7
8	64.5	abc	5
9	69.8	a	7.2
LSD = 5.3268			
Contrasts:			
TRP-B vs Urea			*
TRP-B vs Tryptophan + Urea			NS
Tryptophan + Urea vs Urea			*

TABLE-2: ***Total Leaf Free Amino Acids Content of 'Penn-A4' creeping bentgrass receiving applications of TRP-B, Urea, and Tryptophan + Urea.***

- Our results indicate that if used properly, biosolids containing traces of tryptophan could be an important tool for promoting turfgrass vigor and improving summer stress tolerance of creeping bentgrass. This occurs through increased root production and amino acids content, and those responses are rate dependent.

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