

Research Report to the
Oregon Processed Vegetable Commission
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Title: *Nitrogen fertilizer use efficiency in sweet corn; effect of variety*

Project Leader

Ed Peachey (contact), Horticulture Dept., 541-737-3152, peacheye@hort.oregonstate.edu

Cooperators

John Hart, Department of Crop and Soil Science, OSU

Background

Nitrogen fertilizer prices increased dramatically 2 years ago, and threatened profitable current sweet corn production in the Willamette valley. The cause of the increased cost of nitrogen fertilizer was the cost of natural gas. The cost of natural gas makes up about 90% of the cost of producing ammonia and nitrogen fertilizers are made from ammonia. Because of huge disparity in cost of natural gas around the world, much of the ammonia used in the US to make fertilizer now is produced outside the US. As many as 25 nitrogen fertilizer (ammonia) producing plants in the US have closed since 1999 due to the much lower cost of natural gas in other countries. Ammonia production consumes about 5% of world's natural gas, and accounts for about 2% of world energy production.

Nitrogen use varies dramatically among crops. Short season crops with relatively small biomass accumulation will not need as much nitrogen for growth as long season corn varieties that develop a large canopy. The recent introduction of sweet corn hybrids that tolerate root rot may reduce N fertilizer need. Hybrids such as Coho have extensive root systems that give this variety the ability to maintain yields even when the root system is severely compromised by root rot. Efficient use of nitrogen will reduce the cost of sweet corn production. It will also reduce potential non-point contamination of above and below ground water supplies, and if implemented properly, will reduce the competitive effect of small seeded weeds on sweet corn yield. The long-term goal of this research is to refine nitrogen fertilizer application rates for sweet corn. This project explored the possibility that 'newer' varieties such as Coho utilize N more efficiently than Jubilee, the variety with which N research was conducted previously.

Methods

The experiment was conducted at the Vegetable Research Farm near Corvallis using a split plot design with main effects of corn variety and split plots with fertilizer rate. Three blocks of each variety were planted as main plots that were 30 ft wide by 60 feet long. On May 27th, Jubilee, Coho, Basin, and 1477 were seeded in 30" rows at 28,000 seeds/A. Fertilizer (16-16-16, 200 lb/A) was banded at planting. Outlook herbicide (14 oz/A) and atrazine (1 pt/A) were applied after planting and plots irrigated to incorporate the herbicide. After emergence, the stand was thinned to a consistent population of 26,000 plants/A. Plots were cultivated on June 12 and hand hoed throughout the season to control weeds within the row.

Five side-dress nitrogen treatments (0, 75, 150, 225 lbs/A, and PSNT) were applied to fertilizer subplots that were 10 wide by 30 ft long on July 1 when the corn was at the V5-6 growth stage. The PSNT treatment applied urea based on a soil test of a soil sample taken on June 26 (calculated at 130 lb N/A). Irrigation water (1 in) was applied immediately after plots were fertilized.

SPAD meter, corn height, and LAI (leaf area index) measurements were taken on July 29 when corn was beginning to show silk, and plots were harvested on August 31. Nitrogen uptake was determined by harvesting above ground biomass at harvest and measuring the amount of N present per unit area after correcting for moisture content. The nitrogen remaining in the soil after harvest was measured on Sept 9 by taking 5-12 in deep soil samples from between rows in plots planted to the variety Basin.

Results and Discussion

The project was designed to explore differences in nitrogen use among common sweet corn cultivars. Sweet corn ear yield differed with N application rate. A regression equation was used to draw the line showing the relationship between side-dress N rate, and average yield for all varieties is shown in Figure 1. The data fit the equation well as 95% of the change in yield can be explained by variation in N application rate ($r^2 = 0.95$). This data is significant in that it shows the site was one at which N application increased yield. A site where yield increases with N rate is necessary for evaluation of N rate and variety interaction. In addition, the data affirms that corn varieties can produce top ear yield with moderate rates of N, 75 to 150 lb/a. The shape of the response function is similar to the response function measured in previous N rate work by Hemphill, Hart, and Marx.

Statistical analysis, ANOVA, indicated no interaction between N rate and variety when excluding the 0 N side-dress rate (Table 1). One hypothesis for the research was that Coho would be better at scavenging nitrogen than other varieties based on observations in studies of root rot in corn that Coho develops an exceptional root system.

Varieties differed in yield and N uptake when no side dress N was applied (Table 3). Basin and 1477 produced more yield than Coho without side dress N. At harvest, Basin and Golden Jubilee contained more N than Coho. This data shows varieties differ in ability to use soil N. Unfortunately, the relationship between ear yield and N uptake for the 0 N side dress treatment was poor when all varieties were compared.

Sweet corn ear yield increased with side dress N application rate for Coho and Golden Jubilee, but not for Basin and 1477 (Figure 2). The PSNT soil test adequately predicted the N side dress N rate for Golden Jubilee and Coho, but not Basin and 1477. Even though the PSNT is routinely used for N rate prediction in Oregon and other areas, it was not designed for rate prediction, rather to identify if sufficient N was present for corn production in systems receiving manure. PSNT use with Basin and 1477 should be explored further.

A brief N “budget” illustrates the challenge of using the PSNT or any soil test for N rate prediction in a system that mineralizes substantial N. Approximately 32 lb N/A was banded at planting and the PSNT at V5-6 growth stages showed 45 lb/a was available in the surface foot of soil as $\text{NO}_3\text{-N}$ or plant available N. The sum of these values is 77 lb N/A, substantially less than the N measured in the aboveground portion of the crop at harvest for treatments receiving no side dress N. The average N uptake by Basin at the 0 side dress N rate was 190 lb/A, approximately 2.5 times the amount available at V5-6 development stage.

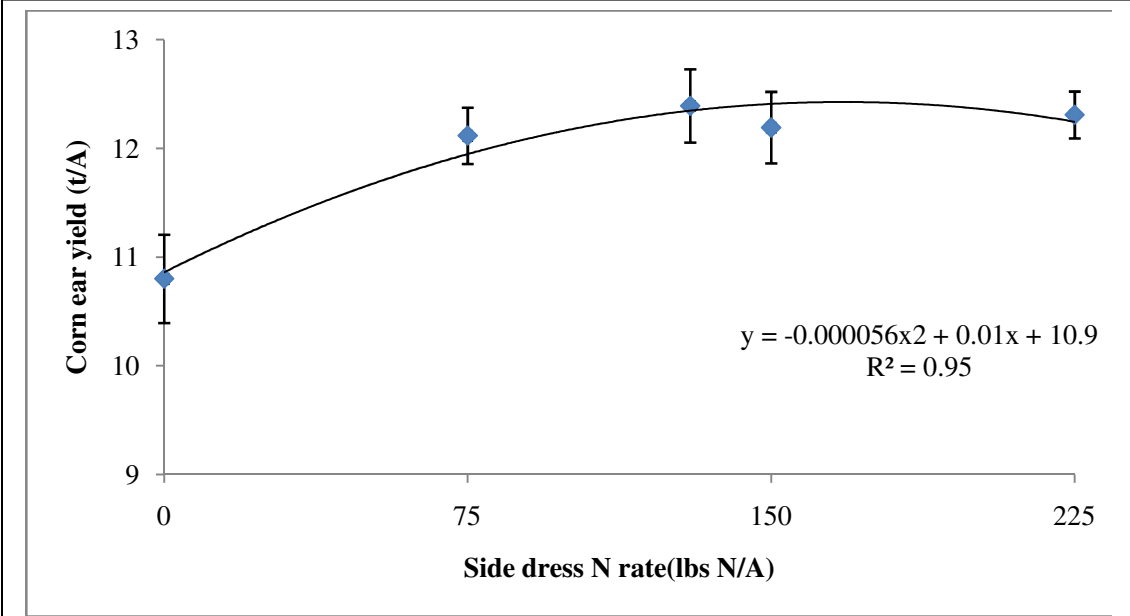


Figure 1. Relationship between side dress N and average ear yield of 4 sweet corn varieties. Note scale of y-axis. (\pm SE).

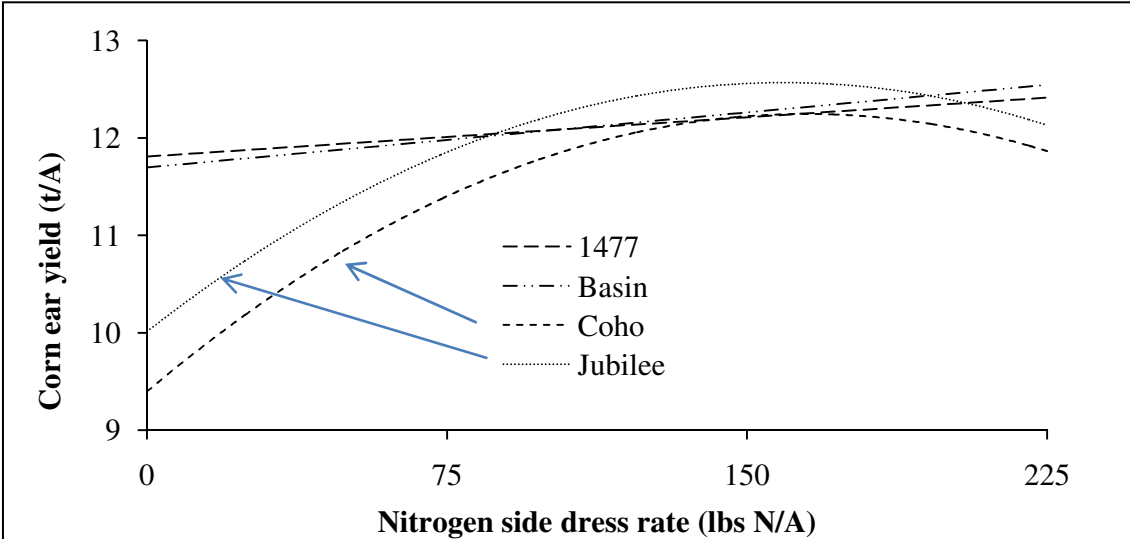


Figure 2. Predicted effects of side dress N rate on yield of four sweet corn varieties. Trend-lines are based on mean values for each variety.

Table 1. Effect of N rate on SPAD meter and Leaf Area Index (LAI) readings and corn ht at silking, and yield of four sweet corn varieties, Vegetable Research Farm, Corvallis, 2009.

Variety	Side-dress N rate (applied on July 1)	Corn silking (July 30)			Yield		
		SPAD meter reading	LAI	Corn ht <i>ft</i>	Ear wt <i>t/A</i>	Biomass	Ear yield per unit biomass
1477	0	53.6	4.96	7.2	11.8	32.7	0.36
1477	75	57.6	6.00	7.3	13.2	39.6	0.34
1477	130PSNT	56.6	5.66	7.0	11.9	38.8	0.31
1477	150	58.4	5.86	7.1	11.9	40.8	0.30
1477	225	58.7	6.38	7.1	12.7	41.1	0.31
Basin	0	54.3	4.74	7.4	12.0	42.2	0.29
Basin	75	58.1	5.81	7.4	11.4	38.1	0.32
Basin	130PSNT	57.4	5.29	7.4	12.4	46.6	0.27
Basin	150	58.0	5.74	7.6	12.5	42.8	0.29
Basin	225	57.2	5.93	7.6	12.5	41.1	0.31
Coho	0	55.4	5.32	7.1	9.4	32.5	0.30
Coho	75	57.3	5.52	7.0	11.2	48.9	0.23
Coho	130PSNT	57.7	5.65	7.1	12.8	48.4	0.27
Coho	150	58.8	6.03	7.0	11.7	46.9	0.25
Coho	225	58.5	5.89	7.1	11.9	47.0	0.27
Jubilee	0	48.5	4.92	7.5	10.0	37.7	0.27
Jubilee	75	54.0	6.12	7.7	12.7	38.5	0.33
Jubilee	130PSNT	55.0	6.06	7.8	12.3	44.3	0.28
Jubilee	150	54.8	6.41	7.6	12.8	46.3	0.28
Jubilee	225	55.9	6.33	7.9	12.1	48.9	0.25
ANOVA							
Variety		<i>0.01</i>	<i>0.01</i>	<i><0.0001</i>	<i>0.35</i>	<i>0.16</i>	<i>0.03</i>
N side dress rate		<i><0.0001</i>	<i><0.0001</i>	<i>0.60</i>	<i>0.001</i>	<i>0.01</i>	<i>0.04</i>
Variety X side dress rate		<i>0.25</i>	<i>0.78</i>	<i>0.39</i>	<i>0.05</i>	<i>0.67</i>	<i>0.56</i>

Table 2. Correlation values for relationship of variables of interest from Table 1 above. Values in *italics* are probability that the correlation value is significant.

	SPAD meter reading	Leaf Area Index	Corn ht.	Ear yield	Corn biomass yield	Ear yield/unit of biomass
SPAD meter reading	-	0.48	-0.35	0.39	0.40	-0.12
		<i>0.02</i>	<i>0.09</i>	<i>0.06</i>	<i>0.05</i>	<i>0.56</i>
Leaf Area Index (LAI)	0.48	-	0.24	0.45	0.39	-0.14
	<i>0.02</i>		<i>0.26</i>	<i>0.03</i>	<i>0.06</i>	<i>0.52</i>
Corn height	-0.35	0.24	-	0.24	0.03	0.07
	<i>0.09</i>	<i>0.26</i>		<i>0.25</i>	<i>0.87</i>	<i>0.76</i>
Ear yield	0.39	0.45	0.24	-	0.30	0.28
	<i>0.06</i>	<i>0.03</i>	<i>0.25</i>		<i>0.15</i>	<i>0.18</i>
Corn biomass yield	0.40	0.39	0.03	0.30	-	-0.81
	<i>0.05</i>	<i>0.06</i>	<i>0.87</i>	<i>0.15</i>		<i><.0001</i>
Ear yield/unit of biomass	-0.12	-0.14	0.07	0.28	-0.81	-
	<i>0.56</i>	<i>0.52</i>	<i>0.76</i>	<i>0.18</i>	<i><.0001</i>	

Table 3. Growth and yield of four sweet corn varieties without side-dress N applied. Means followed by the same letter do differ statistically (P= 0.05).

Variety	Side-dress N rate	N uptake at harvest	At corn silking		Yield			
			SPAD meter reading	Leaf Area Index (LAI)	Corn ht	Ear wt	Biomass	Ear yield per unit biomass
		<i>lb/a</i>			<i>ft</i>	<i>-----t/A-----</i>		
1477	0	144 ab	53.6 a	4.96	7.2	11.8 ab	32.7	0.36
Basin	0	191 a	54.3 a	4.74	7.4	12.0 a	42.2	0.29
Coho	0	119 b	55.4 a	5.32	7.1	9.4 c	32.5	0.30
Jubilee	0	175 a	48.5 b	4.92	7.5	10.0 bc	37.7	0.27
ANOVA	p-value	<i>0.04</i>	<i>0.02</i>	<i>0.35</i>	<i>0.07</i>	<i>0.01</i>	<i>0.10</i>	<i>0.06</i>