Replacement of Conventional Source N Fertilizer with Tryptophan Byproduct N does not Influence Corn Grain Yield

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INTRODUCTION

Tryptophan (TRP) is a protein amino acid containing a hydrophobic side chain and an indole functional group. Tryptophan is an important precursor of indole acetic acid. Biosynthesis of amino acids, including TRP, provides valuable products and byproducts for livestock. However, utilization of products from TRP biosynthesis as plant nutrients is poorly documented. The objective of our study was to determine the effect of a TRP biosynthesis product for replacing nitrogen from conventional nitrogen fertilizers applied pre-plant in iso-nitrogenous treatments on corn (*Zea mays L.*) growth and yield of grain and stover. Additionally, we compared the effects of liquid and dry TRP product formulations with different levels of a high lysine (LYS) N fertilizer source.

MATERIAL AND METHODS

- Plots were located near Boone, Iowa on a Clarion Series soil (fine-loamy, mixed, superactive, mesic Typic Hapludolls). The study site was cropped with soybeans the previous year.
- The experimental design was a randomized complete block design with three replicates. Corn was planted at 79,000 seeds ha^{-1} on May 17, 2013, with a full-season hybrid (Pioneer '33W84'). The TRP product was obtained from Ajinomoto Heartland, Inc. as a by-product from L-tryptophan for animal feed. Tryptophan and LYS products were hand applied. Tryptophan was applied in both dry and liquid form. Lysine was applied only in liquid form. All plots were fertilized for a total N application rate of 196 kg N ha^{-1} (Table 1).
- Morphological and physiological responses were determined on a weekly basis during vegetative (V7 to V19) and reproductive stages (R1 to R5).
  - Corn phenology was determined on twelve plants from the two central rows utilizing the Leaf Collar Method (Fig. 1.)
  - Chlorophyll meter readings were taken on twelve plants from the two central rows with SPAD-502 meter (Konica Minolta, Osaka, Japan) (Fig. 2.)
  - Leaf area index (LAI) was determined with a Decagon AccuPAR (Decagon Devices Inc., Pullman, WA). Four measurements were taken diagonally across the two central rows below the canopy for each plot (Fig. 2.)
  - The normalized difference vegetative index (NDVI) was estimated with a Crop Circle ACS-210 active canopy sensor (Holland Scientific, Lincoln, NE). The sensor was mounted on a hand-held mast, positioned mid inter-row, and carried through the middle of each plot (0.6 - 0.9 m above the corn canopy) at a constant speed of 1.2 m s^{-1}. (Fig. 2.)
- Biomass and yield components were collected from 8 plants in the center two rows at physiological maturity (R6).
- Corn grain yield and moisture were collected from the two central rows two weeks after R6.

Fig 1. Corn growth and development.

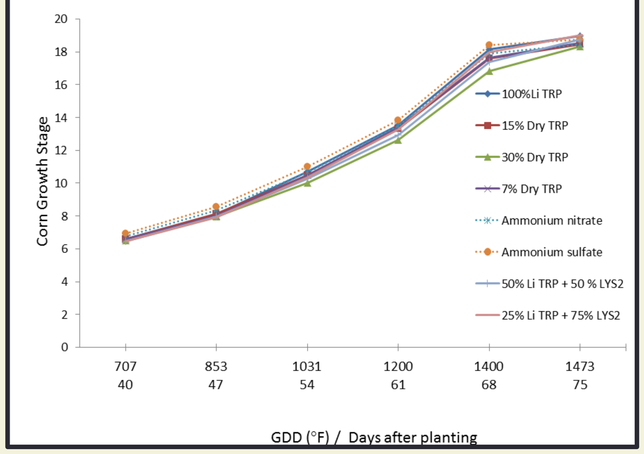

Table 1. Percentage nitrogen by source in eight iso-nitrogenous treatments.

Trt	Formulation	TRP product (%)	LYS product (%)	Ammonium nitrate	Ammonium sulfate
1	Dry	0	0	100	0
2	Dry	7	0	93	0
3	Dry	15	0	85	0
4	Dry	30	0	70	0
5	Liquid	100	0	0	0
6	Liquid	50	50	0	0
7	Liquid	25	75	0	0
8	Dry	0	0	0	100

Fig. 2. Average leaf chlorophyll concentration (A), Leaf area index (B), and Normalized difference vegetative index (C) for eight iso-nitrogenous fertilizer treatments for corn from V8 to V18 and R1 to R5 reproductive stages. Boone, Iowa, 2013.

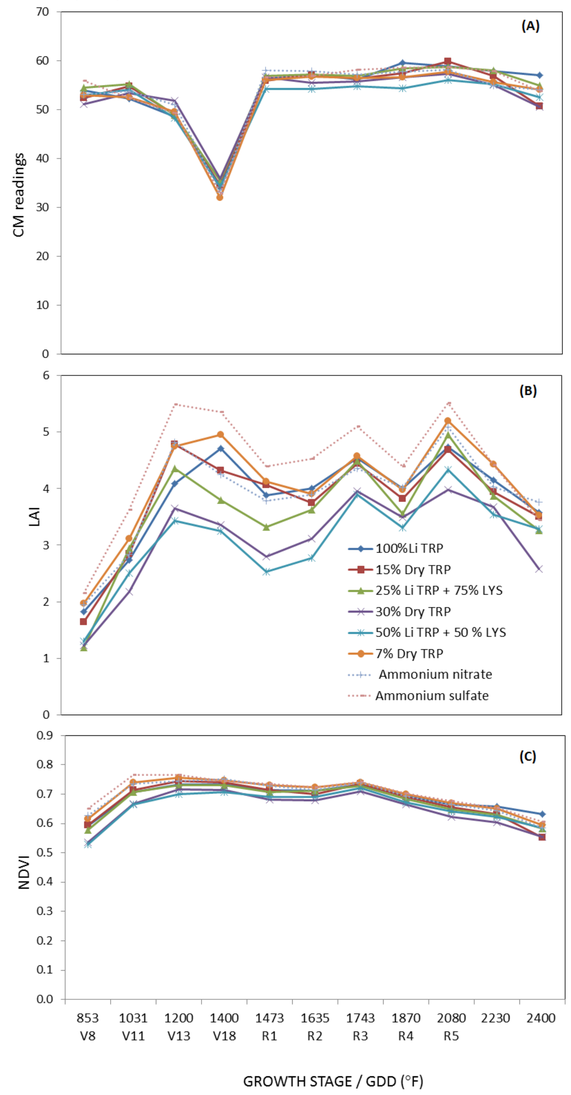

Table 2. Effects of level of TRP upon yield and stover in corn (100% dry matter).

Treatment	Grain yield	Total biomass	Stover yield	Harvest index
	kg ha^{-1}			
Ammonium nitrate	10282	19316	9034	0.53
7% Dry TRP	11142	20422	9279	0.55
15% Dry TRP	9878	18546	8668	0.53
30% Dry TRP	8952	17017	8065	0.53
100%Li TRP	10298	19173	8875	0.54
50% Li TRP + 50 % LYS	9015	16740	7726	0.54
25% Li TRP + 75% LYS	10431	19071	8641	0.55
Ammonium sulfate	11138	20734	9595	0.54
Mean	10142	18877	8735	0.54
P > F	0.32	0.39	0.50	0.59

RESULTS AND DISCUSSION

The 2013 growing season was characterized by excessive rains from April to mid-June, while July and August had cooler than long-term average temperatures and bellow long-term average rainfall. The planting date was later than desired due to excessive spring rainfall. However, yields were still satisfactory.

Grain yield (*P*=0.32), total aboveground biomass (*P*=0.39), stover yield (*P*=0.50) and harvest index (*P*=0.59) were not significantly influenced by N source in 2013 (Table 2). The iso-nitrogenous replacement of ammonium nitrate by TRP at 0, 7, 15, and 30% did not significantly influence the corn yield (grain or stover yields). Results differ from those reported by Moore and Hintz (unpublished results), who found that stover yield was decreased when ammonium nitrate was replaced by 15% of TRP in iso-nitrogenous treatments.

Results from our first year indicate that the TRP product can replace ammonium nitrate without compromising grain or stover yield of corn.

CONCLUSION AND NEXT STEPS

Based on one year of results:

- Replacing N from Ammonium nitrate with N from TRP and LYS products did not influence corn grain or stover yields.
- Additional field and greenhouse evaluations will be conducted in 2014.

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