What's Cropping Up?

A NEWSLETTER FOR NEW YORK FIELD CROPS & SOILS

VOLUME 10, NUMBER 5, 2000

Field Crop Industry Meeting Set for March 13, 2001

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The New York Corn Growers Association and the Crop and Soil Management Statewide Program Committee (SPC) of Cornell Cooperative Extension are cosponsoring the first annual Field Crop Industry Meeting on March 13 at the Holiday Inn in Waterloo, NY. Additionally, the New York Corn Growers Association will hold their annual banquet during the lunch hour of the meeting. The Planning Committee (Ron Robbins and Ann Peck-NY Corn Growers, Keith Culver-Pioneer Hi-Bred, Bob DeWaine-Monsanto, John Deibel-Deibel Corp., Nate Herendeen and Bill Cox-Cornell Cooperation Extension) have developed the general program. The program includes two 1-hour topics in the morning, followed by the 1 1/2 hour banquet, and four concurrent 1-hour topics during the afternoon of which the audience can select two topics to attend. Morning topics include 1) The Potential for Siting Ethanol or Biodiesel Plants in New York and 2) Future Biotechnology Opportunities for New York Growers. The concurrent afternoon topics include 1) Development of Certified Nutrient Management Plans (CNMPS) for New York Dairy Farms, 2) Development of Corn Silage Hybrids, 3) Precision Agriculture Techniques, and 4) Corn Silage and Grain Marketing. Most speakers will have a national perspective, including a national representative from the Corn Growers Association as the banquet speaker. The program has been designed to interest both cash grain and dairy producers. Please reserve March 13 on your calendar for the first annual Field Crop Industry Meeting.

PROGRAM

TIME	TOPIC
10:00	Potential Siting of Ethanol & Biodiesel Plants in NY
11:00	Future Biotechnology Opportunities for NY growers
12:00	Lunch
1:30 - 3:30	Development of Certified Nutrient Management Plans Development of Corn Silage Hybrids Precision Agriculture Techniques Corn Silage and Grain Marketing

Soil Management

Removal of Selective Availability: New Opportunities for Field Data Collection

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Introduction

Many researchers have identified the potential for using global positioning system (GPS) technology to aid in farm management (van Es & Cox, 1998). GPS technology is useful for precisely determining locations in the field for soil sampling, nutrient application, and yield monitoring. However, the cost for obtaining the necessary accuracy using GPS technology has made its use in farm management difficult. Low cost GPS receivers did not typically provide the accuracy necessary for real-time nutrient application or other field related activities.

Recently, however, the accuracy of GPS derived coordinates have improved dramatically due to the United States government decision to stop the intentional degradation of the GPS signals, otherwise known as *selective availability*. The decision to eliminate selective availability may now provide new opportunities for users of lower cost GPS receivers to perform real-time collection of coordinate information.

This article examines the impact that the removal of selective availability may have on GPS field collection by comparing the results of GPS derived coordinates both before and after the removal of Selective Availability.

Background

The global positioning system is a constellation of satellites maintained by the Department of Defense (DoD), used for navigation. Its primary mission is to provide global positioning/navigation for land-, air-, and sea-based strategic and tactical forces (USACE, 1996). However, the system is also available to the general public and is used by engineers, farmers, and recreational hobbyists for determining locations on the Earth. More recently, GPS has been used for in-car navigation and location systems, and is now being incorporated into cellular phones to aid in emergency dispatch.

Accuracy of GPS

When obtaining coordinate locations using GPS, the terms *accuracy* and *precision* are often used. *Accuracy* describes the closeness of a position obtained with the GPS receiver to the known, or true, position of the measured point. *Precision* is the measure of repeatability, indicating how closely several positions fall within each other (Harrington, 2000).

GPS accuracies can range from 100 meters to better than sub-centimeter levels, depending upon the equipment used and the processing techniques. Typically, a user requiring sub-centimeter level accuracies would require a *geodetic grade* GPS receiver, costing tens of thousands of dollars. *Mapping grade* GPS receivers can often obtain accuracies of 1 to 5 meters, while *general navigation* receivers can typically achieve 5 to 100 meter accuracies.

Selective availability, the intentional degradation of the GPS satellite signal by the United States government for security purposes, accounts for the largest source of error within the GPS signal (Hurn, 1989). Other sources of error in the GPS signal include *atmospheric errors, clock errors, receiver noise,* and *multipath errors* that arise from signal deflections caused by large reflective surfaces such as buildings or other structures (USACE, 1996).

While in effect, Selective Availability caused slight complications in obtaining accurate coordinate positions using GPS, as the initial coordinate locations frequently contained errors of upwards of one hundred meters. In order to improve the coordinate accuracy, users were required to perform additional computations to correct for the inaccuracies of the GPS signal. The use of *post-processing* techniques required users to apply known correction factors to the coordinate values obtained by the GPS unit. These corrections, known as *differential correction* required a second GPS unit to occupy a known point and determine to apply the appropriate correction factor. Often, the second GPS unit consists of a government supplied base station with a modem for dial-up connectivity to receive the correction files.

Obtaining the differential correction is accomplished through downloading correction files from a base station after a survey was performed, or computed in real-time through some method of radio transmission from a base station. In either case, the user was required to perform additional work or purchase more expensive equipment capable of reading correction transmissions. Therefore, many users simply avoided the use of GPS technology for real-time field collection, determining that the errors were too great to confidently obtain an accurate location.

Removal of Selective Availability

On May 1, 2000, the United States turned off Selective Availability, and thus removed one of the largest error sources within the GPS signal. The impact of this decision was significant, as users were instantly able to determine more accurate and precise coordinate locations with less expensive equipment. Further, the accuracy improvement for some applications may be sufficient to perform real-time field collection without the need for differential corrections. This improvement has had immediate benefit to car navigation, fleet management, and recreation, with coordinate accuracies that are ten times better than those obtained when Selective Availability was in existence (van der Marel, 2000).

Study on the Cornell University Campus

The Department of Crop and Soil Sciences at Cornell University conducted a study of the effects of the removal of Selective Availability on both the precision and accuracy of GPS derived coordinates. The study included measuring GPS derived coordinates using a Trimble GeoExplorer II GPS receiver on known geodetic benchmarks both before and after Selective Availability was removed.

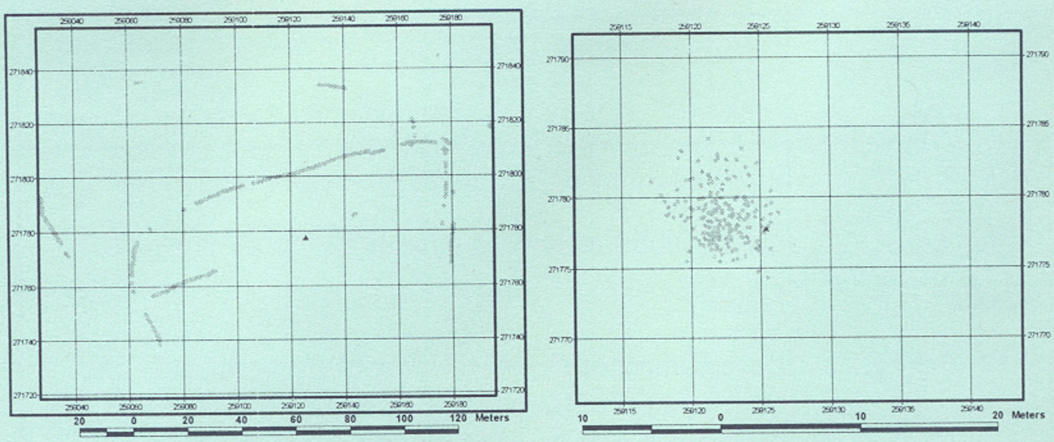

Figure 1 (a) Coordinate locations derived in April 2000 before the removal of Selective Availability shows a wide scattering of points around the true benchmark location (triangle). The grid spacing for Figure 1(a) is 20 meters (b) coordinate locations derived in September 2000 after the removal of Selective Availability shown a "tighter" scattering of points around the true benchmark location. The grid spacing for Figure 1(b) is 5 meters.

Figure 1a shows the location of benchmark T917 on the Cornell University campus in relation to GPS derived coordinates collected in April 2000 (before the removal of Selective Availability), while Figure 1b shows the GPS derived coordinates collected in September 2000 (after the removal of Selective Availability) for the same benchmark. In addition, Table 1 displays the results of the coordinate processing for benchmark T917 before the removal of Selective Availability.

Table 2 displays the results of the coordinate processing for benchmark T917 after the removal of Selective Availability. Comparing the two tables shows a significant improvement of the coordinate values due to the removal of Selective Availability.

The results also indicate that the spatial precision (standard deviation) of the derived coordinate values was significantly improved after the removal of Selective Availability.

Conclusion

The removal of Selective Availability has had a dramatic effect on improving the accuracy of GPS derived locations. In many instances, lower cost GPS units may now be used in field collection for various farm related applications. However, other errors, previously mentioned in this article, continue to exist in the GPS derived coordinates. Therefore, users must be aware of the coordinate requirements for specific farm management applications, and make sound judgments as to the appropriateness of the GPS solution chosen. Currently, the United States Department of Defense predicts that 95% of the coordinates obtained globally using GPS without differential correction will have an absolute accuracy no worse than 22 meters.

Table 1 – Results of GPS processing for Benchmark T917 in April 2000, before the removal of Selective Availability. The table shows the standard deviation for 621 generated points, and the absolute accuracy for the average coordinates.

	April 2000 Coordinate Results with No Differential Correction
	Standard Deviation (621 points)
Northing	23.321 meters
Easting	50.901 meters
Absolute Accuracy	18.42 meters
	April 2000 Coordinate Results with Differential Correction
	Standard Deviation (621 points)
Northing	3.866 meters
Easting	4.017 meters
Absolute Accuracy	2.29 meters

Table 2 – Results of GPS processing for Benchmark T917 in September 2000. The table shows the standard deviation for 197 generated points, and the absolute accuracy for the average coordinates.

	September 2000 Coordinate Results with No Differential Correction
	Standard Deviation (621 points)
Northing	1.913 meters
Easting	1.984 meters
Absolute Accuracy	4.12 meters
	September 2000 Coordinate Results with Differential Correction
	Standard Deviation (621 points)
Northing	1.867 meters
Easting	1.771 meters
Absolute Accuracy	1.49 meters

References

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USACE, 1996. NAVSTAR Global Positioning System Surveying. Manual No. 1110-1-1003. Department of the Army, Unitead States Army Corps of Engineers, Washington, D.C.

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Soil Management

Precision Agriculture Technology

New York State's adoption, adaptation and future

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Wayne A. Knoblauch, Agricultural Resource & Managerial Economics

Many farmers will tell you that they have been using "Precision Farming" all their life, and they are right. Precision farming didn't start with the invention of the computer or yield monitor. It started with the simple premise that land can be managed better when decisions are made on a site by site basis and not necessarily on the arbitrary boundaries of a field. Today there are new tools and new technologies that allow us to reestablish some of that connection to the land that has been lost on today's mechanized farms.

By listening to the comments from users of yield monitor and yield mapping technology we can help to develop a better understanding of this technology's potential. One common idea among reasons given by field crop producers in central NY for using yield monitors is the idea that better information (in this case yield measurements) leads to improved decision making, which leads to improved results. The link between information and results is not surprising—the yield monitor is a tool for collecting information on performance.

Users of yield monitors describe how the technology enhances their efforts to identify problem areas and simplifies their on-farm research efforts. Farmers describe using a yield map to identify areas of low yields. Producers can then utilize problem-solving skills to determine why yields are low and identify solutions. These farmers often mention the decision to install tile drainage in poorly drained areas as an example. Farmers point to how yield monitor/mapping technology enhances their on-farm research efforts. They view the yield monitor as an effective way to measure the performance of different varieties, nutrient rates and the timing of field operations, among others. Measuring crop performance is key to effective evaluation of alternatives and decision making.

Other keys to achieving improved results through technology adoption relate to implementation. First, people trained in the maintenance, calibration and use of the various yield monitor/mapping components, including the information generated, will help to ensure success. Second, the farm manager must be sure that adequate computer resources are available to effectively utilize the information collected. (Will the farm's current desktop computer handle the mapping software?) Third, the farm manager considering adopting yield monitoring/mapping technology should assess the management complexity of the technology relative to their skills. Some farmers will have a difficult time learning the complex hardware and software required for the new technologies. As this equipment becomes simpler and more mainstream in the coming years it should be more accessible to everyone.

A Case Study: Elmer Richards and Sons Precision Agriculture Experiences

In September 1997 Craig and Jim Richards decided to purchase a yield monitor for their John Deere 9500 combine. They wanted to better evaluate yields for various hybrids, identify problem areas in crop fields and generate field maps. Implementing the Greenstar system enabled the Richards to accomplish all of their objectives.

Jim and Craig Richards operate an 800 cow, 2,400 acre dairy farm outside the village of Skaneateles. They grow over 1,300 acres of corn and 1,000 acres of hay. Yield monitoring is done on approximately 800 acres of corn annually. The Richards have invested additional time to maximize returns from implementing precision agriculture technology. Craig spends about ten additional hours per year keeping and maintaining field records and yield information. Yield monitor calibration requires one additional hour of time.

The Richards have made numerous changes as a result of having accurate information to make decisions from. They are better able to select hybrids that perform well under local growing conditions. Additional changes include selecting different herbicides and modifying post-emergence herbicide application. Spraying patterns have also been changed in attempt to reduce compaction.

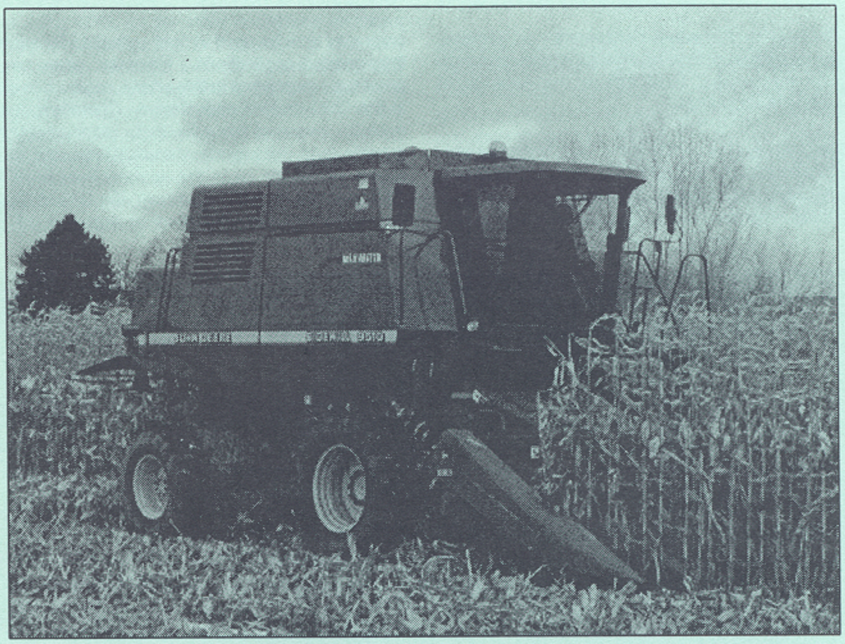

Figure 1 On the Richards Farm corn is harvested with a yield monitor mounted on the combine. Notice the small GPS receiver on the cab roof.

Overall, Craig and Jim hope to achieve better yields through fully implementing precision agriculture technology. They are able to see results from hybrid selection, but believe it is too early to quantify benefits from installing artificial drainage. Both Craig and Jim are convinced that precision agriculture benefits their farm business. They ordered a factory installed yield monitor and supporting software this year when they purchased a John Deere 9510 combine.

Implementing precision agriculture technology has the potential to positively impact farm profitability. This can be accomplished by making more informed decisions on hybrid or variety selection as a result of obtaining more accurate yield response data. While improved record keeping and increased yields through precise input management are key factors influencing farmers to adopt precision agriculture technology; there are environmental benefits for farmers to consider as well.

Yield Monitoring

For the New York State farmer, the yield monitor may be one of the most useful pieces of new farm machinery on the market. Not only can the combine operator see in real-time how much grain is being harvested but by simply a GPS receiver is linked to the system data from each harvest operation can be saved as a file and later converted into a map. These maps are simple tools to compare yields across fields or with a single field across many years.

The yield monitor also facilitates quick and simple on-farm research trials. With virtually no added work, a farmer can plant a farm-specific variety trial. Using a split planter treatment the two varieties are planted in alternating strips across the field. At the end of the season, the yield data for the two varieties can be pulled apart on a computer and compared. Work at Cornell University has shown that it is possible to discern very significant yield benefits, even between two good performing hybrids. This ability to fine-tune hybrid selection for individual farms and achieve even a small yield gain can easily pay for the yield monitoring equipment in a short time.

Variable Rate Technology (VRT)

For some people precision agriculture *is* variable rate technology. It is better to think of this technology as merely one component of precision farming. Ideally we could simply use soil data and yield data to develop application maps for each crop input. Operating from these maps, a sprayer or spreader could apply the precise rate of the right input exactly where it is needed. Reality is a little different. It can be difficult to generate precise application maps for many crop inputs, especially in areas where soil variability is high.

Most research shows strong potential for variable lime applications. Within one Cornell research site a pH range of 5.1 to 7.4 was observed. If one lime rate were used across the field some areas would receive too little lime and some areas would receive far too much.

Fields with very distinct zones of low and high nutrients may also benefit from VRT. Out of the seven fields in the Cornell Precision Agriculture study, two had P and K variability that required management and was distributed in manageable zones. The other five fields had a smaller range of variability or had a more randomized (and therefore difficult to control) distribution. Fields that receive manure tend to have more dramatic nutrient variability.

Another study at Cornell investigated the use of variable seeding rates across a field. Preliminary results point to a limited potential but there may be some value in increasing the seeding rate where early season conditions for germination may be difficult, for instance in higher compaction areas of conservation tillage.

Nutrient planning

Precisely applying crop inputs based on site specific soil tests and yield data can improve environmental conditions. For example, fertilizer and pesticides are more effective in soil with a neutral pH. Utilizing variable rate technology to apply lime based on site-specific soil tests may reduce the amount of lime needed to raise soil pH. The end result is that fields will have a more uniform soil pH and inputs will be more efficiently utilized. Conventional soil testing and lime application methods may result in overapplying lime in some areas, while underapplying it in other field locations.

It is becoming increasingly apparent that one of the most important issues confronting NY dairy farmers today is the issue of manure. While dairy farms use manure to supply crop nutrients it is oftentimes applied to the land at rates far higher than the agronomic optimum. A delicate balancing act is necessary to protect the environment, meet the needs of the plant, and facilitate manure disposal. These types of situations stand to benefit from the new technologies of Precision Agriculture. Not only can manure be more strategically applied but spreader can generate a record showing the precise location, coverage and content of each manure application. These records become an important part of a comprehensive nutrient management plan.

As nutrient management standards and specifications evolve, dairy and livestock farms will be challenged to develop more precise nutrient management plans. Today, manure is being applied with variable rate technology in the same manner as commercial crop inputs. Precision agriculture technology can also prevent overlapping manure when spreading by utilizing parallel swathing equipment. The same equipment can be used when applying pesticides or any other crop input. The result is a reduced potential for nonpoint source pollution on these farms and better implementation of a comprehensive nutrient management plan.

Passing Fad or Farm of the Future?

In order to make sound management decisions we must have good information. Precision agriculture is simply a way to employ powerful information tools to gather data, quickly analyze this data, and develop a strategy that will help you meet your performance goals.

While this technology may not be appropriate for every situation, it is clearly here to stay. It is also important to remember that a site-specific approach does not necessarily need to be a high-tech approach. Each farmer should take the time to decide what precision farming tools will work best for him or her. Both farmers and extension personnel must carefully evaluate the potential of this technology before they decide for or against adoption.

Weed Management

Effect of Conventional and Roundup Ready Weed Control Programs on Yellow Nutsedge Tuber Populations

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Department of Crop and Soil Sciences

Yellow nutsedge is an herbaceous perennial weed that infests large acreages of New York farmland. Although nutsedge produces viable seed, a complex system of basal bulbs, rhizomes, and tubers is mainly responsible for reproduction and spread of this weed in cultivated fields. Tubers, which are produced on rhizomes, may lie dormant in soil for extended periods. Tuber longevity is directly related to depth in the soil with survival increasing with depth.

The widespread use of high (up to 4 lb ai/A) rates of atrazine for quackgrass control through the 1960's and 1970's was responsible for significant increases in yellow nutsedge populations. Nutsedge, which does not emerge until mid- to late May, is not competitive in hay fields or in fields with heavy quackgrass because these cool-season perennials start growth in early to mid-April. Preplant-incorporated (PPI) use of acetamide herbicides such as Dual were subsequently responsible for temporary decline in yellow nutsedge populations. Problems with triazine-resistant common lambsquarters, along with increasing concern about velvetleaf, resulted in the widespread use of Bicep + Prowl tank mixes. Since this combination can not be applied PPI, there was a resurgence in nutsedge populations. In recent years, the introduction of Permit, which has excellent postemergence activity against nutsedge, provided a new tool for managing yellow nutsedge in corn. With the introduction of Roundup Ready soybeans and corn in 1996 and 1998 respectively, questions arose about how this technology might affect nutsedge populations.

Table 1. Yellow nutsedge control, as a percent of the original (1998) population, following herbicide treatments in 1998, 1999, and 2000.

Herbicides	Rate Amt/A	When Appl	Control (%) '98	'99	'00
Bicep Lite II Magnum	1.5 qt	PPI	45	78	-
Bicep Lite II Magnum Roundup Ultra	1.5 qt 2.0 pt	PPI MPO	79	86	90
Bicep Lite II Magnum Roundup Ultra	1.0 qt 2.0 pt	PPI MPO	67	82	-
Bicep Lite II Magnum Roundup Ultra + AMS	1.5 qt 2.0 pt	EPO EPO	86	63	-
Bicep Lite II Magnum Roundup Ultra + AMS	1.0 qt 2.0 pt	EPO EPO	67	60	74
Prowl Permit + COC	3.6 pt 1.0 oz	PRE EPO	82	85	90
Prowl Permit + COC	3.6 pt .66 oz	PRE EPO	83	81	94
Roundup Ultra Permit	2.0 pt .66 oz	EPO EPO	74	79	97
Roundup Ultra	2.0 pt	EPO	15	23	61
Roundup Ultra Roundup Ultra	2.0 pt 1.5 pt	EPO LPO	67	74	84

Long-Term Study

A field experiment was established with DK493RR corn in 1998 and repeated in 1999 and 2000 near Fleming, NY in Cayuga County to determine the effect of repeating various corn herbicide programs, including Roundup Ready technology, on yellow nutsedge populations. Herbicide treatments included PPI applications of Bicep Lite II Magnum alone and followed by mid-postemergence (MPO) Roundup Ultra applications, early postemergence (EPO) applications of Bicep Lite II Magnum plus Roundup Ultra, and EPO applications of Permit and Roundup Ultra alone and in combination. Nutsedge counts were taken in all plots before and after postemergence herbicide applications each year with the "before" counts from the postemergence plots in 1998 serving as a base line for nutsedge populations. In addition, soil samples to a depth of 4 inches were taken prior to herbicide applications each year to determine treatment effect on nutsedge tuber numbers.

Results

Nutsedge control in 1998, as a percent of the original population, varied from a low of 15% with an EPO application of 2 pt/A of Roundup Ultra alone to a high of 86% with an EPO combination of 1.5 qt of Bicep Lite II Magnum plus 2 pt/A of Roundup Ultra (Table 1). The level of control generally increased as these herbicide treatments were repeated on the same plots in 1999 and 2000. Nutsedge counts in 2000 revealed that the control with the EPO application of 2 pt/A of Roundup Ultra had increased from 15% in 1998 to 61% in 2000. The EPO application of 0.66 oz/A of Permit with 2 pt/A of Roundup Ultra provided 97% control after three annual applications. Spraying mistakes are responsible for the missing data in 2000.

The number of nutsedge tubers per square meter are shown in Table 2. According to the LSD (0.05) values, there were no significant differences in tuber populations among these treatments in any of the 3 years. Soil sampling of the plots to a depth of 4 inches in May 1998 prior to imposing herbicide treatments revealed the plot area had about 785 nutsedge tubers per square meter. Subsequent early season sampling in 1999 and 2000 revealed an average of 580 and 245 tubers per square meter respectively after 2 years of consecutive herbicide treatments. Although nutsedge tuber populations dropped about 25 and 70% after 1 and 2 years respectively with these conventional and Roundup Ready weed control programs, there are still adequate tubers in the plow layer to quickly reinfest the plot area if adequate control measures are not continued.

Table 2. Yellow nutsedge tubers per square meter in 1998 prior to herbicide treatments and in 1999 and 2000 following two annual treatments.

	Rate	When	Tubers/Square Meter		
Herbicides	Amt/A	Appl	'98	'99	'00
Bicep Lite II Magnum	1.5 qt	PPI	726	627	298
Bicep Lite II Magnum Roundup Ultra	1.5 qt 2.0 pt	PPI MPO	838	566	244
Bicep Lite II Magnum Roundup Ultra	1.0 qt 2.0 pt	PPI MPO	833	539	256
Bicep Lite II Magnum Roundup Ultra + AMS	1.5 qt 2.0 pt	EPO EPO	945	518	250
Bicep Lite II Magnum Roundup Ultra + AMS	1.0 qt 2.0 pt	EPO EPO	780	524	244
Prowl Permit + COC	3.6 pt 1.0 oz	PRE EPO	741	542	204
Prowl Permit + COC	3.6 pt .66 oz	PRE EPO	575	496	216
Roundup Ultra Permit	2.0 pt .66 oz	EPO EPO	770	700	216
Roundup Ultra	2.0 pt	EPO	965	758	256
Roundup Ultra Roundup Ultra	2.0 pt 1.5 pt	EPO LPO	653	551	277
LSD (0.05)			442	286	130

Calendar of Events

January 2-5	Northeastern Weed Science Society, Cambridge, MA
January 9-10	NYS Agri-Business Association Annual Meeting, Verona, NY
January 23	Western NY Corn Congress, Holiday Inn, Batavia, NY
January 24	Finger lakes Corn Congress, Holiday Inn, Waterloo, NY
January 25	Winter Crop Meeting, Clarion, Ithaca, NY
January 31	Eastern NY Expo 2001, Polish Community Center, Albany, NY
February 8	Cayuga County Corn Day, Auburn, NY
February 11-15	Weed Science Society of America, Greensboro, NC
February 27	Northern NY Corn Congress, Miner Insitute, Chazy, NY
March 13	Field Crop Industry Meeting, Clarion, Ithaca, NY

What's Cropping Up? is a bimonthly newsletter distributed by the Department of Soil, Crop and Atmospheric Sciences 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, 144 Emerson Hall, Cornell University, Ithaca, NY 14853.

Phosphorus and Agriculture

A near final draft of the newly revised Phosphorus Index for New York State is currently being tested. The next article in the Phosphorus and Agriculture series will appear in the first 2001 issue of "What's Cropping Up?" and describe the source component of the NYS P Index.

— NYS P Index working group

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Helping You Put Knowledge to Work