What's Cropping Up?

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Can the Number of Growing Degree Days After the Tasseling/Silking Date Predict Corn Silage Harvest Date?

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The growth and development of corn is governed primarily by temperature or accumulated growing degree days (GDD). Corn requires about 110-120 GDD to emerge under typical conditions, although deep planting or heavy residue will increase the number of GDD for emergence. Likewise, 96-100 day hybrids require about 1250 GDD from emergence to the tassel/silking date and 101-105 day hybrids require about 1300 GDD, although hot and dry conditions in July will increase the number of GDD for silking. A challenge each year is determining when to begin corn silage harvest. We estimated the number of GDD from the tassel/silking date to the silage harvest date for hybrids in our corn silage trial to determine if the accumulated GDD between the two dates can accurately predict the date of corn silage harvest. In both years, all hybrids were harvested in the 65 to 70% whole plant moisture range.

The number of GDD from planting to the tassel/silking date was consistent across the 2003 and 2004 growing seasons (Table 1). The 96-100 day hybrids required about 1250 GDD, whereas the 101-105, 106-110, and 111-115 day hybrids required about 1300, 1335, and 1365, respectively (Table 1). In contrast, the number of GDD from the tassel/silking date to the silage harvest date varied significantly between years for each hybrid group (Table 1). In 2003, the 96-100 day hybrids required about 775 GDD from the tassel/silking date to the silage harvest date compared with only 725 GDD in

Table 1. Tasseling/silking dates, silage harvest dates, and number of calendar and growing degree days (GDD) between the two dates for 96-100, 101-105, 106-110, and 111-115 day hybrids planted in late April of 2003 and 2004 at the Aurora Research Farm.

Hybrid Maturity Group Relative Maturity	Tassel/Silk	GDD °F	Silage Harvest Date	Days	GDD °F
			2003		
96-100	7/24	~1250	8/28	35	~775
101-105	7/27	~1300	9/5	40	~850
106-110	7/29	~1340	9/9	42	~850
111-115	7/31	~1380	9/11	43	~850
			2004		
96-100	7/20	~1250	8/31	42	~725
101-105	7/22	~1300	9/3	43	~750
106-110	7/23	~1330	9/5	44	~775
111-115	7/24	~1350	9/7	45	~800
			2005		
96-100	7/17	~1285	?	?	?
101-105	7/19	~1330	?	?	?
106-110	7/21	~1370	?	?	?
111-115	7/22	~1405	?	?	?

Crop Management

2004. The 101-105, 106-110, and 111-115 day hybrids required about 850 GDD from the tassel/silking date until the silage harvest date in 2003 but only 750, 755, and 800 GDD, respectively, in 2004. August of 2003 was dry (1.43 inches of precipitation) and hot (678 GDD) so the corn was somewhat drought-stressed in late August (Table 2). About 2 inches of precipitation occurred on August 31-September 1, which resulted in significant rehydration of corn. Consequently, the harvests of the 101-105 and 106-110 day hybrids were delayed a few days until date for the 96-100 day hybrids, despite harvesting before any rehydration occurred in both years.

Predicting corn silage harvest, based on GDD from the tassel/silking date to the silage harvest date, is not consistent because other environmental factors can also influence when corn silage harvest begins. Nevertheless, the use of accumulated GDD from the tassel/silking date can be used as guide on when to begin corn silage harvest. The 2005 growing season can be a good test for the accuracy of this method

Table 2. Monthly growing degree days (GDD, 86-50°F system) and precipitation at the Aurora Research Farm during the 2003 and 2004 growing seasons and through August 15 of the 2005 growing season.

	2003		2004		2005	
Month	GDD	Precip.	GDD	Precip.	GDD	Precip.
May	251	4.34	408	6.82	233	1.00
June	458	3.14	449	1.75	654	4.33
July	642	5.68	609	5.47	734	2.05
August	678	1.65	563	5.55	384†	2.24
	2029	14.81	2029	19.59		

† From August 1st through August 16th.

their moistures got back down to below 70%. August of 2004 was cool (563 GDD) and wet (5.55 inches of precipitation) so the corn was not drought-stressed. The 3 inches of precipitation that occurred on August 28th did not result in rehydration as indicated by whole plant moistures of 67-68% for the 96-100 day hybrids on August 31st. Apparently, antecedent soil moisture and corn conditions (i.e. drought-stressed) influence the degree of rehydration of corn, which influences the silage harvest date. Other factors, however, also contribute to when corn silage harvest begins as indicated by the 50 GDD difference between years between the tassel/silking date and silage harvest because of the hot and dry growing season (Table 2). Based on the GDD from the tassel/silking date of the 96-100 day hybrids through August 16th, the 96-100 day hybrids should be almost ready for harvest on this date because 720 GDD have elapsed between July 17th (tassel/silking date) and August 16th. We harvested the 96-100 day hybrids on August 18th, 6 days earlier than any previous year (August 22, 1999 was the previous earliest date). About 780 GDD had elapsed between the tassel/ silking date and harvest date but only 32 calendar days. We will share with you in our next issue of *What's Cropping Up?* how accurate this method was for predicting the corn silage harvest date.

Crop Management

How Late Can You Plant Winter Wheat in New York?

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Because of the dramatic increase in soybean acreage in New York (200,000 acres in 2005), a significant portion of the wheat acreage now follows soybeans in the rotation. The 2004 growing season was quite cool so many soybean fields were not harvested until late October. Many farmers opted not to plant winter wheat in late October or early November because of potential negative effects of the late planting date. We decided to compare winter wheat at a typical planting date (September 21) and a late planting date (October 29) to determine what the yield reduction would be with a 5 ½ week planting delay. We planted Caledonia soft white winter wheat at four seeding rates (1.5, 2.0, 2.5, and 3.0 bu/acre) on the two dates to also see if an increased seeding rate (beyond the recommended 2.0 bu/acre) can ameliorate some of the negative effects of a delayed planting date.

The 2004-2005 wheat growing season was atypical, especially during May and June (Table 1). Temperatures in the last 10 days of September and October were slightly above normal so the timely-planted wheat grew quite well and initiated tillering by November. Likewise, temperatures in November and December were slightly above normal so the late-planted wheat established itself reasonably well before the onslaught of winter weather.

A snow cover was present from mid-January until late March at Aurora so both the timely and late-planted wheat came through the winter in good shape. Green-up didn't occur until the end of March because of the cool March weather, but April was warm so wheat began the stem elongation phase in early May. May was exceptionally cold and dry so both the timely and late-planted wheat were quite short in stature. June turned hot and remained dry until the middle of the month. Abundant rainfall in the second half of June probably benefited the late-planted wheat more because its delayed development allowed it to be in the grain-filling period for a longer period under favorable moisture conditions.

Surprisingly, yields did not differ between planting dates (Table 2). A planting date x seeding rate interaction did not occur, although regression analyses indicated maximum yields at 2.0 bu/acre for the timely-planted wheat and 2.4 bu/acre for the late-planted wheat (data not shown). The late-planting

Table 1. Average temperature, total precipitation, and total snowfall at the Aurora Research Farm during the 2004-2005 wheat growing season.

	TEMPERATURE		PRECIPITATION		SNOWFALL
Month	2004-05	30-yr mean	2004-05	30-yr mean	2004
	°F		in.		in.
September	65.0	62.1	4.13	4.21	-
October	51.3	50.9	2.57	3.20	-
November	42.1	40.4	2.28	3.36	1.0
December	30.1	29.7	2.48	2.45	3.5
January	21.9	23.7	3.23	1.92	36.0
February	27.1	25.1	1.42	1.88	10.5
March	30.3	33.8	2.03	2.50	20.0
April	48.1	45.3	4.85	3.28	-
May	53.5	57.6	1.0	3.17	-
June	72.5	66.7	4.33	4.09	-

vs. the timely-planting date actually had higher test weight probably because it benefited more from the precipitation during the second-half of June.

It is difficult to draw any firm conclusions from one year of data, especially when May was one of the coolest and driest months on record and June was one of the warmest months on record. Nevertheless, it appears that wheat can be safely planted until late October in the Finger Lakes region when November and December temperatures are slightly above normal and there is adequate snow cover during the winter months. We will continue this study for two more years to determine if soft white winter wheat can yield reasonably well when planted in late-October.

Table 2. Grain yield and test weight of Caledonia soft white winter wheat planted on 21 September and 29 October at 1.5, 2.0, 2.5, and 3.0 bu/acre seeding rates at the Aurora Research Farm.

	PLANTING DATE	
Seeding Rate	September 21	October 29
Bu/acre	Yield (bu/acre)	
1.5	58	57
2.0	62	62
2.5	59	59
3.0	58	62
LSD 0.05[†]	NS	
	Test Weight (lbs/bu)	
1.5	58	59
2.0	57	60
2.5	57	59
3.0	57	60
LSD 0.05[†]	0.5	

[†]LSD 0.05 compares means between planting dates.

Nutrient Management

Copper and Zinc Accumulation in Manured Soils

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Considerable research in the past 5-10 years has focused on how manure applications affect soil nitrogen (N), phosphorus (P), and potassium (K) levels, both from plant nutrition and environmental perspectives. However, manure consists of more than just N, P and K. A recent survey of the trace metal content of dairy manure in New York State showed levels of copper (Cu) and zinc (Zn) that were elevated compared to all other trace metals analyzed (McBride and Spiers, 2001). Similar trends were seen in Vermont by Jokela and others (2005). Both Cu and Zn are added to most dairy rations as part of a mineral mix; however the highest concentrations result when hoof-bath treatment solutions containing copper or zinc sulfate are disposed of in the manure stream. An average corn silage crop will remove about 0.014 lbs of Cu and 0.016 lbs of Zn per ton of silage (35% dry matter). Given current average manure Cu and Zn data for New York, as described by McBride (2001), and a yield of 17 tons of silage per acre, an application of more than 700 gallons of liquid dairy manure per acre will result in more Cu being added than removed with harvest. Similarly, 160 gallons per acre of this manure will be enough to apply the amount of Zn and average corn crop will remove. These calculations show that on our dairy farms even the lowest manure application rate will result in the addition of more Cu and Zn than required by the crop. Copper and Zn are not as mobile as nitrate due to their high affinity for sorption to organic matter so these elements tend to accumulate in the soil. The question remains: is this a problem for our current farming systems?

Case study

We analyzed soil profiles from a case study farm in Steuben County with over 40 years of dairy and/or poultry manure addition. With this study we wanted to determine the long-term effects of manure application on Cu and Zn accumulation in the plow layer, its distribution over the soil profile and bioavailability in the soil. The soils of the farm are classified as either Wellsboro or Oquaga channery silt loams. We do not have accurate historical manure spreading records or analyses over the past 40 years so we used the total P content of the soils as an estimate of manure history (higher total P concentrations representing longer durations of manure application or higher loading rates). Agronomic soil tests such as Mehlich-3 and Morgan can not reliably predict when copper or zinc toxicity might occur to plants or microbes (interpretations have mostly been limited to identification of deficiency situations), but they can be used to monitor soils for evidence of increased Cu and Zn accumulation over time. As the farm's historic fertility program includes Mehlich-3 soil tests, we report on trends in Mehlich-3 soil test data but similar trends would be observed if the Cornell Morgan test was used.

Cu and Zn accumulation in the plow layer

The Cu and Zn content of the 0-7 inch plow layer were both accumulating with manure application (i.e. as total P levels increased). Copper accumulation was higher in the dairy manure amended fields while Zn accumulated more rapidly in the fields that had a history of poultry manure addition. The increased Cu accumulation in dairy manure amended soils could be attributed to $CuSO_4$ used in hoof bath treatments. The higher Zn accumulation in poultry manure amended fields was due to higher loading rates of manure and higher concentration of Zn in poultry manure compared with dairy manure. The elevated Zn levels in poultry manure were most likely due to sloughing of the cage plating over time. Also when we plotted farm soil fertility records over time for individual fields, a clear and gradual increase in both Cu (dairy manure amended fields) and Zn (fields with poultry manure history) could be seen. This is similar to trends that were observed and reported on by Ev Thomas at the Miner Institute (Thomas, 2001).

Distribution over depth

Because the accumulation of Cu and Zn in the surface layer of the soil was evident, we wanted to examine whether any of the accumulated metal was moving down through the soil profile. Soil samples were collected every 2 inches down to a depth of 20 inches and analyzed for Mehlich-3 extractable Cu and Zn. Figure 1 shows that there is little evidence of any downward movement of Cu past the plow layer. The only exception was the field with the longest history of poultry manure application that showed slightly elevated Zn levels up to a depth of 12 inches. While analysis of the soil profile suggests there is no Cu or Zn translocation through soil, it is possible that some metal could move via preferential flow paths as a complex with organic molecules. However, when analyzing leachate samples taken from 30 inch deep intact soil cores from these fields, we saw no appreciable increase in Cu or Zn loss in leachate from manure amended soils compared to the fields that received no manure. In short: currently, Cu and Zn accumulation on the fields of this farm is mainly restricted to the surface soil layers.

Availability/Toxicity

If Cu and Zn are accumulating in the surface layer, should we be concerned with plant toxicity? Analyses of the soil samples for bioavailable Cu and Zn using the hot 0.01 *M* $CaCl_2$ extraction showed that even in the fields with the highest accumulation of Cu and Zn, bioavailable Cu and Zn levels were still ten fold below levels that could be of concern with regards to plant toxicity. It should be noted that the soils at the case study farm ranged in pH from 5.8 and 7.4. At high pH, metals will be tightly bound to soil organic matter and Fe and Al oxides in soil. These metals become more available when soils become more acidic. Thus, it will be important to maintain the soil pH at agronomic optimum levels for field crops in fields with elevated soil Cu and Zn levels in order to prevent potential toxicity problems.

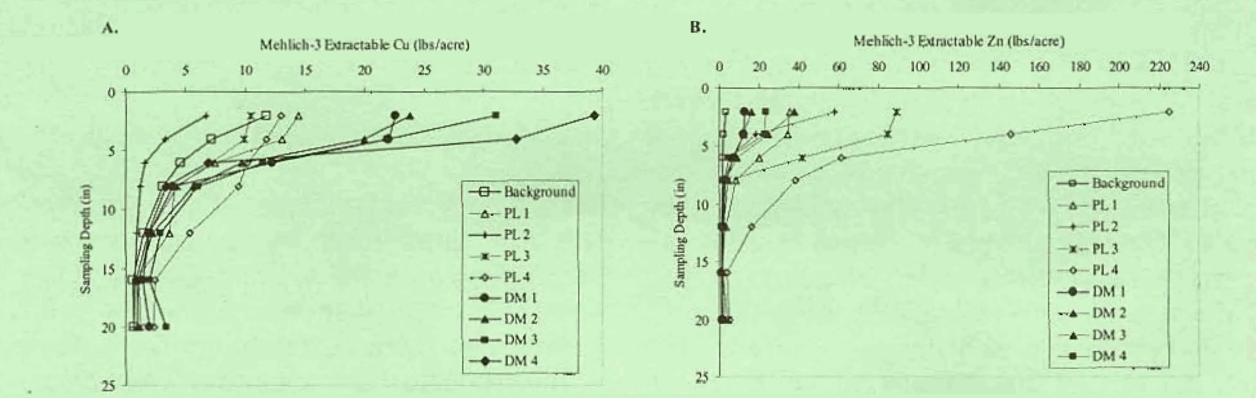

Figure 1. Mehlich-3 extractable Cu (A) and Zn (B) distribution over depth in four dairy manure amended fields, four poultry litter amended fields, and a background field on a farm in Southern New York State.

What it means to you

Fields with a long-term history of manure application on the case study farm showed elevated Cu and Zn in the surface soil layer. We found no evidence of either leaching of these metals through the soil profile or levels in the rooting zone that would lead to corn, grass or alfalfa toxicity issues. While the levels of Cu and Zn in the manure from our case study farm are representative of those found by others in NY State, very few fields in the state (at most only the typical "field behind the barn") will have the elevated P levels of the fields selected for our study. The NY P Runoff Index discourages manure addition to soils with a very high P index so manure applications will be restricted because of risk of loss of P long before Cu and Zn levels have had a chance to reach levels of concern in these soils. In addition, crops like corn and alfalfa do not show a clear correlation between accumulation of Cu and Zn in soils and plant tissue concentrations or crop yield, mainly due to limited translocation of these elements from the roots to the shoot (Mantovi, 2003; Warman and Cooper, 2000).

Although Cu and Zn accumulation on dairy farms may not be a problem in the short-term, it is important to analyze manure and soils for Cu and Zn over time. At present, no soil extraction method has been sufficiently tested to accurately predict plant availability or solubility of metals in a wide range of soil types. However, a bulk of research has been done to correlate total soil metal concentrations, as determined with an acid digestion, to plant toxicity effects. Rough guidelines given by Murray McBride suggest that total soil Zn of 200 ppm and total soil Cu of 100 ppm may cause toxicity effects on our field crops given they are kept at the agronomic optimum pH. At lower soil pH, toxicity effects could occur at lower total Cu and Zn levels. We recommend that soils be analyzed for total metals (acid digestion) every five years to monitor the impact of current management practices on Cu and Zn accumulation. If soil test levels increase to levels that could impact crop growth, changes in management practices should be made.

For more information

A good article on copper sulfate foot baths by Rick Stehouwer and Greg Roth can be found in Penn State's Dairy Digest of March 2004: http://www.das.psu.edu/user/dairy/newsletter/fullStory.cfm?newsID=376.

References

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Calendar of Events

Oct. 5-7, 2005	Northeastern Division of American Phytopathological Society, Geneva, NY
Oct. 25, 2005	Field Crop Dealer Meeting, Comfort Suites, 7 Northside Drive, Clifton Park, NY
Oct. 26, 2005	Field Crop Dealer Meeting, Ramada Inn, 141 New Hartford St., New Hartford, NY
Oct. 27, 2005	Field Crop Dealer Meeting, Batavia Party House, 5762 East Main Road, Batavia, NY
Oct. 28, 2005	Field Crop Dealer Meeting, Auburn Holiday Inn, 75 North Street, Auburn, NY
Nov. 15-16, 2005	National Soybean Rust Symposium, Nashville, TN
Nov. 29 - Dec. 1, 2005	Northeast Region Certified Crop Adviser Conference, Waterloo Holiday Inn, Waterloo, NY

What's Cropping Up? is a bimonthly newsletter distributed by the Crop and Soil Sciences Department at Cornell University. The purpose of the newsletter is to provide timely information on field crop production and environmental issues as it relates to New York agriculture. Articles are regularly contributed by the following Departments at Cornell University: Crop and Soil Sciences, Plant Breeding, Plant Pathology, and Entomology. **To get on the mailing list, send your name and address to Pam Kline, 234 Emerson Hall, Cornell University, Ithaca, NY 14853.**

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