Nitrogen Credits Following Sweet Corn and Cover Crop Effects on Nitrogen Carryover: A 3-Year Summary

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Abstract: Sweet corn for processing is grown on over 100,000 acres in Minnesota predominately under rain fed conditions on fine-textured soils. Previous research has found that sweet corn stover can provide 78 to 86 kg N/ha with a C:N of 32:1 to 35:1. Sweet corn stover may therefore supply an N credit to a subsequent crop The objective of this study was to determine the N credit for field corn from a previous crop of sweet corn with and without a cover crop of rye planted after the sweet corn crop, compared with using soybeans or field corn as the previous crop. In each of four blocks, four whole plots were planted in 2017, 2018, and 2019 with one of four crops: field corn, soybeans, sweet corn, and sweet corn followed by rye. In the years after these crops were grown (i.e., 2018, 2019, 2020), field corn was planted in every plot, and each plot was divided into subplots receiving N as urea at six rates: 0, 50, 100, 1150, 200 and 250 kg N/ha. Averaged over 3 years, the economically optimum N rate (EONR) was approximately 221 lb N/A for field corn following field corn. In contrast, when field corn followed soybeans, sweet corn, or sweet corn and rye, the EONR was in the range of 168-180 lb N/A, with no clear advantage to one of these rotation crops over another, although the EONR for field corn following soybeans was numerically higher than for sweet corn or sweet corn plus rye. Based on these results, sweet corn provides an N credit about 20-25 lbs N/A. If terminated before May 10 the rye cover crop after sweet corn harvest did not provide any additional advantage or disadvantage in terms of yield or N demands to the subsequent field corn crop, but it did sequester about 56 to 67 kg N/ha prior to planting the field corn. When the rye crop was terminated after May 10, the C/N ratio of the residue was higher and no N credit for a previous crop of sweet could be taken. In all cases, a rye cover resulted lower residual nitrate-N in the top 2 feet in the fall and spring than no rye cover crop.

Introduction

In 2020, Minnesota ranked second in the US for processing sweet corn, with about 100,000 acres planted. Most of the crop is grown under rainfed conditions on fine-textured soils in southern Minnesota, often in rotation with field corn and soybean. Relative to field corn, sweet corn has a relatively short growing season because the crop is harvested at an immature stage of growth and then processed for canned or frozen produce. Because sweet corn is harvested as an immature crop (Figure 1), significant nutrients, and in particular nitrogen, remain in the residue. In general, sweet corn stover can contain as much as 60-80 lbs of N/A with a C to N ratio of 30:1 to 35:1. With these relatively low C:N ratios and a harvest time many weeks to months before freeze-up, there is a high potential for nitrogen mineralization during the fall or following spring, and sweet corn may therefore provide a nitrogen credit to a subsequent crop. Currently, no N credit is given for a previous crop of sweet corn. One of the risks involved with a nitrogen credit from sweet corn residue is that there is also a potential for leaching losses over the fall and early spring. To circumvent this problem, a properly planted cover crop can help to minimize leaching, as well as providing additional benefits such as reduced erosion and, in some cases, disease suppression.

To evaluate the potential for a nitrogen credit from a previous sweet corn crop, a three-year study funded by AFREC was conducted at the Southern Research and Outreach Center in Waseca. The main objectives were to 1) determine the effects of a previous sweet corn crop relative to soybeans and field corn on nitrogen response by a subsequent field corn crop and 2) determine the effect of a winter rye cover crop following sweet corn on field corn nitrogen response and nitrogen carryover.

Methods

The first step in this study was to establish previous crops of sweet corn, soybean, and field corn. The previous crops (field corn, soybean, sweet corn, and sweet corn + rye) were established in large plots in 2017, 2018 and 2019. Each large plot was replicated four times and a different field was used each year that had followed a large bulk planting of field corn. Field corn N response following these previous crops was evaluated in 2018, 2019 and 2020. The nitrogen rates applied within each large plot ranged from 0 to 250 lbs N/A in 50 lb N/A increments. The nitrogen source was urea and was broadcast applied and incorporated just before planting the field corn in the spring.

The rye cover crop following sweet corn was planted with a no-till grain drill (Figure 2) at the end of August or early September following sweet corn harvest in mid-August, with a seeding rate of 90 lb/A. Rye growth in the fall and spring is shown in Figures 3 and 4. The rye was killed in the first or second week of May and then disked in 3-8 days later. Biomass and C/N ratio of the rye cover prior to killing was recorded (Table 1.) Note that in the third year the C/N ratio of the rye was higher than the previous two years and may have had an impact on corn nitrogen response as discussed below. Field corn was planted in mid-May of each year.

Results

Residual Soil Nitrate and Carryover

Averaged over the three years, the rye cover crop reduced residual nitrate in the top two feet of soil in both the fall and the following spring compared to no rye cover (Table 2). The highest residual nitrate in the fall just before the soil freeze up was with sweet corn as the previous crop (with no rye cover crop). In the spring just before planting, the highest residual nitrate was with soybean as the previous crop.

Previous crop effects on economically optimum nitrogen rate (EONR)

The effect of previous crops on the EONR is presented in Table 3. In all years, the EONR was lower for field corn following soybean and sweet corn than continuous field corn, and in two out of three years, the ENOR was lower following sweet corn with rye than continuous field corn. In the third year, the EONR was slightly higher following sweet corn and rye than continuous field corn. The reason for the higher EONR in the third year with the rye cover crop is likely due to a higher C/N ratio of the rye residue. The cover crop was not killed until May 15 that year, suggesting that letting the rye crop grow too long in the spring will reduce the potential for a

nitrogen credit from a previous sweet corn crop. Overall, the nitrogen credit for sweet corn is slightly less than the nitrogen credit provided by a previous crop of soybean.
Yield at the EONR was also affected by the previous crop (Table 4). In all cases, yield with field corn as the previous crop resulted in lower yield at EONR than soybean, sweet corn, and sweet corn + rye. Overall nitrogen response by field corn as affected by previous crop is summarized in Figure 6. The results clearly show that, at all N rates, field corn yields were higher following sweet corn and soybean then following field corn. Adding more nitrogen helped increase yield in continuous field corn, but there was also a rotation effect that could not be overcome by adding more nitrogen fertilizer.

Conclusions

Based on this three-year study, we can conclude that field corn following field corn had a much higher nitrogen requirement than field corn following soybean and field corn following sweet corn with or without rye as a cover crop. The nitrogen credit for sweet corn is about 15 lbs less than that for soybean. Currently the soybean nitrogen credit is about 35-40 lb N/A. Therefore, a safe nitrogen credit for sweet corn would be about 20-25 lb N/A. If rye is used as a cover crop following sweet corn, the rye should be terminated by before May 10 to ensure that a nitrogen credit can be taken. If rye is not terminated by May 10, then a nitrogen credit should not be taken for a previous sweet corn crop. Use of rye following sweet corn resulted in lower residual nitrate in the soil in the fall and the following spring and therefore would reduce the potential for nitrate leaching during the months after sweet corn harvest and prior to planting of field corn.

Table 1. Biomass accumulation, nitrogen uptake, and C/N ratio of the rye cover shortly before killing.

Year	Biomass	Nitrogen	C/N
	T/A	lbs/A	
2018	0.8 b	57 b	14 b
2019	0.9 b	63 ab	14 b
2020	1.7 a	84 a	20 a

Table 2. Effect of previous crop on residual nitrate in the 0-2 ft depth in the fall and spring averaged over 3 years

Previous Crop	Fall Nitrate-N	Spring Nitrate-N
	---------- lb/A ----------	
Field Corn	34.1	51.2
Soybean	35.7	61.6
Sweet Corn	43.2	50.9
Sweet Corn + rye	29.3	36.8

Table 3. Effect of previous crop on EONR over 3 years.

Previous Crop	2018	2019	2020
	---------- lb N/A ----------		
Field Corn	249	257	178
Soybean	144	126	122
Sweet Corn	149	146	142
Sweet Corn + Rye	161	188	186

Table 4. Effect of previous crop on EONR and yield at EONR – 3-year average.

Previous Crop	EONR	Yield at EONR
	lb N/A	bu/A
Field Corn	228 a	178 b
Soybean	131 b	201 a
Sweet Corn	146 b	200 a
Sweet Corn + Rye	178 b	207 a

Figure 1. Sweet corn following mechanical harvest. (Photo credit Charlie Rohwer)

Figure 2. Grain drill used to plant rye. (Photo credit Charlie Rohwer)

Figure 3. Rye growth in October. (Photo credit Charlie Rohwer)

Figure 4. Rye cover crop April 25, 2018. (Photo credit Charlie Rohwer)

Figure 5. Rye cover crop in early May. (Photo credit Charlie Rohwer)

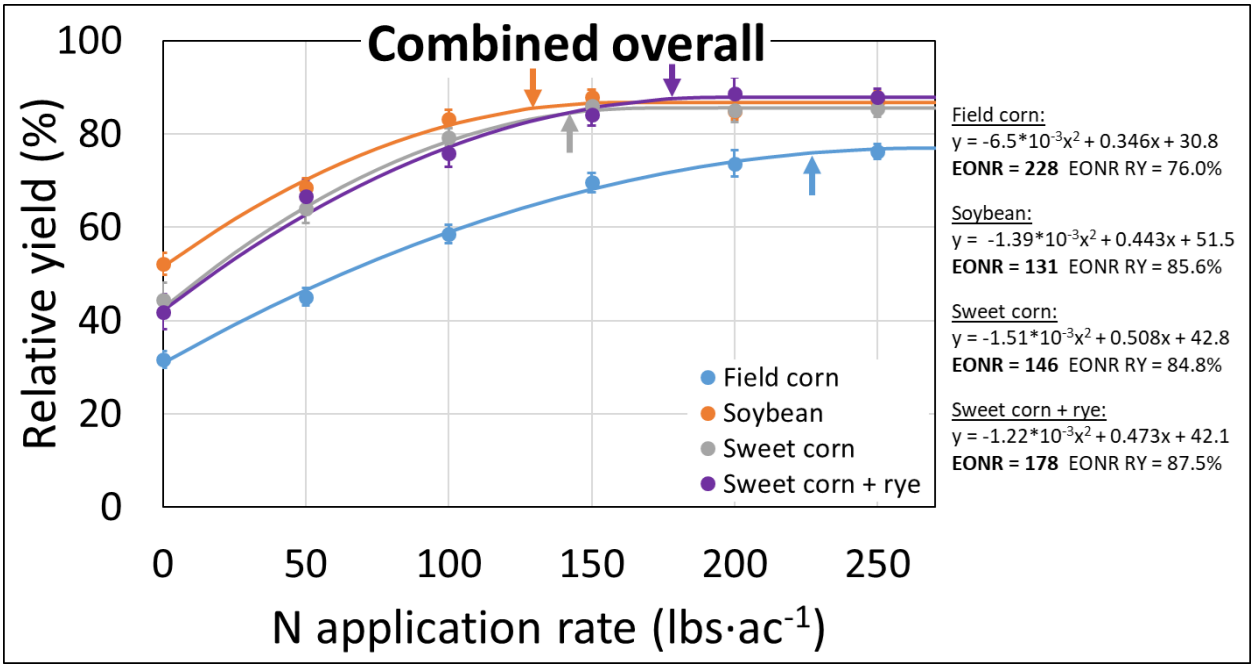

Figure 6. Effect of previous crop on field corn nitrogen response averaged over 3 years.