Pulse Crop Improves Early Nitrogen Uptake, Growth and Yield of Wheat in No-till

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Introduction

Conventional tillage is gradually being replaced by no-till or minimal tillage in Montana. To prevent nitrogen (N) leaching over the winter and to synchronize N supply with crop uptake, most N fertilizer is broadcast applied during early spring to produce high protein content wheat in central Montana. However, this practice has been found to have low nitrogen use efficiency (NUE, bu/lb N input) in the traditional dryland wheat production system (Chen et al., 2012). Low NUE not only negatively impacts the environment, but also increases costs. Pulse crops have been successfully introduced to wheat-based production systems in Montana. The objective of this study was to investigate the effects of crop rotation with pulses on NUE of the subsequent wheat crop.

Methods

The experiment was initiated in 2004 in adjacent long-term no-till (LTNT, 15 years) and long-term sweep-till (LTST, >20 years) fields at the MSU Central Agricultural Research Center. Both fields have the same crop and fertilization management history. The treatments included two crop rotations: spring wheat-winter wheat (SW–WW) and spring pea–winter wheat (SP–WW). Winter wheat received 0, 40, 80, or 120 lb N/acre as urea broadcast April 20, 2006. The experiment was a randomized complete block design arranged as split-plots with four replications. On May 12, 2006, aboveground WW plant tissue was collected to measure biomass accumulation and N uptake. Winter wheat grain was harvested in August with a plot combine.

Results

Tillage and rotation influenced early spring WW biomass response to N (Figure 1). In the LTNT field, spring WW biomass was lower in the SW–WW than in the SP–WW rotation at lower N rates, but the differences became narrower with increasing N rates, and no difference was observed at 120 lb N/acre (Figure 1a). This indicates that insufficient N was available for WW in early spring in the SW-WW rotation under the no-till practice, at all but the highest N rate. However, in the LTST field, lower biomass was only detected in the SW–WW at the 0 N level. No differences were found between SP–WW and SW–WW rotations at higher N rates (Figure 1b). This implies that tillage improved the availability of surface-applied N for the crop, especially in the continuous wheat production system. Spring surface applied N was apparently more available to the crop in the ST than NT system, especially in the continuous wheat production system.

Different responses of WW to spring broadcast N in the LTNT and LTST fields under SW–WW and SP–WW rotations may be explained by crop N uptake shortly after urea application. The N uptake by WW under LTNT was significantly higher in SP–WW than in the SW–WW rotation at both 0 and 120 lb N/acre input levels (Figure 2a). Nitrogen uptake in the SP–WW and SW–WW rotations at 0 N were 4.5 and 2.1 lb N/acre, respectively, and

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N uptake in the SP–WW and SW-WW rotations at 120 lb N/acre were 7.7 and 5.6 lb N/acre, respectively, at late tillering. In the LTST field, however, no differences in N uptake were found between the SP–WW and SW–WW rotations at 0 or 120 lb N/acre (Figure 2b).

These early stage differences in N uptake and biomass accumulation translated to lower WW grain yield in the SW–WW rotation than in the SP–WW rotation, especially in no-till. Using multiple years of data, the maximum WW grain yield was estimated at 24 bu/acre for SW–WW at 80 lb N/acre, and 39 bu/acre for SP–WW at 80 lb N/acre in the LTNT field; while the maximum yield in the LTST field was 37 bu/acre for SW–WW at 80 lb N/acre rate, and 48 bu/acre for SP–WW at 120 lb N/acre.

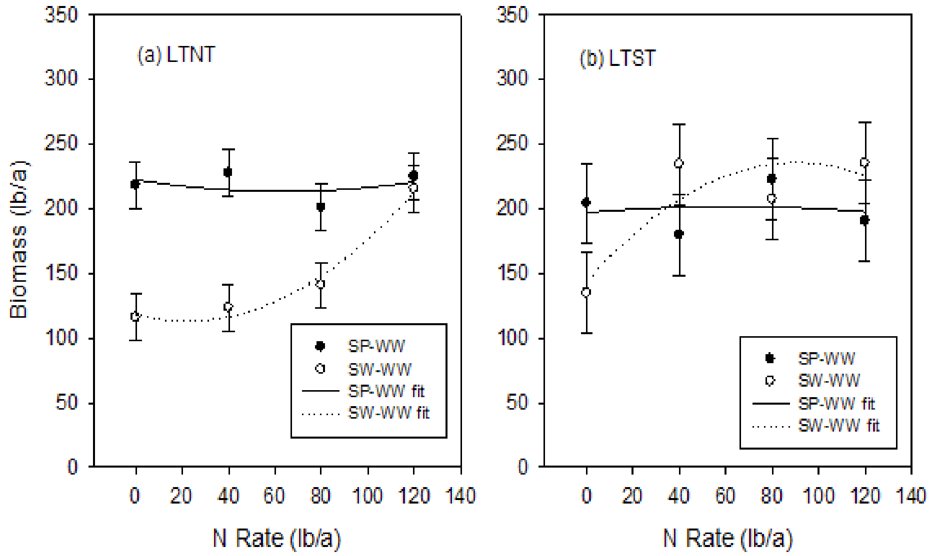

Figure 1. Biomass of winter wheat on May 12 in (a) long-term no-till (LTNT) and (b) long-term sweep-tilled (LTST) fields under spring pea-winter wheat (SP–WW) and spring wheat-winter wheat (SW–WW) rotations responded differently to mid-April broadcast N.

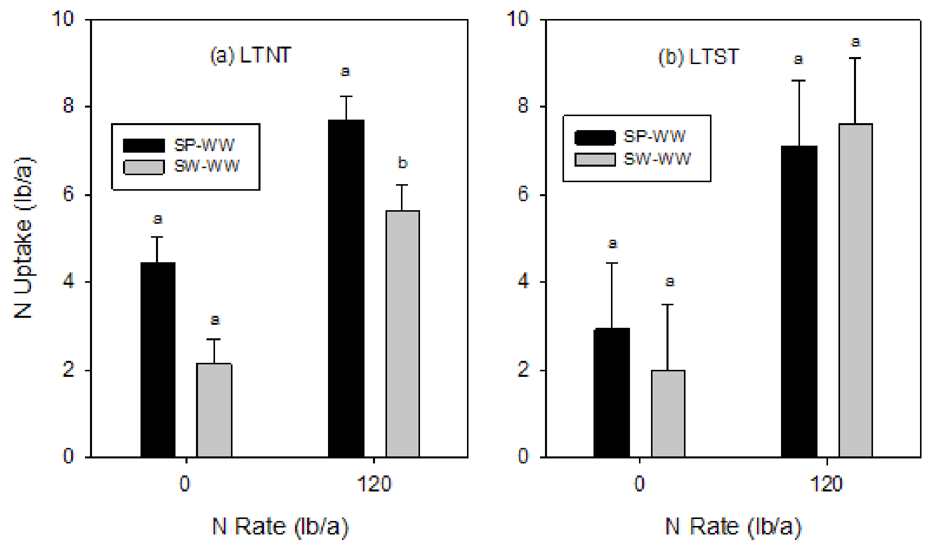

Figure 2. Nitrogen uptake of winter wheat on May 12 in (a) long-term no-till (LTNT) and (b) long-term sweep-tilled (LTST) fields under spring pea-winter wheat (SP–WW) and spring wheat-winter wheat (SW–WW) rotations with two rates of mid-April broadcast N.

Fertilizer Facts

- A larger portion of urea spring broadcast onto no-till wheat stubble was unavailable to the crop than in sweep-till, three weeks after application.
- N uptake of WW in the spring was greater following pea stubble than following wheat stubble.
- Winter wheat yields follwing pea were much higher than following spring wheat.

Acknowledgment

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References

Chen, D., K. Neill, M. Burgess, and A. Bekkerman. 2012. Agronomic benefit and economic potential of introducing fall-seeded pea and lentil into conventional wheat-based crop rotations. Agron. J. 104:215-224.

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