What's Cropping Up?

A NEWSLETTER FOR NEW YORK FIELD CROPS & SOILS

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Can Corn be Grown without Nitrate Contamination of Groundwater?

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Economical production of field corn requires an adequate supply of nitrogen in the soil. This can be achieved through the application of commercial fertilizer or organic sources such as animal and green manures. Proper nitrogen management is important to reduce crop production cost and the potential for nitrate contamination of groundwater, because much of the nitrogen in soils is converted to nitrate which can leach to groundwater. Nitrate contamination has been measured extensively in the midwestern US and sporadic "hot spots" have been found in the Northeast.

Cornell University's nitrogen fertilizer recommendations are based on the *optimum economic rate* and have been developed through extensive field studies of yield response to different fertilizer rates under an array of crop rotations and manure management practices. These fertilizer recommendations account for other potential nitrogen sources such as soil organic matter, manures and crop residues. For example, nitrogen fertilizer recommendations are reduced when corn follows alfalfa, which supplies mineralized nitrogen. The economic rate of fertilization also reduces the potential of nitrate contamination of groundwater, because it minimizes excess soil nitrogen at the end of the season. However, evaluation of the environmental impact on groundwater was based on only few direct measurements of groundwater recharge under fields of corn and some data on nitrate in streams and groundwater. In many other states, the environmental impact was not explicitly considered when the recommendations were developed. Moreover, it is believed by many scientists that economical corn production without groundwater contamination (i.e., nitrate levels below the 10 parts per million (ppm) federal standard for drinking water) is impossible due to the inefficiency of nutrient uptake by crops. Simply stated: annual crops are unable to take up all soil nitrogen and soil is a leaky medium, therefore, nitrate leaching is unavoidable.

The Study

In order to evaluate the impact of several nitrogen management strategies on nitrate leaching potential, a field study was initiated at the Willsboro Research Farm in Northern New York. One objective of this experiment aimed at answering the question *"Will the use of moderate fertilization rates with appropriate timing of application prevent excessive nitrate leaching and contamination of groundwater?"*

Two sites were used for this study: a fine-textured Kingsbury clay and a coarse-textured Cosad loamy fine sand. Each site contains multiple plots (60-by-60 feet and 45-by-45 feet on the clay and sand site, respectively) with a subsurface drainage system at 3 feet depth. Drain lines terminate into manholes which allow for sampling of drainage water. Each plot is surrounded by impermeable PVC lining to a depth of six feet to make them hydrologically independent.

A three year alfalfa sod was plowed down in September 1991 on the Kingsbury clay site and corn was grown during the 1992, 1993, and 1994 growing seasons. On the Cosad sand site, a 20-year grass sod (primarily fescue) was plowed in the spring of 1992 and corn was similarly grown in 1992, 1993, and 1994. Shallow groundwater samples were obtained by collecting drain outflow. Samples were collected at variable time intervals ranging from 4 hours to several months, depending on drain flow conditions. In most cases, no flow occurred in the winter (frozen soil) and summer (dry soil), and samplings occurred primarily in the spring and fall. Preliminary results of nitrate contents are presented here using seasonal averages; more detailed analyses of leaching losses and crop uptake will be presented in later articles.

Results

The experimental setup allows for a direct comparison of leaching losses under two different soil types on the same research farm. The figure on p. 2 shows nitrate concentrations in drain outflow on the Kingsbury clay from 1990 to 1994 (prior to and after plowing the alfalfa sod) and those for the Cosad sand during the period 1992 to 1994 (after plowing of the fescue sod). Nitrate concentrations were very low (less than 1 ppm) when the Kingsbury clay site was still under alfalfa sod. Apparently, alfalfa uses the biologically-fixed nitrogen efficiently without much nitrate loss to leaching. However, nitrate concen-

SOIL MANAGEMENT

trations increased to an average of about 5 ppm in the fall of 1991 after the sod had been plowed and organic matter became mineralized. These increased further in the following spring to levels averaging 15 ppm. Concentrations decreased dramatically to less than 2 ppm in the fall of 1992 after corn had been grown on the site with only 20 lbs/ac of starter fertilizer, and increased slightly to 4 ppm during the next spring. The corn crop apparently absorbed most of the nitrogen mineralized from the sod, thereby reducing nitrate leaching. The 1993 corn crop received 90 lbs/ac of nitrogen (20 starter and 70 sidedress, based on the University of Vermont's Pre-Sidedress Nitrate Test and slightly higher than the Cornell-recommended rate). Nitrate concentration in drain outflow during the following fall of 1993 and spring of 1994 remained below 3 ppm. Under the Cosad sand, the nitrate concentrations averaged 8 ppm in the spring of 1992 and gradually decreased to 4 ppm in the spring of 1994 under the same fertilization levels as used at the clay site .

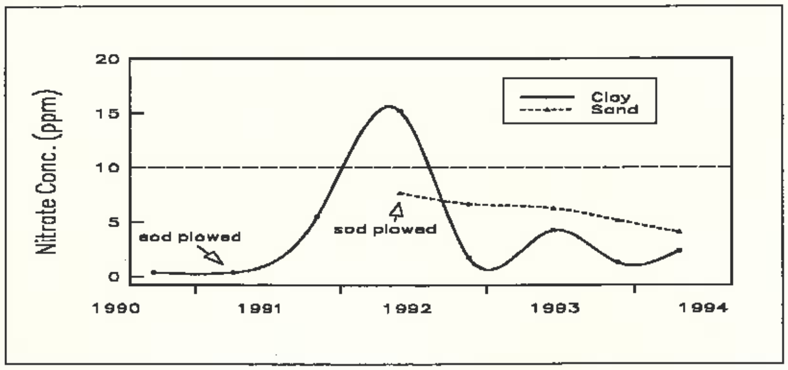
Conclusions

The results presented here provide some insight into the movement of nitrate to shallow groundwater. The highest concentrations were observed immediately after plowing of a sod, a process which results in considerable mineralization of organic nitrogen. Concentrations under the fall-plowed alfalfa sod on the clay soil were considerably higher than those under the spring-plowed fescue sod on the sand, despite the generally higher permeability and leaching potential of the sand. This may be explained by the fact that fall plowing of the alfalfa sod provided an extended period for nitrogen mineralization, while the spring-plowed sod had limited time prior to nitrogen uptake by the subsequent corn crop. Alternatively, the alfalfa sod would be expected to yield more mineralizable nitrogen than the old fescue sod.

A very meaningful conclusion of this study is that nitrate levels in groundwater were below the 10 ppm level under corn production with moderate chemical fertilizer rates and the use of split applications (fall 1992 through spring 1994). Apparently, the rapid release of organic sources of nitrogen resulted in much higher nitrate levels (spring 1992). This may be explained by better control of soil nitrogen under well-timed fertilizer applications at appropriate rates. The results also show a small difference in nitrate leaching between the two soil types after two years of corn production (1993 and 1994). As expected, shallow groundwater in the sandy soil had higher nitrate levels than the clay soil due to higher percolation rates (more leaky) and possibly lower denitrification rates (gaseous loss of nitrogen from excessive soil wetness). Again, the lower nitrate levels for the sandy soil in 1992 can primarily be attributed to different sod characteristics and time of plowing.

This study has shown that corn *can* be grown without resulting in high nitrate levels in groundwater if organic sources of nitrogen are accounted for and moderate fertilizer applications are used. We looked at a worst-case scenario where shallow groundwater was sampled from immediately under the corn root system. At a landscape scale, more spatial dilution is expected which would generally reduce nitrate levels. It should be pointed out that the fertilizer additions were timed relative to crop uptake through sidedress applications. The results might have been very different if all fertilizer nitrogen was applied as plowdown.

This study also demonstrated that the management of organic sources of nitrogen may be very critical and the timing of sod plowing (or manure applications for that matter) relative to nitrogen uptake by a subsequent crop may be very important. In this case, the early release of green-manure nitrogen from fall plowing may have resulted in higher nitrate levels compared to spring plowing where nitrogen release is in synch with uptake by the corn crop. In a future article, we will discuss the effects of overfertilization on nitrate levels in groundwater. Our results suggest that even moderate overfertilization (30-50 lbs/ac) may result in significant amounts of leftover soil nitrogen at the end of the season and elevated nitrate levels in groundwater during the following fall and spring.



Corn Silage Quality

CROP MANAGEMENT

Jerry Cherney and Bill Cox
Soil, Crop and Atmospheric Sciences

In the past 5 years, much has been said about corn silage quality and the potential for improving silage quality by hybrid selection. Now that the 1994 corn silage crop is history, selection of corn hybrids for 1995 will not be far off. What should be the role of forage quality in the selection of corn silage hybrids?

History

Increases in both grain and silage yield have occurred over the last 60 years due to breeding and management advances. In Europe, breeding for yield, lodging, and pest resistance actually decreased whole plant digestibility, and a similar trend may have occurred in the U.S. in the past. Corn silage has not received much attention in the past from U.S. seed companies, because only 6-8 percent of the total U.S. corn acreage is harvested as silage. New York state corn production is atypical of the U.S. in general, with almost 1/2 of the corn acreage harvested as silage.

Quality vs. Yield

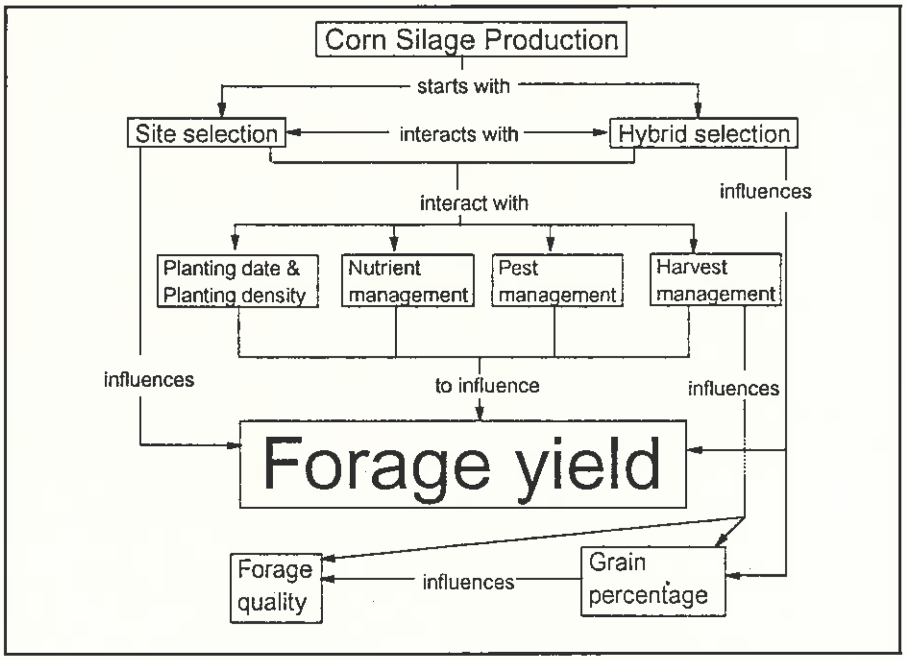
The concept map shown in the figure includes the major components in the corn silage production system and demonstrates the major linkages in the system. Other factors, such as weather, will affect the outcome, but they cannot be controlled (except for use of irrigation). While other interactions between components do occur, the ones shown here are considered the most important. Corn silage production is based on site and hybrid selection, and these two components determine the maximum yield possible under optimal environmental and crop management conditions. Hybrid selection also directly affects grain percentage.

Site and hybrid selection interact with four primary crop management components to maximize yield for a particular growing season. Grain percentage has a strong influence on whole plant forage quality. Harvest management (or stage of maturity) also directly impacts forage quality. Although planting date and density, as well as nutrient and pest management can influence quality, they are primarily tools to increase dry matter yield. The concept map implies that we have much more control over silage yield than we do over silage quality. It also implies that the major effect of hybrid selection on forage quality is through changes in grain percentage.

Breeding for Quality

Corn silage is both a grain and a forage. Depending on the rest of the ration, corn silage can be used as an energy source, a fiber source, a protein source, or all three. Plant breeding objectives must be reconciled with potential animal performance, as well as other ration components. Because breeding goals are not clear-cut, it may be very difficult to make improvements in forage quality through breeding. Actual improvement in forage quality may be verified only through animal trials, because chemical, in vitro, and in situ techniques may not correctly rank the true value of hybrid differences in quality.

There is some experimental evidence that hybrids may have biologically significant differences in fiber quality. However, until more evidence is provided about potential differences in silage quality of hybrids (differences not related to grain percentage), we should continue operating under the current model.



SOIL MANAGEMENT

Root and Top Biomass of Cover Crops Varies with Species and Management

Jane Mt. Pleasant
Soil, Crop and Atmospheric Sciences

Increasingly, growers are looking to use cover crops to improve soil physical properties. Adding plant residues may increase air and water movement in compacted or degraded soils. Unfortunately, we know little about the best or most efficient ways to improve these soils using cover crops. It would seem that species that produce large amounts of biomass would be most effective.

It's obvious that cover crops differ greatly in aboveground production of biomass. There may be as much or more variation among species in root production, but because it takes place below the soil surface, we frequently ignore this factor. In terms of improving soil physical properties, root structure and production are likely to be critical characteristics. Understanding the effects of management practices on top as well as root biomass can help growers use cover crops more effectively.

An experiment was established in 1993 to determine the impact of seeding date (July 29 and August 25) and nitrogen rate (0 and 50 lbs/A topdressed N) on the root and top biomass of ten species of cover crops. The crops were sampled in December 1993 to measure root and top dry weights.

Cover crops seeded in July produced twice the biomass compared to the August seeding. The effect was similar for both roots and tops (Table 1). Nitrogen rate had no effect on top growth but the higher N rate slightly decreased root production (Table 1).

Table 1. Effects of seeding date and topdress nitrogen rate on top and root dry matter production of cover crops, averaged over 10 species. Samples December 1993.

	Tops	Roots
	------lbs/A------	
Seeding Date		
July 29	3332	905
August 25	1723	388
N Rate (lbs/A		
0	2508	730
50	2516	582

Among species, the cover crops varied widely in top and root production (Table 2). Canola was the most productive species in both root and top biomass, but among the other species those which produced large top weights were not the ones with the most root biomass. Additionally, seeding date affected root and shoot production of the species differently.

For example, among the broadleaf species, canola produced much more root and top biomass than the two legumes. It's advantage over the legumes was even more striking at the August seeding date (Figure 1). Crimson clover outproduced red clover in top biomass at both seeding dates, but red clover had approximately six times as much roots as crimson clover when seeded in July.

Among the grasses (Figure 2), annual species (oats, rye and annual fescue) produced more top growth than the perennial

Table 2. Top and root dry matter from ten cover crop species averaged over two planting dates (July 29, August 25) and two nitrogen rates (0 + 50 lbs/A). Sampled December 1993.

Cover Crop Species	Tops	Roots
	lbs/A	
Canola (Ceres)	3978	1017
Crimson Clover	1199	216
Medium Red Clover (Arlington)	899	774
Oats (Newdak)	3774	327
Rye (Aroostook)	2215	470
Annual Fescue (Zorro)	2378	816
Bromegrass (Matua)	1729	254
Fescue (Pennlawn)	1308	537
Perennial Ryegrass (Grimalda)	2556	694
Perennial Ryegrass (Logro)	2526	666

species (bromegrass, fescue, and perennial ryegrasses), particularly at the August date. In terms of root production, the perennial grasses did better at the July seeding, but the annual grasses had the advantage in August. Oat and rye produced much more top growth than annual fescue, but annual fescue had more roots than the small grains, especially when seeded in July.

These data represent only a single season of observation, but they do suggest several important points in managing cover crops to improve soil physical properties.

1. To accumulate large amounts of root and top dry matter, early seeding (July) is essential.

2. Nitrogen has little effect on biomass production of cover crops seeded in July or August.

3. Canola, oats and rye will produce significant amounts of top biomass even when seeded in August.

4. Canola and red clover produce large amounts of root biomass, the perennial grasses produce modest amounts of roots, but all require seeding in July to accomplish this.

Additional research will be needed to establish whether there are differences between root and top biomass in terms of their effects on soil physical properties.

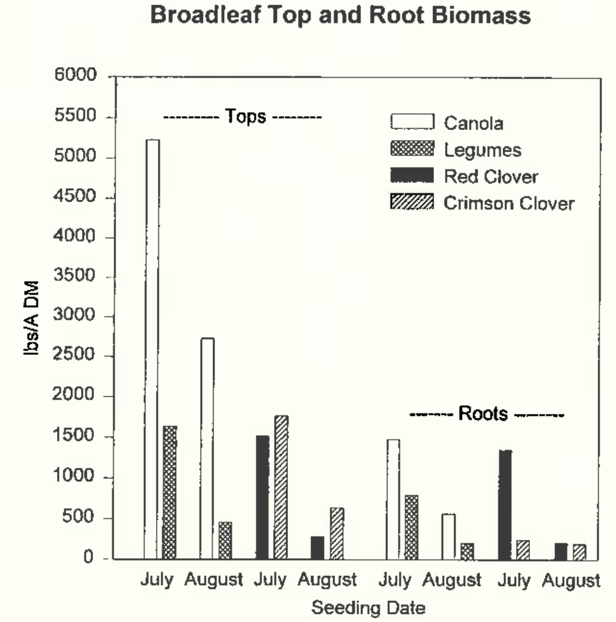


Fig. 1

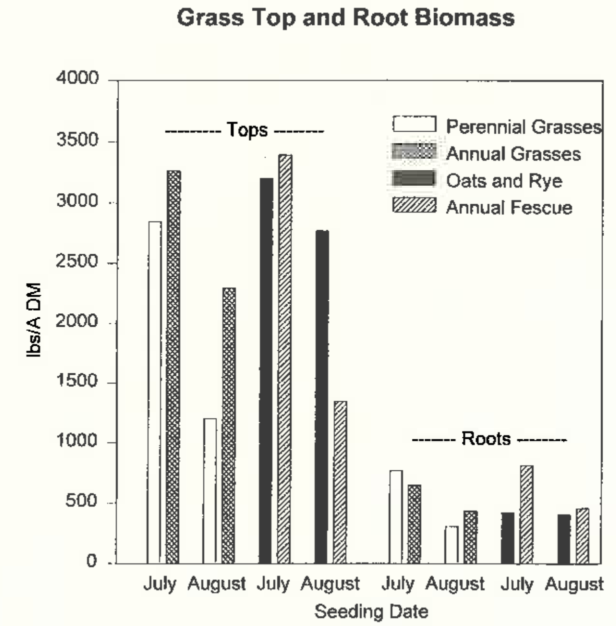


Fig. 2

WEED CONTROL

Sencor Boosts Velvetleaf Activity of Postemergence Herbicides in Field Corn

Russ Hahn
Soil, Crop and Atmospheric Sciences

Velvetleaf is not always controlled with preplant-incorporated or preemergence herbicide applications in field corn and often requires sequential control measures. Postemergence applications of Buctril or Banvel are recommended for these situations. The addition of atrazine to these applications, or the use of Buctril + Atrazine or Marksman improves velvetleaf control over that with these herbicides alone. Although Sencor is not yet registered nationally by EPA for this type of application, results indicate that the addition of 2 oz/A of Sencor DF will boost velvetleaf control with Buctril, 2,4-D, or Banvel.

Research Methods

Field experiments conducted in 1993 and 1994 compared Buctril, 2,4-D amine, 2,4-D ester (LVE), and Banvel alone and in combinations with 2 oz/A of Sencor DF for postemergence velvetleaf control. Buctril and the 2,4-D formulations were applied at a rate equivalent to 1 pt/A while Banvel was applied at 0.5 pt/A. All treatments (including the check) received 2 pt/A of Dual preemergence for annual grass and/or yellow nutsedge control.

Corn (Pioneer 3901) was planted May 26, 1993 at the Valatie Research Farm in Columbia County. Early postemergence (EPO) applications were made on June 17 when velvetleaf had 2 to 4 true leaves. Treatments were also applied postemergence (PO) on June 25 when velvetleaf had 4 to 6 true leaves. In 1994, corn (Pioneer 3751) was planted May 20 at the Livingston County BOCES and herbicides were applied EPO June 16 when velvetleaf was in the 2- to 4-leaf stage.

Control Ratings

Velvetleaf control was significantly better when 2 oz/A of Sencor DF was added to the EPO applications than when the tank-mix partners were applied alone in 1993 and 1994. The average velvetleaf control ratings for the two years are shown in Figure 1. EPO applications of Buctril benefitted the least from the addition of Sencor. Velvetleaf control with 1 pt/A of Buctril alone averaged 83% while the combination with Sencor increased control to 97%. Sencor provided the largest boost for 2,4-D amine with control increasing from 17 to 89%. The LVE formulation of 2,4-D and Banvel provided 63 and 59% control when applied alone and 95 and 94% control when applied with Sencor respectively.

Buctril and 2,4-D LVE applications did not benefit significantly from the addition of Sencor when PO applications were made when velvetleaf was in the 4- to 6-leaf stage in 1993 (Figure 2). Velvetleaf control for these four treatments averaged 95%. The addition of Sencor improved velvetleaf control from 50 to 85% for 2,4-D amine and from 65 to 96% for Banvel when applied at this stage of development.

Figure 1. Velvetleaf control with early postemergence (EPO) applications of Buctril, 2,4-D, and Banvel alone and with 2 oz/A of Sencor DF in 1993 and 1994.

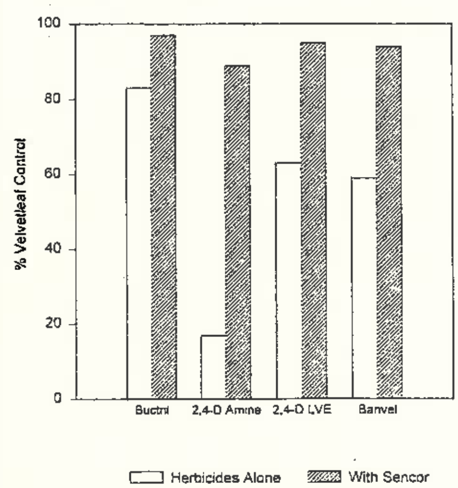
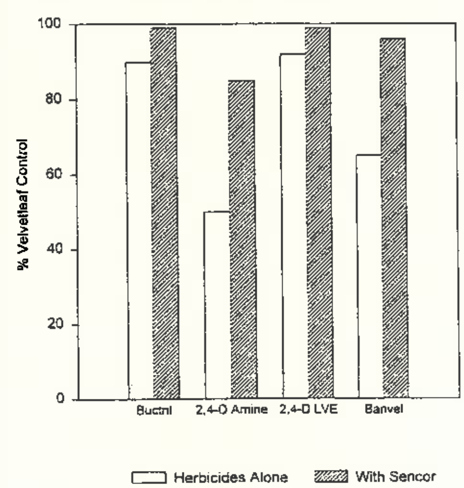


Figure 2. Velvetleaf control with postemergence (PO) applications of Buctril, 2,4-D, and Banvel alone and with 2 oz/A of Sencor DF in 1993.



Each of the sequential postemergence treatments had significantly higher grain corn yields than the preemergence Dual check in 1993. The check yielded 48 bu/A while the sequential treatments had an average yield of 81 bu/A. Among the sequential treatments, significant yield increases resulted only when Sencor was added to the EPO and PO applications of 2,4-D amine. This increase averaged 17 bu/A for the two treatments.

Advantages

These results clearly demonstrate that velvetleaf control is better when 2 oz/A of Sencor DF is added to postemergence applications of Buctril, 2,4-D, or Banvel than when these herbicides are applied alone. This response is similar to that observed when low rates of atrazine are tank-mixed with these herbicides or when prepackaged mixtures such as Buctril + Atrazine or Marksman are used.

As a competitively priced alternative to atrazine, Sencor's registration for use in these postemergence combinations would have several advantages over their atrazine counterparts. Sencor 1) is not a restricted-use herbicide, 2) has no application zone restrictions around wells and other water sources, 3) has no 12-inch height restriction for corn, 4) use would allow the use of reduced rates of 2,4-D and Banvel for improved crop tolerance, and 5) does not carryover from one season to the next. Since Sencor is a triazine herbicide, it would provide no advantages for the control of triazine-resistant biotypes of smooth pigweed, common groundsel, lambsquarters, or ragweed.

CCA TRAINING SESSION

Once again, we will sponsor a Certified Crop Advisor (CCA) Training Session to help you prepare for the National and State CCA exams to be administered on February 3, 1995 at the New York State Grange in Cortland. **The training session will be held December 6-8 at the Sheraton Inn in Ithaca.** Because the exams are now administered annually, this will be the only opportunity to participate in the training session and to take the exam in the coming year. The tentative agenda for the training session will be:

Dec. 6 (Tuesday); Field Crop Management; 10-6:00

Dec. 7 (Wednesday); Pest Management; 8:00-6:00

Dec. 8 (Wednesday); Soil Management; 8:00-6:00

The registration fee will be $100. The registration fee will cover daily costs for a continental breakfast, AM coffee break, lunch, PM coffee break and snack, and a 3-ring binder of training materials. **To register, please send a check for $100 made out to Cornell University by November 23 to:**

Pam Kline
144 Emerson Hall
Dept. of Soil, Crop & Atmospheric Sciences
Cornell University
Ithaca, New York 14853

Rooms are available at $59/single or $59/double at the Sheraton Inn (800-257-6992). If you wish to stay at the Sheraton, you must register by November 14 and identify yourself as part of the CCA block.

If you have questions, please call Pam Kline at 607-255-2177.

Calendar of Events

Nov. 13-18	American Society of Agronomy Meetings - Seattle, WA.
December 1-2	Liquid Manure Application Systems - Rochester Marriott Thruway Hotel
December 6-8	CCA Training Session - Sheraton Inn - Ithaca, New York
January 17	So. Tier Corn Congress - Ithaca Armory - Ithaca, New York
January 18	Finger Lakes Corn Congress - Holiday Inn - Waterloo, New York
January 19	Western NY Corn Congress - Sheraton Inn - Batavia, New York
February 3	National and NY State CCA Exam - NYS Grange - Cortland, New York

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