NITROGEN TIMING FOR BOOT STAGE TRITICALE FORAGE YIELD AND PHOSPHORUS UPTAKE

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ABSTRACT

Optimal N timing for boot stage winter triticale forage production and phosphorus (P) removal is not well established. Irrigated winter triticale in low and relatively high Olsen P soil was treated with six rates of fall pre-plant N and two rates of late winter N at Parma in 2006 and 2007. Triticale boot stage biomass, protein, nitrate-N, P concentrations, and P uptake and were determined. Fall preplant N increased forage production and frequently produced more boot stage triticale biomass. It also tended to increase P uptake, but reduced P and forage protein concentrations likely due to plant dilution. Higher N increased forage P concentrations in high P soil in one of two years. Available soil P did not affect forage protein. Forage protein in the range of 10.5 to 11.0% was necessary for maximum forage production. It appears that more N is required for maximizing P removal than is required for maximizing production.

INTRODUCTION

A phosphorus based manuring standard reduces manuring rates as compared to a N based standard, and ultimately requires the purchase of fertilizer N to maintain or maximize forage production. This occurs because the N:P ratio of manure, especially if composted, is lower than the N:P ratio of harvested forage.

Maximizing total P removal in harvested crops accommodates higher manuring rates or more rapid P remediation. To maximize total P removal and forage production a double crop forage system has evolved in southern Idaho comprised of a winter crop of triticale harvested at boot stage followed by corn planted for silage.

Whereas the N and P requirements for maximizing the grain yield of irrigated small grains or corn silage are reasonably well established, the N requirements and timing for boot stage triticale forage are not. For winter cereal grain production, late winter/early spring topdressed N is frequently more effective than fall pre-plant fertilizer N. Fall pre-plant fertilizer N reportedly increases vegetative growth without increasing grain yield and is discouraged by NRCS 590 standards governing animal waste applications. Whereas excessive vegetative growth for the production of grain is undesirable, it may be beneficial for a boot stage forage harvest, P removal and P remediation. Forage P concentrations reportedly increase with higher available N.

Protein is routinely measured in harvested forages for balancing rations. Forage protein may also indicate whether triticale winter forage received adequate N. But information is lacking on the protein concentrations associated with maximum forage production.

OBJECTIVES

The objective of this study was to evaluate N rate and timing effects on boot stage triticale forage yield, protein, and P uptake. The trial was also designed to provide data that could help interpret boot stage triticale forage as a post-harvest aide in evaluating N management.

METHODS

To evaluate N timing and rate for triticale boot stage forage production, protein, and P content, winter triticale field trials in the 2005-06 and 2006-07 seasons were conducted on a Greenleaf silt loam involving six preplant urea N rates (0, 60, 120, 180, 240, and 300 lb A^{-1}) and two rates of N (120 and 240 lb urea N A^{-1}) topdressed in late winter (20 March 2006, 14 February 2007). The N treatments were applied as subplots within main plots differing in previous compost rates (applied in 2002 and 2003) that resulted in moderately low (8.4 in 2006 and 13.9 ppm in 2007) and high preplant residual P (71 in 2006 and 54 ppm in 2007). Winter triticale (Trical 336) was planted 28 September 2005 and 26 September 2006 in 7 inch spaced rows at a rate of 150 lb seed/A. Boot stage forage biomass was harvested both years (3 May 2006 and 4 May 2007), the total N, nitrate-N, and P concentrations measured and forage protein concentration and total P uptake calculated. The split-plot treatment arrangement had four replications. The data were analyzed using Analysis of Variance (SAS, 9.1)

RESULTS AND DISCUSSION

Boot Stage Forage

Triticale boot stage forage yield averaged 35% and 22% higher in the higher P soil (previously compost treated) in 2006 and 2007, respectively (Fig. 1). Boot stage forage increased in both years with preplant applied N (Fig 1). Optimum preplant N for forage yield was 120 lb A^{-1} in 2006 and 60 lb A^{-1} in 2007 despite residual N at planting that did not differ appreciably between the two years. Forage biomass was generally more productive with fall preplant N than spring topdressed N at the 120 lb A^{-1} N rate (Fig. 2).

Forage Protein and Nitrates

Boot stage forage protein concentration increased linearly with N applied (Fig. 3). Protein increased to N rates well beyond those required for maximum forage production. Available soil P did not appreciably affect forage protein. However, forage protein did not decline even though forage biomass increased with higher soil P. Forage protein in 2006 was consistently lower with fall preplant N than with late winter topdressed N, possibly due to dilution with greater biomass (Fig. 4). The trend was not as evident in 2007.

Forage nitrates can be toxic to livestock when available N appreciably exceeds the optimum. Boot stage forage nitrate-N concentrations increased only when the N rates far exceeded the optimum for yield (Fig. 5) and tended to be higher with late winter topdressed than fall preplant N (data not shown).

Boot stage forage protein concentrations resulting from the preplant N applied were related to the relative forage production (percent of maximum within each year). Maximum production coincided with boot stage forage protein ranging from 10.5 to 11.0% (Fig. 6).

Forage P Concentrations and Uptake

Forage P concentrations in both years were higher in soil with higher soil test P as expected (Fig. 7). While P concentrations were unaffected by increasing N rate in lower P soil, triticale P concentrations increased with higher N in higher P soil in 2006. Also in 2006, forage P concentrations were generally higher with late winter topdressed N than with preplant N regardless of available P. This trend was not as evident in 2007.

Forage P uptake was 64% and 52% greater in higher P soil in 2006 and 2007, respectively (Fig. 7). The uptake of P consistently averaged numerically higher with preplant N than late-winter topdressed N, consistent with timing effects on biomass, though the means seldom differed significantly. Also, in higher P soil, higher N tended to increase P uptake (6.8% to 16.5%) as it did P concentrations, but the means did not differ significantly.

In summary, fall preplant N was more productive than late winter topdressed N. The N applied in excess of that required for maximum production was necessary for improved forage protein and for maximizing P removal in at least one of the two years.

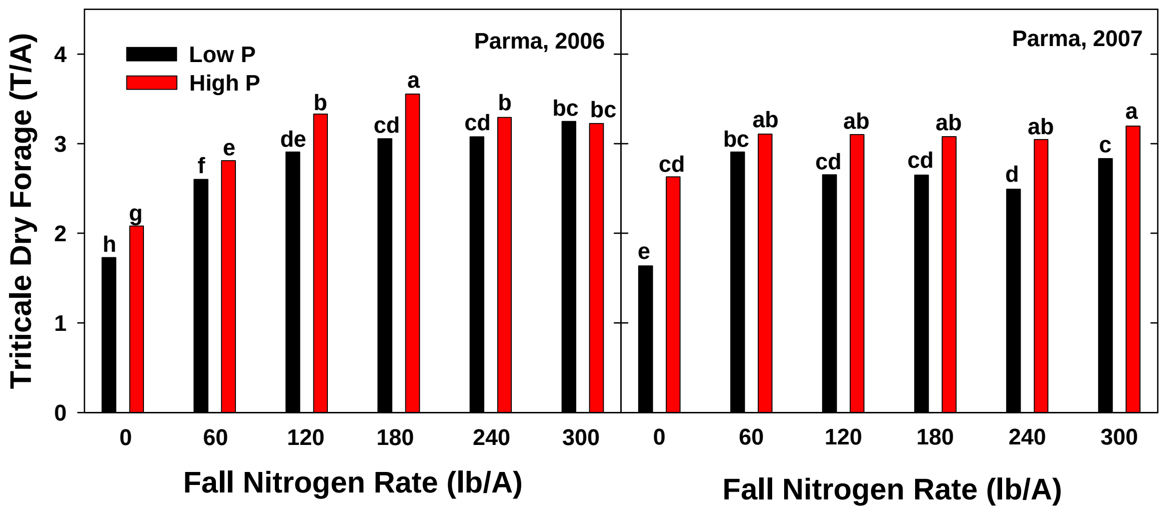

Figure 1. Triticale boot stage dry forage at Parma in 2006 and 2007 in low and high P soil as affected by fall preplant N. Columns within years with letters that differ are significantly different at the 10% probability level.

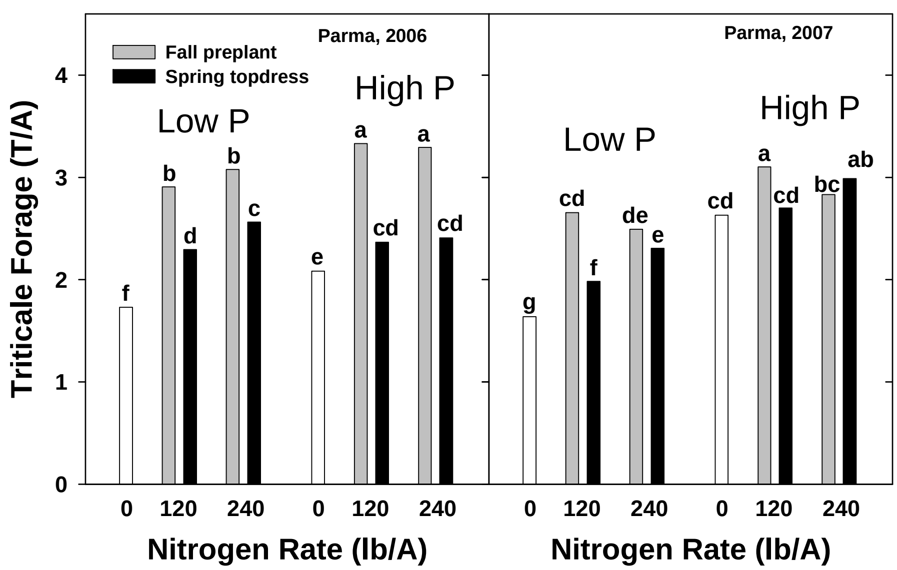

Figure 2. Triticale boot stage dry forage at Parma in 2006 and 2007 in low and high P soil as affected by N timing and rate

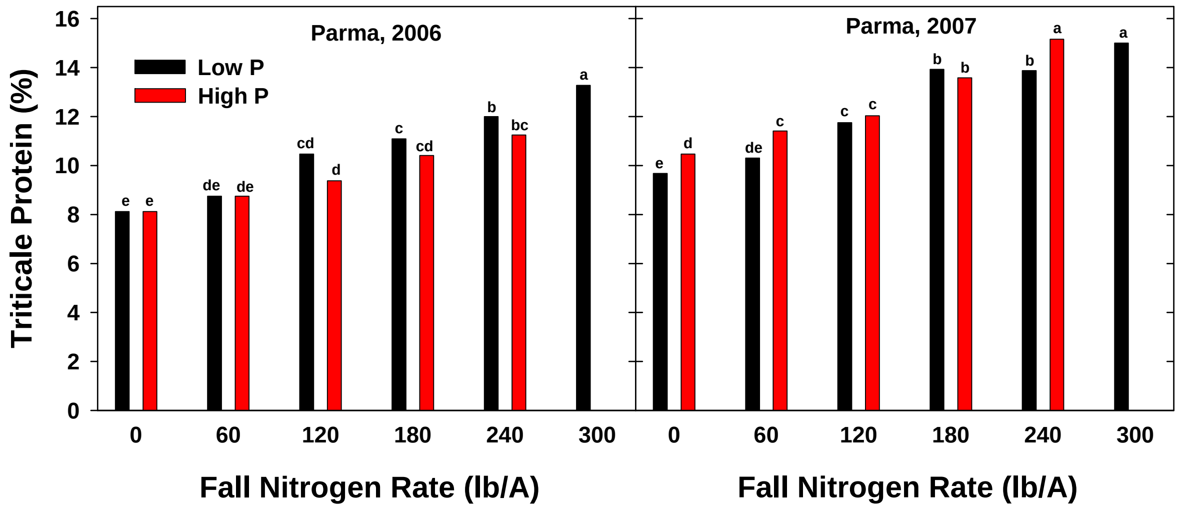

Figure 3. Triticale boot stage forage protein at Parma in low and high P soil in 2006 and 2007 as affected by fall preplant N. Columns with the same letters do not differ at the 10% probability level.

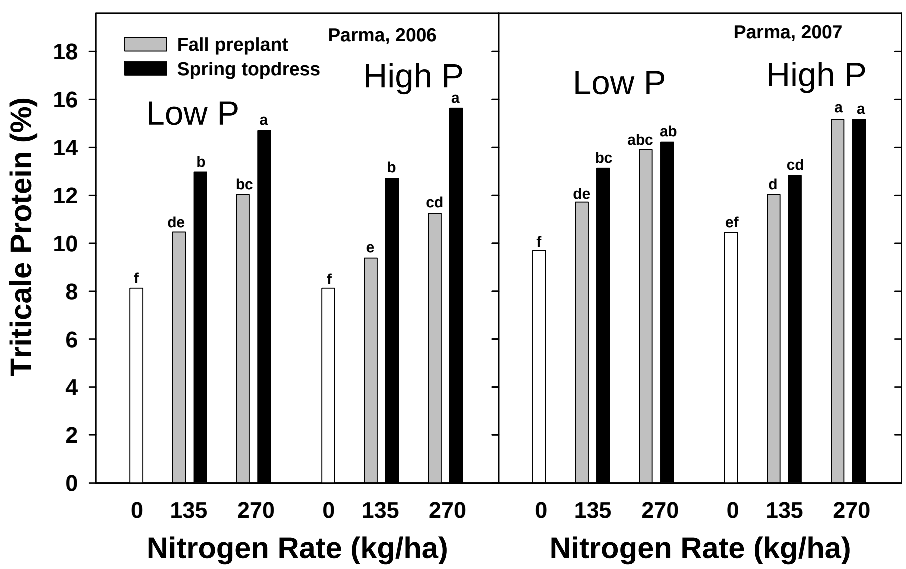

Figure 4, Triticale boot stage forage protein in low and high P soil at Parma in 2006 and 2007 as affected by N timing and rate. Columns with letters that do not differ are not significantly different at the 10% probability level.

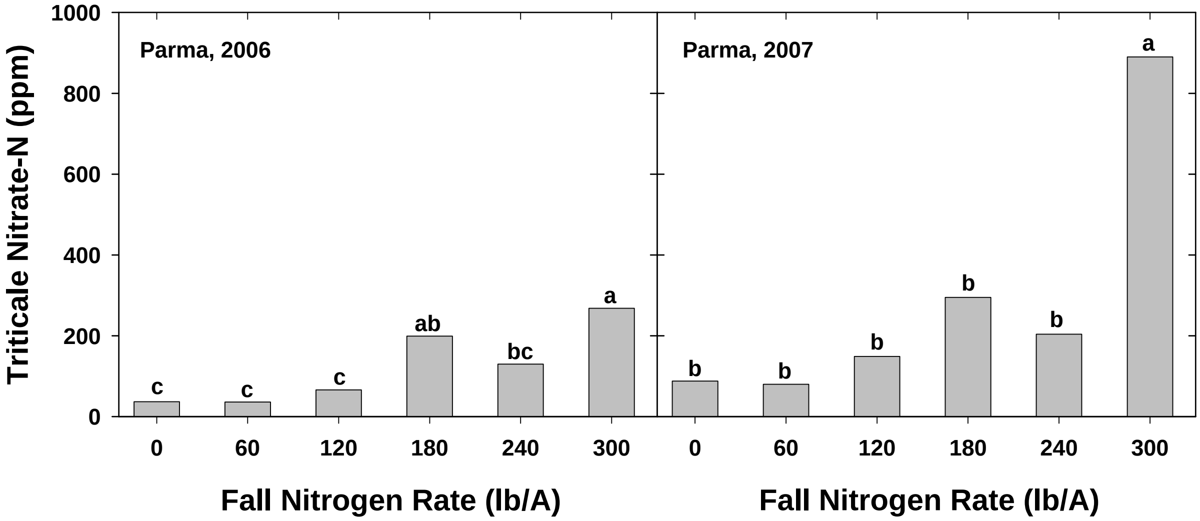

Figure 5. Triticale boot stage forage nitrate concentrations in low and high P soil at Parma in 2006 and 2007 as affected by fall preplant N.

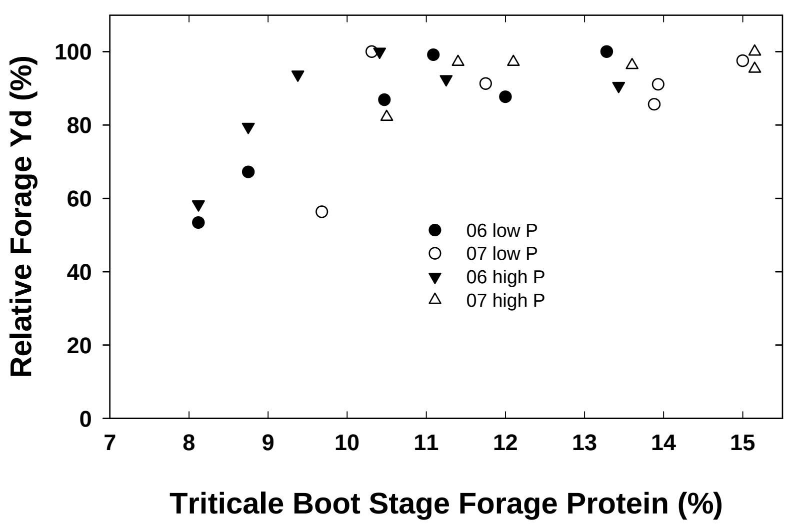

Figure 6. Triticale boot stage relative forage yield at Parma in 2006 and 2007 as related to forage protein.

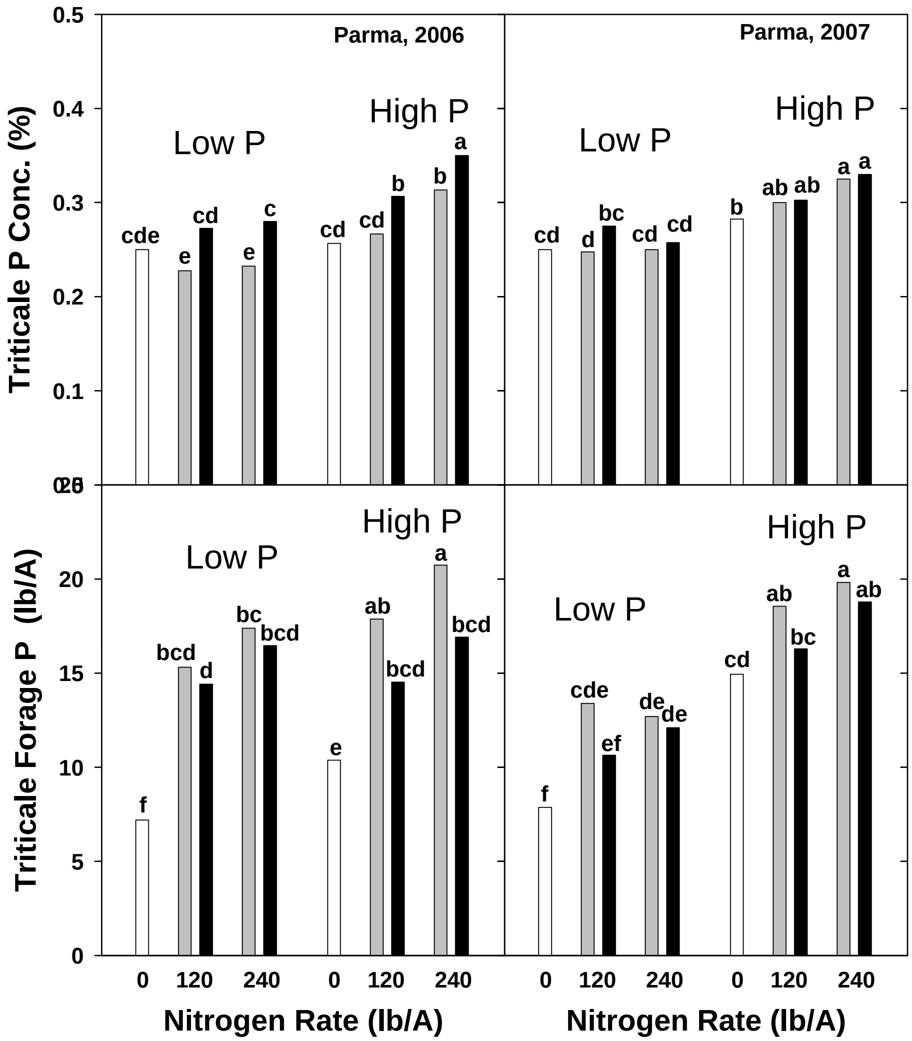

Figure 7. Triticale boot stage forage P concentration and P uptake at Parma in low and high P soil in 2006 and 2007 as affected by N timing and rate. The darkest bars are the late winter applied N. Columns with letters that are the same are not different at the 10% probability level.