Manipulating Stubble Height and Row Spacing in Forage Corn for Agronomic and Ecological Benefits

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Project Goals

The goal of the project was to test the hypothesis that increasing corn silage cutting height and decreasing row spacing has the potential to improve soil health and forage quality with minimum impact on silage yield and milk production.

The study evaluated the effects of two corn silage cutting heights (6” vs. 21”) and two row-spacing (15” vs. 30”) treatments on silage yield, quality, and milk production; and selected soil health indicators related to C and N cycling, soil moisture, and wind dynamics.

The dairy industry contributes ~40% to the state's economy in New Mexico (NM) and generates more than one billion dollars in revenue each year. Corn silage is the main row crop grown as high quality forage for the dairy industry.

The typical corn silage production involves wide row spacing and short cutting height (3 to 6 inches from the ground), which is not sustainable because removing most of the residue out of the field leaves soil exposed to wind and water erosion. The soil degradation is further exacerbated by long fallow periods (6-12 months) between crops, which is common in NM because of limited water available for irrigation. The lower most part of a corn plant from 12-18 inches is high in water content and low in quality, thus contributes less to dairy performance. Increasing silage cutting height could increase agronomic and environmental benefits.

About the study

The two-year study was conducted at a private farm on a half circle of center-pivot irrigated field near Clovis, NM and at the Agricultural Science Center at Clovis. Corn was planted in 2017 and 2018 using no-tillage. The corn variety ‘9678VTP’ was used at 22,000 seeds per acre. The row spacing-cutting height combinations evaluated were: 15” narrow row spacing with short cutting height (6”), 15” row spacing with tall cutting height (21”), 30“ wide row spacing, with short cutting height [6”), and 30“ row spacing with tall cutting height (21”).

Another study at the Agricultural Science Center at Clovis examined the relationships between forage corn vertical biomass distribution and forage quality of various corn varieties.

Highlights

- Reducing row spacing from 30” to 15” in corn silage increases yield by 28% and milk production by 22%.
- Narrow row spacing improved biologically active organic matter by 20-25%.
- Increasing silage cutting height improved feed quality and reduces erosion.
- Ecological benefits in silage corn production system can be maximized by planting corn in narrow row spacing and leaving more residues in the ground.

Key Findings

- Reducing row spacing from 30” to 15” increased silage yield by 28% and milk production by 22%.
- Increasing silage cutting height from 6” to 21” decreased silage yield by 20%, but improved quality as reflected in decrease in fiber content by 6 to 8% and increase in starch by 11%.
- Milk production was numerically higher with more tonnage of corn. Neither row spacing nor cutting height had a significant effect on milk produced per tonnage of silage.
- Soil analysis results revealed a small increase in soil organic matter (1-4%) due to taller cutting height treatments.
- Narrow row spacing improved labile organic carbon (20-25%) in the third year of study suggesting the potential to improve soil health in the long-term.
- Looking at the vertical corn biomass distributions and quality relationships, there was a significant difference between the different plant portions for forage yield, quality characteristics, and milk production.
- Corn ear contributed the highest (59 %) to total dry forage yield while the least contribution (5%) was from the bottom plant portion (6-13”).
- Moisture content in plant portions was the lowest in the ear (48 %) while significantly higher moisture was recorded in the plant portion below the ear (76-78 %).
- Forage quality of ear and above the ear plant portions were higher than below ear plant portions indicating their significance in the overall corn forage quality and hence feed value in the animal feed ration.
- Key forage quality parameters such as protein (10% vs. 5.4%), starch (53% vs. 5.3%), and total digestible nutrients (74% vs. 55%), were significantly higher in the ear than the other portions of the plant.

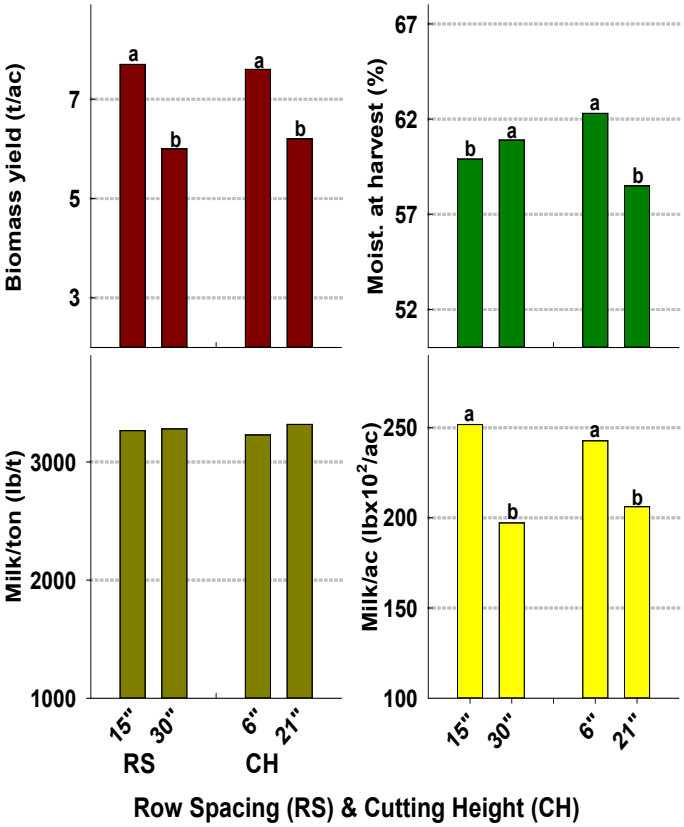

Figure 1. Effects of corn silage row spacing and cutting height on forage yield, moisture at harvest and milk production in 2017-2018 (two year average).

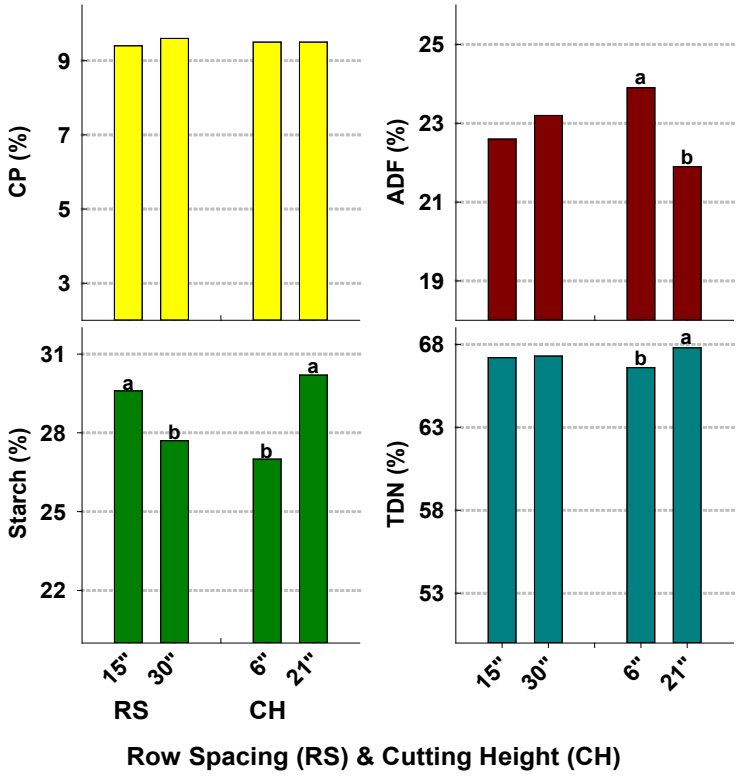

Figure 2. Effects of corn silage row spacing and cutting height on forage quality in 2017-2018 (Two year average). Crude protein (CP), acid detergent fiber (ADF), total digestible nutrients (TDN).

Key Findings

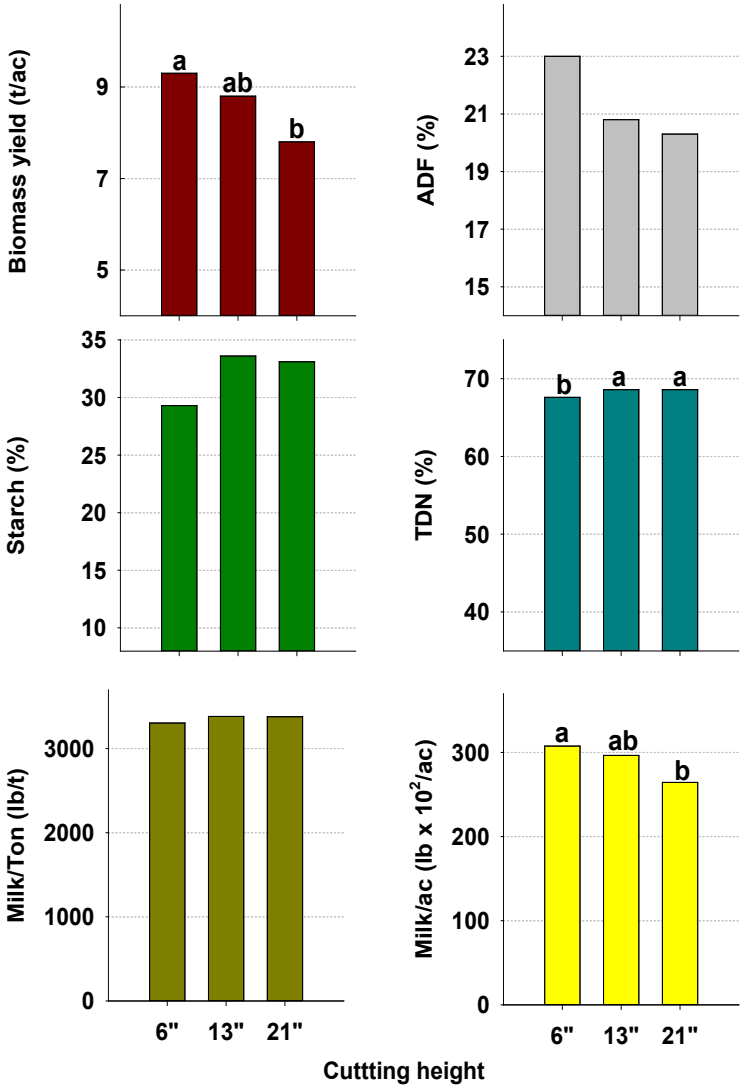

Figure 3. Corn silage forage yield, quality and milk production in relation to three cutting heights in 2017. Acid detergent fiber (ADF), total digestible nutrients (TDN). Five varieties average.

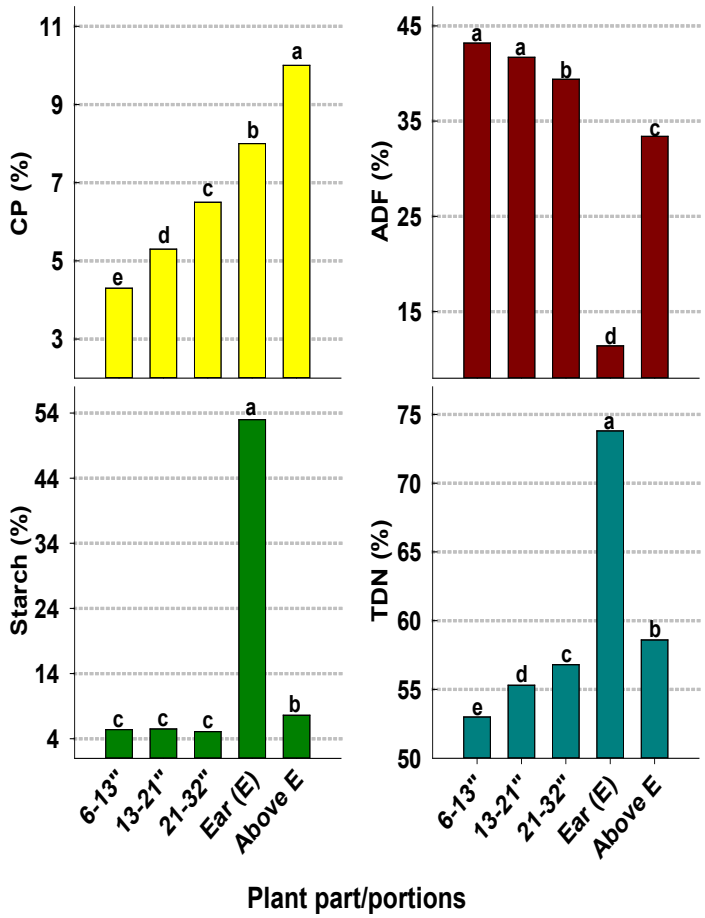

Figure 4. Vertical corn silage quality distributions in corn in 2018-2019. Crude protein (CP), acid detergent fiber (ADF), and total digestible nutrients (TDN). Two years and 5 varieties average.

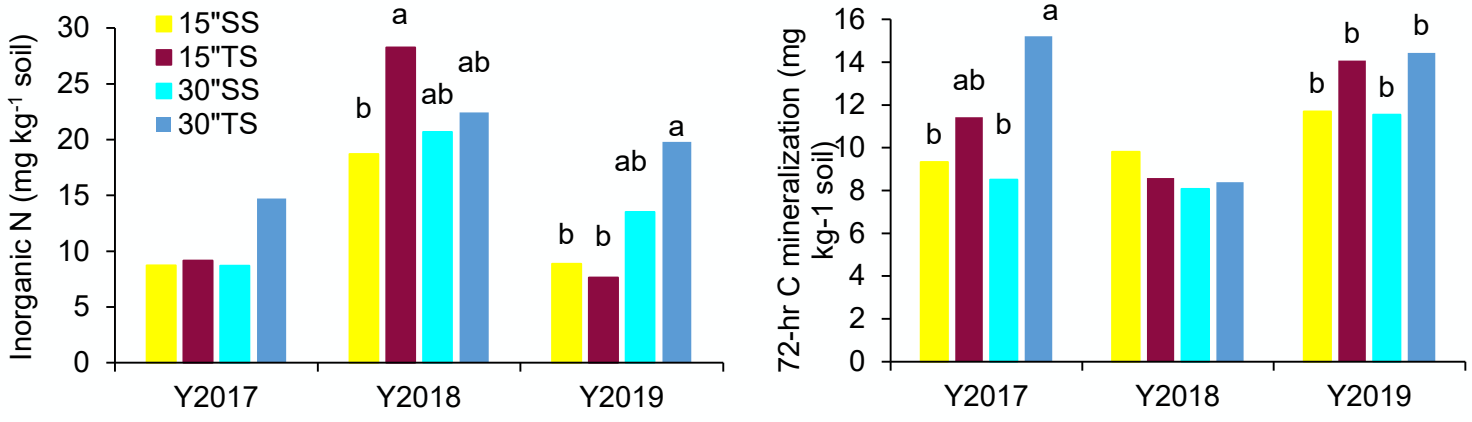

Figure 5. Effect of corn silage row spacing (15” and 30”) and cutting height (short: ss, tall: TS) on soil inorganic N and soil C mineralization in 2017-2019.

Recommendations

1. **Increase silage cutting height for improved feed quality and ecosystem services.**
   - Increase in silage cutting height decreased the tonnage of silage by 11%, but significantly improved the feed quality.
   - Cattle fed with tall cutting height silage produced more milk per tonnage of feed.
   - Taller stubble in the ground reduces soil erosion by both wind and water.
   - More organic input (residue recycling) from stubble increases soil organic matter storage.
   - A taller cutting height is expected to leave more of the tougher bottom stem in the field, which upon decomposition can utilize residual nitrogen and reduce N leaching.

2. **Reduce row spacing for high silage yield.**
   - Silage yield increased by reducing row spacing from 30 to 15 inches.
   - Milk production per acre increased with high silage yield.

3. **Maximize ecological benefits by planting forage corn in narrow row spacing, leaving more residues in the ground.**
   - Leaving the bottom plant parts which are high in indigestible fiber (mostly lignin), nitrate, and moisture, which reduces feed quality but has potential to improve soil health by reducing erosion and increasing organic matter.
   - Narrow row spacing improved labile SOM fraction suggesting the potential to improve soil health in the long-term. Wind, in general, was slightly reduced by reducing corn row spacing and increasing cutting height.
   - Integrating tall stubble achieved with higher silage cutting heights, narrow row spacing and cover cropping provides better soil coverage, which leads to improved soil moisture retention, carbon sequestration, and sustainability of forage corn production and hence dairy farming systems in New Mexico and similar agroecosystems.

This study did not determine

- The ideal cutting height. Based on forage quality of different parts of corn plant, a estimated cutting height of 12” would be a good starting point for farmers to test out on the fields, based on their equipment, soil quality and need for income.
- The cost savings from taller cutting height due to leaving the wetter portions of stalks in the field. It is expected that there is a cost savings from less drying time needed with harvesting the drier, more nutritious portions of the plant.
- The ideal row spacing. Research has confirmed that row spacing of less than 30” reduces weed pressure, reduces soil evaporation and produces higher biomass and grain.
- A cost benefit analysis of no-till and cover crops. These are other conservation practices known to improve soil health and reduce soil evaporation.

Acknowledgments:

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