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Nitrogen and Seeding Rates of Forage Corn

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Moving to a high seeding rate increased DM and TDN yields and decreased CP and P concentrations in forage corn. Using a high nitrogen fertilizer rate increased yields of DM, TDN and CP, increased soluble protein concentration, and reduced P concentration. However, when net returns were calculated, the current recommended seeding rate (30,352 seeds/ac or 75,000 seeds/ha) and N rate (100 lb N/ac) were found to be the most profitable.

Interest in using corn as a forage for winter grazing by beef cattle is growing in Saskatchewan. The continuous improvement in low corn heat unit (CHU) corn hybrids has allowed for the expansion of corn into the shorter growing season areas of the Prairies. Currently, the provincial recommendation for corn seeding rate is 30,352 plants/ac (75,000 plants/ha) and for nitrogen (N) fertilizer is 100 lb N/ac (soil N plus fertilizer). However, these recommendations are based on the grain and silage corn hybrids available before the newer low CHU hybrids that are typically used in the short growing season regions. Because of the much higher input costs for corn compared to traditional annual forage crops such as barley or oats, further investigation was needed to better evaluate the planting density and N fertilizer rate required for forage corn production in Saskatchewan.

Research was conducted to determine the agronomic and economic effects of plant density and N fertilizer on forage corn yield and nutritive quality, as well as evaluate any interactions between the planting density and N fertilizer parameters. Trials were established at 6 sites from 2016 to 2018, for a total of 16 site-years. The sites were chosen for their differences in CHU, soil zones, and growing conditions, representing the range of conditions across Saskatchewan, and included Scott (2100 CHU), Lanigan (2150 CHU), Melfort (2175 CHU), Yorkton (2250 CHU), Outlook (2300 CHU, irrigation), and Redvers (2450 CHU).

Plots were seeded with a corn planter when soil temperatures reached 10C at a 2 inch) depth. Three seeding rates were tested: 30,352 seeds/ac (75,000 seeds/ha), 40,470 seeds/ac (100,000 seeds/ha), and 50,587 seeds/ac (125,000 seeds/ha). After plant counts were taken, the average established plant populations across all site-years for each seeding rate were within 11% of the targeted seeding rates. Established plant densities were 28,319 plants/ac for the low seeding rate, 36,626 plants/ac for the moderate, and 44,938 plants/ac for the high seeding rate.

Three nitrogen fertility treatments of 100, 150 and 190 lb N/ac (soil nitrate-N + fertilizer N) were tested. The N fertilizer used was urea treated with a urease-inhibitor and the full rate was applied prior to planting. Phosphorus and sulfur were applied based on soil test recommendations.

Dekalb and Pioneer hybrid corn varieties were planted at each site. The specific varieties used varied among site-years based on the CHU rating of the sites and seed availability. Harvest began for all treatments when the cob kernels of the middle treatment (moderate seeding rate and 150 lb N/ac) reached half milk line.

For the economic analysis, seed costs used were $91, $121 and $152/ac for the low, moderate and high seeding rates, respectively. Fertilizer was priced at $0.19/lb N, $0.45/lb P_2O_5, and $0.38/lb S.

High seeding rates increased dry matter, TDN and crude protein

As the seeding rate increased from the low rate to the high rate, the dry matter (DM) yield, total digestible nutrients (TDN) yield, and crude protein (CP) concentration all significantly increased. The DM yield increased significantly by 0.4 mt/ac going from the low to the high seeding rate. Moving from a moderate to high seeding rate also significantly increased DM yield by 0.2 mt/ac. However, only a modest and non-significant increase in DM yield was found going from the low to the moderate rate. There were no significant differences in TDN yield going from the low to moderate or the moderate to high seeding rates.

Crude protein concentration had a significant decrease of 3 mg/g going from the low seeding rate to the moderate and high seeding rates. There were no significant differences in CP yield between any of the seeding rates. Increasing the seeding rate from low to moderate and high plant densities also significantly increased the soluble protein concentration, an important component in fibre digestion for ruminants.

Phosphorus was the only mineral impacted by seeding rate. Phosphorus concentration significantly decreased at the high rate compared to the low seeding rate, but this P reduction was small and was likely due to increased forage yield but without additional P fertilizer applied.

High nitrogen rates also led to higher DM, TDN and CP

On average across all site-years, increasing the N rate from 100 lb N/ac to 190 lb N/ac significantly increased the forage DM yield by 0.2 mt/ac. However, this yield increase was only significant at 3 of the 16 site-years. Differences in weather (temperature and precipitation) between sites led to the variability observed among site-years. The TDN yield was also significantly more (0.19 mt/ac) at the 190 lb N/ac compared to 100 lb N/ac rate when averaged across all site-years, but was only significant at 5 of the 16 site-years.

Crude protein yield, CP concentration and soluble protein increased significantly with each incremental increase in nitrogen rate. The average CP yield across all site-years increased as N fertility increased and was significant at 9 out of 16 site-years. Redvers was the only site to observe this trend in all three years of the trial. Results for CP concentration varied across site-years, ranging from 4.4 to 9.4%. The low end of this range is below what is recommended for gestating beef cows (7 to 8%).

The mineral concentrations (P, Ca, Mg, K, Na, Cl) also significantly increased from the 100 lb N rate to the 190 lb N rate but varied among site-years. Phosphorus concentration showed the highest increase at these fertilizer rates compared to all other minerals.

There were no interactions between nitrogen rate and seeding rate on forage yield or quality.

Economic analysis

Individually, the highest seeding rate and the highest N rate (190 lb N/ac) each provided the most grazing days, but there was no interaction between seeding rate and N rate for grazing days. Grazing days ranged from 204 head to 357 head per day/ac, depending on the site-year.

The highest seeding rate significantly increased gross revenue compared to the lowest seeding rate by $36.66/ac, but net revenue was decreased by $24.06/ac due to the cost of additional seed. The cost per mt of DM and cost per mt of TDN were significantly higher by $7.09 and $11.85, respectively.

The highest N rate (190 lb N/ac) also significantly increased gross revenue by $23.84/ac over the lowest N rate, but the net revenue was not significant ($5.59/ac more return at the high rate vs the low rate). There were no significant differences between the cost per mt of DM or TDN for the N fertility rates.

The costs to produce 1 mt of dry matter in this study were lower than the cost/mt of DM for other alternative winter feeds, such as cereal straw or second-cut alfalfa, suggesting that corn grazing is a viable option for cattle producers in Saskatchewan.

In summary, while high seeding rates and N fertility rates increased yield, TDN and protein of forage corn, there was not enough economic benefit to offset the increased seed and fertilizer costs. Based on this study, the current provincial recommended rates for planting density of 30,352 plants/ac and nitrogen of 100 lb N/ac (soil N plus fertilizer) are adequate for low CHU forage corn production. Variability found between sites and years will play a role in corn production and quality, and producers will need to feed test and supplement accordingly on their own operations each year.

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