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2000 AGRONOMY RESEARCH REPORT

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2000 AGRONOMY RESEARCH REPORT

edited by Michael Barrett

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Agronomy Research 2000

Summaries and Reports of Applied and Field Research

The Department of Agronomy of the University of Kentucky has a tradition of excellence in both basic and applied research. Basic research by faculty in the department, working in areas such as plant biochemistry, physiology, molecular biology, and genetics, has the long-term objective of increasing crop plant productivity and value.

Problem-solving applied research within the department is aimed at near-term benefits to Kentucky agriculture. In addition to research on crop productivity, another major focus of the department is research designed to preserve soil and water quality for agricultural and other uses.

The University of Kentucky recognized this unique combination of excellence in basic and applied research and its contributions to Kentucky's economy when it designated the department as a "distinguished, nationally competitive" research program and one of 20 "targets of opportunity" for the University. As such, the department is looked upon as one of the programs to help lead the way in establishing the University of Kentucky as a top 20 research university by the year 2020.

The *Agronomy Research Report* is published in even years to inform professional agronomists, crop producers, and crop consultants about recent developments in the University of Kentucky Department of Agronomy. While the department conducts both basic and applied research studies, this report emphasizes recent findings of applied and field experiments with importance to Kentucky agriculture. It contains brief updates on continuing projects and initial reports on recently completed studies.

Research Highlights

Examples of interesting and potentially useful accomplishments during the last year include:

New Crops: Work has been initiated with several types of novel soybean varieties, including high protein, tofu, natto, and high sucrose materials. This project is intended to assess both the comparative yield and quality of such varieties, with an eye to helping Kentucky farmers make reasoned decisions on whether or not to begin growing such novel soybean types.

No-Till Wheat: Studies at the University of Kentucky indicate that no-till wheat is beneficial and economically feasible for many growers in the state. Research is continuing on the long-term effects and Best Management Practices for no-till wheat. Long-term research has shown that both corn and soybeans, when included in a cropping system with wheat, achieve higher yields when planted after no-till wheat as compared to conventionally tilled wheat. Currently, more than 25 percent of the wheat acres in Kentucky is no-till planted.

Working with both primary wheat consulting groups in the state and with the support of the Kentucky Small Grain Growers Association, we have been conducting side-by-side comparisons of tilled and no-tilled wheat. Over the first three years of this study, we have found that no-till yields generally run between 3 and 6 bushels per acre lower than tilled yields. However, when the input costs for both systems were subjected to a partial budget analysis, no-till actually came out slightly ahead ($1.60 per acre). Since we did not factor in a dollar value for reduced topsoil erosion under no-till management, it would seem that growers should give careful consideration to this system.

In response to increased interest in no-till wheat production, no-till variety trials were grown at two locations in the state in conjunction with conventional tests in order to compare varietal performance under the two production methods. Two years of data indicate that, in general, varieties perform equally well in both conventional and no-till systems.

Corn: Recent corn-row width studies conducted in many corn-producing states have shown responses to row widths narrower than 30 inches, but these responses have occurred mostly in areas of the Central and North Central United States. After five years of research on the effect of row width and plant population on corn yields in Kentucky, there does not appear to be any advantage for 20-inch rows over 30-inch rows. The research indicated that in Kentucky, plant population is more important for obtaining high corn yields than narrow rows and that a final population of 26,000 to 30,000 plants per acre is needed for corn with a high-yield potential.

Soybean: Soybean has genes that produce a wide range of pubescence densities. Higher-than-normal pubescence reduces feeding by aphids and thus reduces the spread of soybean mosaic virus (SMV) transmitted by the aphids. However, soybean yield depression is associated with the genetic donors of the pubescence-increasing genes. We developed experimental soybean lines with increased pubescence densities but without the associated yield depression. High-yielding soybean that avoid SMV infection should be possible.

Tobacco: KT 200, a new black shank resistant burley tobacco hybrid, was released by the Kentucky-Tennessee Tobacco Improvement Initiative in April 2000. The new variety was released because of its relatively high resistance to black shank. KT 200 also has high resistance to black root rot, wildfire, tobacco mosaic virus, tobacco vein mottling virus (TVMV), and tobacco etch virus (TEV). The release of KT 200 should provide a burley variety with better resistance to black shank combined with good yield potential and resistance to TVMV and TEV.

Ten years of tobacco research has shown that topping time can affect yield. Topping at 25 to 75 percent bloom produces the best yield, but topping at bud and 100 percent bloom may reduce yield. Quality increases if burley tobacco is topped early (10 to 25 percent bloom). Late-maturing varieties tend to handle bud topping better than early-maturing varieties. Yield may be maximized at approximately 20 to 22 leaves. Leaving more leaves does not necessarily increase yield, but it may reduce weight per leaf.

Harvesting tobacco at the right time is important for maximizing yield and quality. While cutting too early significantly reduces yield, cutting too late severely degrades quality. Combined analysis of data from five locations revealed that yields increase as harvest date is delayed up to four weeks after topping. However, leaving tobacco in the field longer than four weeks does not improve yields. Research in other years has indicated that quality declines rapidly when tobacco is left standing longer than four weeks after topping.

Kura Clover: Two selection cycles were conducted for high seed and forage yields in kura clover at each of two locations: Lexington and Pittston, Kentucky. The objective was to extend the range of kura clover adaptation to more southern locations and to surface mine spoils. Those genotypes that performed well at Lexington also were high performing on the Pittston surface mine spoil. It is anticipated that another cycle of selection will be necessary before release of a new variety.

Red Clover and Ladino Clover: Red clover was more productive and less persistent than ladino clover in two identical trials at Quicksand and Lexington comparing varieties of the two species. Red clover yielded more than ladino clover at both locations, especially in dry conditions. Ladino stands were thicker than red clover at the end of 1999 at both locations.

Fescue: Studies have been ongoing since 1994 to determine the grazing tolerance of new endophyte-free tall fescues compared to endophyte-infected Kentucky 31 (Ky31+). In the first study (grazed two seasons), Cattle Club, Richmond, and Johnstone tall fescue persisted as well as Ky 31+. In the second study (grazed three seasons), Festorina, Dovey, and Barcel were equivalent to Ky31+. The presence of the endophyte did improve grazing tolerance.

Other Research: One of the benefits of no-till may be a positive change in microbial diversity and substrate use. We examined microbial community substrate use in continuous corn plots that had been in no-till or conventional-till soil management for almost 30 years. Microbial communities were distinct in each tillage practice, and no-till plots had significantly greater substrate use than conventional till plots. The data are further evidence that conservation practices benefit soil biological properties.

We determined that the concentration of fecal bacteria in runoff from poultry litter-amended no-till soils exceeded that from soils in which the litter was incorporated. However, the total fecal bacteria loss was reduced in no-till because greater water infiltration occurred in the no-till area. Poultry litter application to no-till soil was, overall, a better management practice to control fecal bacteria runoff than was incorporation by tillage.

The enterohemmorhagic *Escherichia coli* bacterial pathogen O157:H7 is endemic in livestock and has caused several recent deaths. We observed that O157:H7 was not inherently better at surviving in soil than a nonpathogenic *E. coli* strain, and both strains were sensitive to soil matric stress. Because most *E. coli* strains are nonpathogenic, rapid detection methods combined with conservative treatment guidelines should mitigate potential problems with O157:H7 released into the environment.

Homeowner constructed wetlands are increasingly popular on-site wastewater treatment systems. There is little information on the effect of various vegetation types on fecal coliform removal. Wetlands with cattails, fescue, mixed vegetation, or no vegetation were examined for removal efficiency. Regardless of treatment, fecal coliform reduction was greater than 90 percent during the sampling period.

We have engineered plant trichomes to accumulate a compound that increases the mortality of aphids feeding on the leaves and reduces aphid colonization of the leaf itself.

We have developed the techniques necessary to manipulate the genome of tobacco at the single cell level, so that very large numbers of potential genetic changes can be produced before the production of entire plants. As a result of this new approach, we produced several tobacco lines that have altered production of compounds that show pharmacological properties and other lines that show resistance to a herbicide.

Understanding gene regulation during plant embryo and seed development will be essential for designing molecular strategies to increase agricultural productivity. As a first step, we are isolating genes regulated by AGL15, a member of a class of regulatory factors that are often involved in critical developmental decisions.

Precision Agriculture Opportunities for Kentucky: Agronomic Research at the University of Kentucky

T.G. Mueller, R.I. Barnhisel, and S.A. Shearer

Precision agriculture is about doing the right thing, at the right time, in the right place, in the right way. Technologies employed include global positioning systems (GPS), yield monitors, geographic information systems (GIS), variable rate technologies (VRT), sensors (i.e., soil electrical conductivity), and remote sensing. The goal is to use these technologies to make better decisions about soil use and to optimize crop and soil management. Precision agricultural management is not very different from traditional management approaches. It is still about basing decisions on the best available crop and soil information, which used to be field or farm yield or fertility averages. But today with high-tech tools, yield data are being collected every 15 feet or so, and fertility samples are collected on 1- to 4-acre grids. Precision agriculture technologies are a reality on farms in Kentucky, as many of our producers are already monitoring yields and to a lesser extent conducting variable rate fertilization. Unfortunately, there are few proven methods for using these technologies.

A decision about soil use is the first that a farmer makes for a field or area within a field. Should this land be cropped? If so, with what crop or crop rotation? Certainly, traditional approaches (i.e., soil surveys) can be used successfully for aiding in decision making. These approaches are based on the principle that soil limitations dictate appropriate soil uses, unless these limitations can be overcome through management practices. Precision agriculture approaches are based on the same principle. However, yield monitoring and GIS allow farmers to quantitatively compare the economics of one decision about soil use to another. Digital soil surveys can be overlain on yield maps to explain variability; however, NRCS surveys may or may not be at the scale to explain much of the variability. Agronomy researchers are working on a project to determine whether precision agriculture technologies (i.e., electrical conductivity sensors and elevation models) can be used to make intensive (first-order) surveys more economically and more accurately.

Soil conductivity seems to be an important tool for making soil use decisions because it is related to topsoil depth and depth to bedrock. A study is under way to establish appropriate conductivity measurement protocols for Kentucky soils to explain the causes of soil conductivity variability and ultimately relate it to grain yield variability. The use of precision agriculture tools for soil use decisions has the potential for improving farm profitability. Another research project is designed to develop and evaluate statistical models for predicting soil properties across landscapes (depth of topsoil, soil organic carbon content, and clay content) as an alternative to grid-based sampling or traditional soil survey techniques. The ability to predict these variables accurately would be very useful. For example, regions near the edges of fields or along slopes with little topsoil are often low yielding and unprofitable. If these areas are removed from production, field profitability may improve. Further, if these areas are enrolled in the Conservation Reserve Program (CRP), the whole field economics will improve even more. Researchers in the Department of Agricultural Economics are developing economic decision aids that use yield maps for enrolling unproductive land into CRP. Better soil use decisions not only improve farm profitability, but they also benefit society as well. Removing highly erodible land from production conserves water and soil by reducing erosion and runoff. Adding buffer strips at field borders next to streams (riparian zones) reduces sediment, nutrient, bacterial, and pesticide losses to streams.

Precision agriculture has the potential for improving the efficiency of crop and soil management. If factors that limit productivity and profit can be identified within a field using soil sampling and digitized soils maps or making field observations with GPS, then management steps such as site-specific tillage, variable rate nutrient management, or seeding can be taken. But before soils or crops can be managed, their properties must be assessed. Faculty in the Department of Agronomy are conducting a study to determine if remote sensing can be used to predict forage quality. An investigation is under way to determine how intensively fields must be grid-soil sampled to create accurate maps of soil properties using various interpolation procedures.

There are also studies to determine whether terrain attributes can be used to enhance the predictions of soil properties, thereby improving the accuracy of grid sampling. One study is being conducted to determine the ecological patterns with which perennial weeds are distributed across agricultural fields. Understanding these patterns may help predict the probable location of perennial weeds in the future.

After a particular soil or crop condition is known, there must be some basis for management. Studies are being conducted to determine cause-effect relationships in the landscape. What causes yield variability? Is it landscape position, soil type, or chemical or physical properties? The goal of one research project is to develop an efficient method for creating "management opportunity maps" indicating the factors that likely limit yield across agricultural fields. These maps would be created with historical yield maps and soil sampling for fertility and by making field observations using soil survey techniques. If these causes are understood, then management steps can be taken to improve yields.

Plant available soil water is one of the most important causes of yield variation in Kentucky soils. It is affected by soil type and landscape position. Site-specific irrigation is one way to manage soil water differences in agricultural fields, but unfortunately irrigation is not economical in most areas of Kentucky. Another approach is to alter crop and soil management to match the soil's ability to provide water to plants. In drought-prone areas, it may be a good idea to reduce seeding rates to conserve water. Often, when water limits grain yield, other factors such as nitrogen will not limit plant growth (law of the limiting). Therefore, it may be advantageous to back off nitrogen fertilizer rates on areas that tend to be droughty. Several research projects involving Agronomy, Biosystems and Agricultural Engineering, and Agricultural Economics are evaluating the use of landscape position and soil type as a basis for variable rate seeding and nitrogen fertilization.

There are approaches that could be used for fertilizer recommendations. One approach may be to apply back to the field what has been removed during harvest. A study is being conducted to determine if nutrient removal calculated from yield maps can be used as a basis for fertilization. Another study is being conducted to determine if topographic position can be used to predict the need for starter fertilizer. This relates to soil temperature and the kinetics of phosphorous diffusion in cold soils. Another basis for fertilization is soil sampling either on grids or in zones. An experiment is being conducted to track the changes in soil fertility over time associated with variable rate fertilizer applications based on samples collected at various resolutions.

One expectation is that precision agriculture technologies will improve environmental quality. There is a study to evaluate impact of management practices on soil microbial diversity across Kentucky landscapes. The idea is that some management practices may be more appropriate on some soils or landscape positions than others.

Much of the funding for this work is from two USDA grants that were earmarked for the University of Kentucky. Other supporters include the Kentucky Corn Growers and the Kentucky Soybean Promotion Board. While we have focused on agronomic research in this publication, it is important to recognize that precision agriculture problems are multifaceted and complex and therefore deserve an interdisciplinary research approach. Our colleagues in the departments of Biosystems and Agricultural Engineering and Agricultural Economics are involved with many of our research projects but are also conducting their own precision agriculture research.

Table 1. Researchers at the University of Kentucky who are actively involved in precision agriculture research.

Agronomy	Agricultural Engineering	Agricultural Economics
Morris Bitzer	Tom Burks	Dave Debertin
Richard Barnhisel	John Fulton	Carl Dillon
Chad Bromer	Sam McNeill	Steve Isaacs
Mark Coyne	Scott Shearer	Ron Fleming
John Grove	Tim Stombaugh	Jeremy Stull
Than Hartsock	Joe Tarraba	
Steve Higgins	Larry Wells	
Tasos Karathanasis		
Tom Mueller		
Lloyd Murdock		
Grant Thomas		
Jim Thompson		
Mike Collins		
Ken Wells		

New Crop Opportunities for Specialty Grains

L.J. Grabau

The University of Kentucky College of Agriculture has just received a $556,000 federal grant from the USDA to focus on new crop opportunities in both horticultural and agronomic crops. The emphasis of the horticultural projects will be on specialty peppers, blackberries, nursery plants, and greenhouse plants. Meanwhile, the agronomic emphasis will be on novel types of corn, soybean, and wheat. The overall goal of this “New Crops” project is to enhance the profitability of Kentucky crop enterprises by opening up new, value-added markets for plant products. The agronomic group has chosen to work with the three primary grain crops, reasoning that Kentucky farmers are quite experienced in producing these commodities and will be able to quickly pick up the limited number of new adaptations required to make the specialty grain crops work well for them. Cooperating with agronomy faculty in this sustained effort will be faculty from Biosystems and Agricultural Engineering, Entomology, and Agricultural Economics.

While it is obvious that Kentucky’s tobacco producers are under severe pressure, it is also true that the commonwealth’s grain producers are under substantial pressure. As their productivity of corn, soybean, and wheat continues to grow, global demand for these commodities has been somewhat soft. In part, this has been due to a weakening of national economies, especially in Asia. Our growers are actively searching for ways to improve the market value of the grain crops they grow. One bright spot has been for soft white winter wheat; some growers have received premiums of up to $0.60 per bushel on that wheat market class. Other examples of potential specialty grain types include high oil corn and triple-null soybean. Some such specialty grains may fit in a relatively narrow market niche (for example, tofu for direct human consumption), while others may fit into a much broader market niche (for example, livestock feed). Many of Kentucky’s producers are eager to learn about potential opportunities to enhance their financial situation, and this project is designed to deliver the knowledge they need to assess such opportunities.

Market prices for corn, soybean, and wheat, which together account for nearly all of Kentucky’s grain crop production, have been relatively low over the past several growing seasons. While some growers have been able to devise new combinations of inputs to reduce their production costs without incurring yield penalties, most growers are convinced that the best way to improve the profitability of their operations is to secure higher market prices for their products. The concept of "value-added" commodities has been invoked in other Kentucky industries as a means by which more of the additional product value generated through post-production processing can be captured by the state. In the case of specialty grains, the additional value is due to genetic modifications made in the crop variety prior to its planting.

Such modifications have resulted in an impressive array of specialty types of these three major grain crops. For example, soybean specialty types include clear hilum, for tofu markets; sulfonylurea tolerant soybean (STS), sold as non-GMOs to European markets; other non-GMO types, also for European markets; low saturates, high oleic acid, and low linolenic acid types, all with improved vegetable oil quality; high sucrose, low in stachyose and raffinose and good for poultry feed and human food; organically produced, high protein types, mostly for the tofu market; high oil types; natto, small seeded types for Asian markets; and triple-null lipoxygenase types, which have distinct advantages for food products. Corn and wheat have somewhat fewer available specialty types, but both have important newly emerging materials.

With so many specialty grain types being developed, it is somewhat perplexing to producers to determine which may be bona fide opportunities for their operations. They need information on both yields of the specialty types, and the stability of the particular quality factors of interest. Some specialty grains may produce slightly lower yields per unit area, and growers need to have a reliable estimate of just how much that yield penalty might be. In addition, some specialty characteristics may be sensitive to environmental conditions during the growing season. For example, low linolenic acid types may have even lower linolenic acid levels if they are produced under the warm seedfill conditions common in Kentucky. This project will provide accurate information on both the yields and selected quality characteristics of each specialty grain type tested, thus giving producers a solid information base from which to decide the sorts of specialty grain types to investigate under their own unique conditions. Growers will also need to know if they should manage specialty grain crops differently, as well as what modifications in postharvest handling might be necessary. This "New Crops" initiative is expected to provide critical information to and support for Kentucky grain producers looking to take advantage of the emerging specialty grain crops.

Agronomy Research Report 2000 for Plant Cell Biology and Gene Expression Groups

G.B. Collins, R.D. Dinkins, M.S.S. Reddy, C.A. Meurer, C.T. Redmond, and K.P. McAllister

The Plant Cell Biology (PCB) and Plant Gene Expression Laboratories (PGEL) have been active in soybean tissue culture and transformation for more than a decade. Since 1993 we have been a recognized academic leader with the formation of the United Soybean Board-funded Center for Soybean Genetic Engineering and Tissue Culture. In 1995 the PCB/PGEL Laboratories at the University of Kentucky served as the lead institution for the development of the multistate Soybean Center with the inclusion of the soybean research groups of Drs. Wayne Parrott and John Finer at the University of Georgia and the Ohio State University, respectively. This collaborative effort has led to many improvements in soybean transformation and tissue culture that have been published in peer-reviewed journals, presented at scientific meetings, and disseminated to the public via the World Wide Web (<www.ca.uky.edu/PCB> and <www.ca.uky.edu/PGEL>). This collaboration also permitted the University of Kentucky to develop and patent an improved strain of *Agrobacterium tumefaciens,* named KYRT1, specifically for soybean transformation.

The Center for Soybean Tissue Culture and Genetic Engineering was instrumental in the simultaneous development in 1997 of transgenic soybean carrying the Zein gene from corn for an improved amino acid profile. Initial tests of these transgenic lines under greenhouse conditions demonstrated real gains in the percentage of the sulfur containing amino acids Methionine and Cysteine (Table 1), amino acids for which soybean is deficient. The highest expressing lines of soybean carrying this genetically modified trait will be field tested at both the Lexington and Princeton research stations in 2000 for protein profile under normal production conditions. Seed derived from these field trials will be used for animal feeding trials.

The Center for Soybean Tissue Culture and Genetic Engineering was again expanded in 1999 with the inclusion of the research laboratories of Drs. Lila Vodkin and Jack Widholm at the University of Illinois. Additional progress continues in soybean tissue culture and soybean genomics stemming from this collaborative relationship.

The Plant Cell Biology and Plant Gene Expression Laboratories have also been collaboratively active within the University of Kentucky College of Agriculture. In conjunction with the Plant Pathology research group of Dr. Said Ghabrial, we have

Table 1. Amino acid profile of soybean lines, expressed as percentage of total.

Soybean Line Designation	Amino Acid				
	Cysteine	Methionine	Glycine	Proline	Lysine
Non-GMO Control	1.60%	1.88%	4.07%	5.31%	6.93%
GMO Control	1.88%	2.05%	3.94%	5.01%	6.74%
OSU Zein 4	1.97%	2.14%	4.26%	5.19%	6.85%
OSU Zein 10	**2.16%**	**2.24%**	**3.82%**	**5.20%**	**7.07%**
UK Zein 12	1.98%	2.20%	3.86%	5.08%	6.44%
UK Zein 15	1.84%	2.11%	3.92%	5.00%	6.64%
UK Zein 25	1.91%	2.26%	3.87%	5.15%	6.77%
UK Zein 29	**2.04%**	**2.21%**	**4.40%**	**5.07%**	**7.09%**

engineered multiple lines of soybean with genes for resistance to Bean Pod Mottle Virus, a pathogen that is extremely damaging when combined with Soybean Mosaic Virus. Recent efforts using a leaf assay have demonstrated resistance to this potentially destructive virus (Table 2).

The Plant Cell Biology and Plant Gene Expression Laboratories have also been involved with all aspects of tobacco biology, from gene discovery to field trials of plants transgenic for potential agronomic traits. Tobacco has served as both target crop for genetic modification and as an ideal model system for testing transgenes destined for other plant species, such as soybean.

Our demonstrated efficiency using tobacco as a model system has resulted in a positive reputation both within and outside the university. We have provided expertise and training in tobacco transformation as a model system to other University of Kentucky laboratories, research groups from other universities, and private industry groups. This positive reputation has also made both the Plant Cell Biology and Plant Gene Expression Laboratories a highly desirable part of any campus tour for foreign government dignitaries, private company executives and scientists, visiting researchers from other academic institutions, and student (graduate and undergraduate) recruiting tours. This has provided the University of Kentucky with a platform for informing the public at large with a balanced and positive view of plant biotechnology and the benefits that it provides.

The Plant Cell Biology and Plant Gene Expression Laboratories have also made notable progress in the introgression into tobacco of genes for plant development, flowering, metabolite synthesis, pathogen resistance, and herbicide tolerance. Several field trials and greenhouse assays have been conducted with these plant lines, with many more trials ongoing or being planned.

The most recent ongoing field trials with tobacco have involved field evaluation of transgenic lines for resistance to the black shank disease-causing organism under natural conditions. This trial will be taking place in three locations throughout the state in conjunction with the University of Kentucky Tobacco Breeding group and the University of Kentucky Plant Physiology group.

Table 2. Analysis of soybean lines transgenic for Bean Pod Mottle Virus - Coat Protein.

	Feature					
	DNA				BPMV Resistance	
Soybean Line	GUS Gene	BPMV Gene	NPTII Gene	Protein	Mild Strain	Severe Strain
T139-1	+	+	-	+	+	-
T183-1	+	+	-	+	+	-
T183-2	+	+	-	+	+	-
T200-1	+	-	-	-	-	-
T407	+	+	+	+	NA	+
T477	+	-	-	-	NA	-

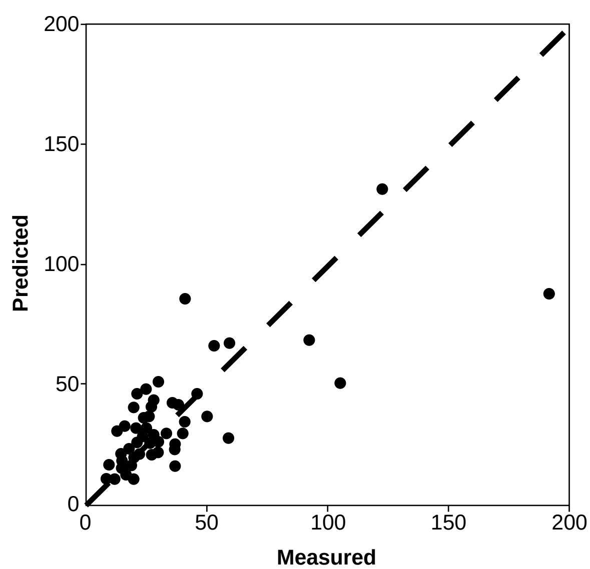
Note: Plant numbers 139-1, 183-1, 183-2, and 200-1 are plants demonstrating stable inheritance of the BPMV transgene. Plants 407 and 477 are still in the initially transformed plant stage and have not yet been evaluated for stable inheritance. NA indicates that the data are not yet available.

Assessing Soil Fertility Map Quality in Kentucky

T.G. Mueller, S.A. Shearer, K.L. Wells, S. Adams, and A. Kumar

For site-specific soil fertility management to be beneficial to Kentucky farmers, soil properties must be known with some degree of accuracy. A study of map quality for site-specific fertility management is being conducted at several locations (Calloway, Caldwell, Daviess, Hardin, Henderson, Nelson, and Shelby counties) representing important agricultural regions in Kentucky. Soil samples were taken on grids (i.e., 100-ft grid). Additional points were collected with a two-stage sampling approach (stratified-random), and these points will be used to calculate map quality (mean squared error). All samples were analyzed for pH, BpH, P, K, Ca, Mg, Zn, and OM (organic matter) by the Division of Regulatory Services. The grid data (100-, 200-, and 300-ft grids) are being interpreted using inverse distance weighted and kriging. Both procedures are used to make maps in commercial precision agriculture software. Analysis of one location indicates map quality was less than desired at the 100-ft grids (Figure 1). At lower intensities (200- and 300-ft grids), map accuracy diminished further. The industry standard 330-ft (2.5-acre) grid would not have been adequate to accurately map soil fertility in this field. The data from

Figure 1. Plot of predicted versus measured for interpolated (kriged) soil P (lb P acre^{-1}) using the 100-ft grid. The line represents the 1:1 line. For a good map, the data should be closely clustered along the 1:1 line. A better map was desired at the 100-ft scale.



the other seven locations will be analyzed during the summer of 2000. We recommend to farmers and industry that when grid sampling, additional check data points be collected to estimate map quality.

For more information, contact Tom Mueller (mueller@pop.uky.edu; www.uky.edu/~mueller).

Soil Electrical Conductivity Variability

N.J. Hartsock, T.G. Mueller, S.A. Shearer, G.W. Thomas, K.L. Wells, and R.I. Barnhisel

Commercial sensors are available that allow rapid field mapping of soil electrical conductivity; however, there has been little research in this area. This study was conducted to determine the nature and causes of soil electrical conductivity variability in Kentucky. Soil conductivity measurements were taken using a Veris® 3100 soil electrical conductivity sensor at various times on several fields representing different agricultural regions of Kentucky. Soil fertility measurements (pH, BpH, P, K, Ca, Mg, and organic matter), soil moisture (12-cm), soil temperature, topsoil thickness, penetrometer with depth, depth to fragipan, depth to clay increase, and depth to bedrock were measured on a number of points in each field. Conductivity varied in both space and time. Many of the spatial patterns that occurred were temporally stable. Conductivity was positively related to cation concentration (e.g., Ca, Mg) and soil moisture (e.g., R2=0.75, Shelby County; R2=0.48, Hardin County; Figure 1), and inversely related to depth to clay increase (e.g., R2 = 0.28, Hardin County; R2 = 0.66 Shelby County; Figure 2) and depth to bedrock (e.g., R2 = 0.33, Shelby County; Figure 3). Electrical conductivity may be useful in production agriculture because conductivity relates to factors that affect soil productivity, use, and management.

Figure 2. Plot of deep electrical conductivity versus depth to clay increase.

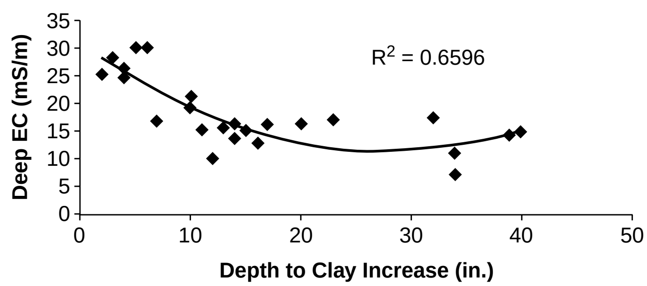


Figure 1. Plot of shallow electrical conductivity versus volumetric soil water content.

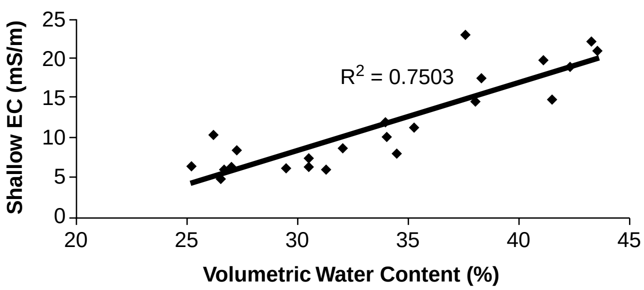
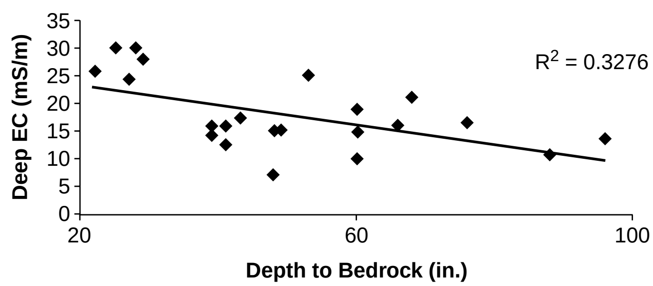


Figure 3. Plot of deep electrical conductivity versus depth to bedrock.



Topography and Community Substrate Use

G.W. Thomas, T. Mueller, and M.S. Coyne

The speed with which biological soil properties can respond to soil management practices and inputs is a potentially important factor in successfully implementing precision agriculture. It is critical to have quantifiable parameters that will reflect the impact of precision application or management on the biology of soil. However, several factors have prevented biological assessment of soil from playing more of a role in this new technology: biological properties have extreme spatial variability; common measurements such as microbial plate counts are insensitive and imprecise; appropriate biological criteria to map soils consistent with the goals of precision agriculture have been lacking.

Our goal was to investigate biological diversity, as quantified by community substrate use, for its usefulness in revealing mapped sites potentially amenable to change and for its relationship to other chemical and physical properties collected during assessment of sites for precision agriculture.

Community substrate use is a relatively new approach to examining biological diversity. In principle, the type and number of substrates that the microbial population in soil uses will reveal something about the diversity of that population. Low numbers of substrate use will be indicative of constrained microbial populations, while different patterns of substrate use will be indicative of distinct microbial communities.

Preliminary studies elsewhere have suggested that tillage management, soil type, N use, crop rotation, and dominant vegetation will all influence community substrate use. We have also observed that topography influences microbial substrate use. Because topography and soil type will be two of the most readily mapped and most permanent features of a landscape, we determined to examine soil biological diversity using these two features.

An exploratory study was carried out in two farmers' fields using BIOLOG GN microplates to determine the diversity of microbes as affected by soil position in the landscape. The BIOLOG GN plate has 95 separate microbial substrates that give a distinct blue color within 48 hours after inoculation with a soil slurry if the substrate is used.

In one field, located on a karstic plain, the microbes taken from depressions (sinkholes) tended to be more diverse than those taken from ridge and slope positions. In the second study, a transect taken along a drainage gradient showed more diversity in the moderately well-drained soil than in any of the soils that were more limited in drainage.

At present, a principal components analysis is being carried out on these two fields, and preliminary results show very good separation according to landscape position, giving hope that microbial diversity will be a useful tool in characterizing soils beyond chemical and physical criteria.

Vegetation Effects on Fecal Bacteria Removal in Homeowner-Constructed Wetlands

C. Potter, M.S. Coyne, and A. Karathanasis

Homeowner-constructed wetlands for on-site wastewater treatment have created considerable interest over the last several decades. Constructed wetlands duplicate processes occurring in natural wetlands where water, plants, microorganisms, and the wetland substrate purify water through several mechanisms (adsorption, precipitation, biotransformation, uptake). They are used as a secondary treatment for domestic wastewater when other forms of secondary treatment are not feasible. Constructed wetlands have been shown to treat biological oxygen demand (BOD), suspended solids, and nutrients to within required discharge ranges. Although the treatment efficiencies of constructed wetlands have great potential for reducing nutrients and bacteria, the influence that plants have on these systems still needs to be more closely examined.

The primary goal of this research was to investigate planted and unplanted constructed wetlands on the basis of treatment efficiency. Three systems planted with cattails, three systems planted with a variety of flowering plants, three systems planted with fescue, and three systems without vegetation were evaluated. Samples were collected at the inflow and outflow ends of each system and analyzed on a monthly basis for BOD, fecal coliforms, fecal streptococci, ammonium-N, nitrate-N, nitrite-N, soluble-phosphorus, pH, redox potential, and temperature. Total nitrogen, total phosphorus, and dissolved organic carbon were analyzed every other month. Here, the removal of fecal bacteria and BOD by the constructed wetland systems will be discussed.

Fecal bacteria usually do not persist long outside the gut of their host organism. Through several mechanisms, such as natural dieoff, sedimentation, and adsorption, fecal bacteria are removed from constructed wetland systems. For fecal coliforms, all systems showed approximately 90 percent removal during most months (Table 1). However, in some months several systems performed poorly. Reasons for this could include more people in the household (i.e., visitors) or inadequate water supply to the system (i.e., due to vacationing). Cattails appeared to have had the greatest treatment potential for fecal coliforms with 90.2 percent average removal. Fecal streptococci removal was greatest in the constructed wetlands planted with a variety of flowering plants (95.6 percent), followed closely by the systems that remained unplanted (94.9 percent). Cattail and fescue systems still removed almost 90 percent of the fecal streptococci (Table 1).

Table 1. Percent removal of fecal bacteria.

Wetland Type	System	Fecal Coliforms	Fecal Streptococci
Cattails	1	91.4	81.5
	2	86.5	91.5
	3	92.5	95.2
	Avg.	90.2	89.4
Variety	1	95.6	98.0
	2	90.1	93.7
	3	83.9	95.2
	Avg.	89.9	95.6
Fescue	1	84.3	95.1
	2	89.1	86.9
	3	91.6	85.4
	Avg.	88.4	89.1
No Plants	1	83.9	92.4
	2	89.1	95.1
	3	95.9	97.0
	Avg.	89.6	94.9

The BOD analysis began in November 1999 for most of the constructed wetland systems. To date, BOD removal tends to be sporadic among each of the wetland systems as illustrated by the cattail (Figure 1) and unplanted (Figure 2) systems. The systems containing cattails as the dominant vegetation have been the most efficient at treating BOD, with an average treatment efficiency of 71.4 percent. The systems that contain no vegetation averaged about 68.4 percent, and the systems containing a variety of plants and fescue averaged 60.8 percent and 56.2 percent, respectively. The greater removal of BOD from the cattail and no-vegetation systems may be a result of better oxygenation throughout these systems. Cattails are hydrophytes; their ability to bring large amounts of oxygen into their rooting system would result in more oxygen entering the constructed wetland. The systems containing no vegetation may have been slightly warmer and stimulated greater decomposition of dissolved organic matter within the wetland.

Data also indicate that seasonal and temperature differences play a major role in the treatment efficiency of the constructed wetland systems. The collection of data will conclude in September of 2000, by which time we hope to perceive whether any significant differences exist between the wetland types.

Figure 1. Percent biological oxygen demand (BOD) removal in cattail systems. Each bar represents a separate wetland system.

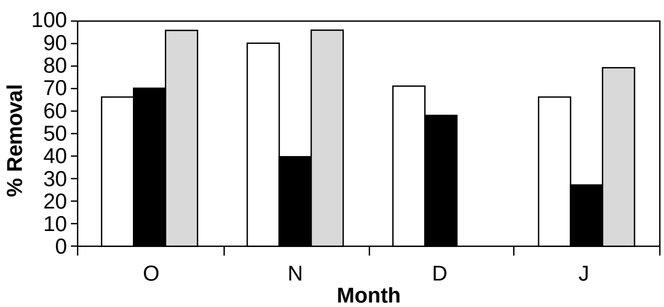
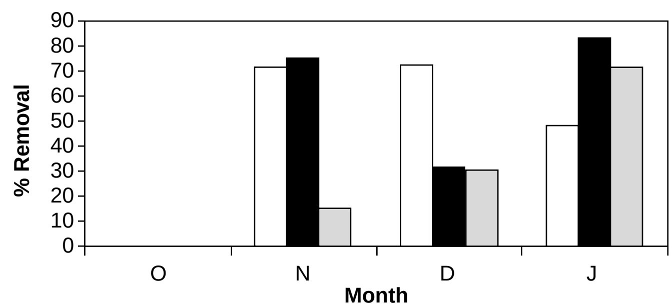


Figure 2. Percent biological oxygen demand (BOD) removal in systems with no plants. Each bar represents a separate wetland system.



Management of Seeded-Bermudagrass during the Establishment Year

G.C. Munshaw, D.W. Williams, and P.B. Burrus

A study of seeding rates and nitrogen fertility regimes was conducted using seeded-bermudagrass managed as golf fairway/athletic field turf. The objectives were to investigate how best to manage seeded-bermudagrass during the establishment year to maximize survival of the first winter. Stolon production and fitness were the response variables of most concern.

Table 1. Main effects of four seeding rates and four N frequencies on percent plot coverage in 1998 and 1999.

		Seeding Rates (lb 1000 ft^{-2})				N Frequency (days)			
		0.25	0.50	0.75	1.0	Once	30	14	7
Observation Dates		% Cover				% Cover			
1998	6/18	50† b	72 a	65 a	75 a	72 a	66 a	63 a	62 a
	6/25	51 b	77 a	76 a	83 a	75 a	68 a	75 a	75 a
	7/21	79 b	88 a	87 a	87 a	91 a	84 b	85 b	80 b
1999	7/20	75 c	85 b	90 ab	93 a	84 a	85 a	87 a	86 a
	8/13	88 ab	86 b	96 a	94 ab	87 a	88 a	93 a	96 a

† Values followed by the same letter within the same observation date are not significantly different ($P<0.05$).

'Mirage' bermudagrass was established in the second week of June in 1998 and 1999. Seeding rates were 0.25, 0.50, 0.75, and 1.0 lb pure live seed (PLS) per 1,000 sq ft. Nitrogen was applied at a rate of 1 lb N per 1,000 sq ft either once only at establishment, or every 7, 14, or 30 days following establishment.

The percentage of plot cover was estimated visually during the establishment period. Stolons were harvested three and four months following establishment. Stolon fresh weights and mean diameters were determined. Total nonstructural carbohydrate (TNC) accumulation in stolons was measured in 1999 using stolons harvested just after plots entered dormancy for the winter.

There were no significant interactions between seeding rates and N fertility regimes in either year. The low seeding rate was significantly slower to reach full cover than the higher rates (Table 1). However, there were no differences in coverage among seeding rates at the end of both growing seasons. There were also no differences in overall turf quality among seeding rates by the end of both growing seasons. Increasing N frequencies did not result in faster plot coverage in either year (Table 1).

The lowest seeding rate did produce significantly more stolons than the highest rate in both years of the study (Table 2). Additionally, the lowest seeding rate produced larger stolons (Table 3). There was not a significant response to N treatments in 1998. In 1999, the high N frequency produced more but smaller stolons (Tables 2 and 3).

TNC concentrations were not different among seeding rates. The intermediate N frequency (14 day) resulted in significantly higher TNC concentrations among N treatments (Table 4).

Previous research has indicated that stolons are important structures for winter survival of bermudagrass. Results from this study indicate that turf managers choosing to use seeded-bermudagrass may improve survival of the first winter following establishment by adjusting seeding rates and N frequencies. Reduced seeding rates and judicial N applications resulted in significantly more and larger stolons and higher TNC concentrations as plants entered the first winter.

Table 2. Main effects of four seeding rates and four N frequencies on fresh weights of bermudagrass stolons in 1998 and 1999.

		Seeding Rates (lb 1000 ft^{-2})				N Frequency (days)			
		0.25	0.50	0.75	1.0	Once	30	14	7
Observation Dates		grams stolon 162 cm^{-2}				grams stolon 162 cm^{-2}			
1998	September harvest	9.7[†] a	8.1 b	8.1 b	7.7 b	8.9a	7.9 a	8.1 a	8.7 a
	October harvest	9.8 ab	9.2 ab	8.0 ab	7.4 b	9.2 a	8.0 a	9.0 a	8.2 a
1999	September harvest	8.0 a	6.5 b	5.6 b	5.5 b	5.4 b	6.8 a	6.9 a	6.5 ab
	October harvest	7.7 a	6.9 a	6.4 ab	5.1 b	5.4 b	6.4 a	6.9 ab	7.4 b

[†] Values followed by the same letter within the same observation date are not significantly different (P<0.05).

Table 3. Main effects of four seeding rates and four N frequencies on stolon diameter of bermudagrass at four months after seeding in 1998 and 1999.

	Stolon Diameter (mm)							
	Seeding Rates (lb 1000 ft^{-2})				N Frequencies (days)			
Observation Dates	0.25[†]	0.50	0.75	1.0	Once	30	14	7
October 1998	1.2 a	1.2 ab	1.1 ab	1.0 b	1.2 a	1.1 a	1.0 a	1.1 a
October 1999	1.4 a	1.4 ab	1.3 ab	1.2 b	1.5 a	1.4 ab	1.2 bc	1.0 c

[†] Values followed by the same letter within the same observation date are not significantly different (P<0.05).

Table 4. Main effects of four seeding rates and four N frequencies on percent total nonstructural carbohydrates on dry weight of bermudagrass at four months after establishment in 1999.

	Percent TNC of Dry Weight							
	Seeding Rates (lb 1000 ft^{-2})				N Frequencies (days)			
Observation Dates	0.25[†]	0.50	0.75	1.0	Once	30	14	7
October harvest	13.5 a	13.3 a	14.3 a	13.1 a	13.3 ab	14.1 a	15.2 a	11.5 b

[†] Values followed by the same letter within the same observation date are not significantly different (P<0.05).

Impacts of Typical Cultural Practices on the Severity of Gray Leaf Spot of Perennial Ryegrass

D.W. Williams, P. Vincelli, and P.B. Burrus

Gray leaf spot has become a very important fungal disease of high-maintenance perennial ryegrass. Recent epidemics in central Kentucky have necessitated total renovation of large acreages of turf. Little is known about the effects of common cultural practices on the incidence and severity of this disease.

A study was conducted in 1998 and 1999 to investigate the impacts of mowing height and nitrogen fertility on the severity of gray leaf spot on perennial ryegrass managed as a golf turf. Mowing heights simulated golf fairway (0.75 inch) and golf rough (2.5 inches) systems. Nitrogen (urea) was applied as a split-plot treatment once per month 1 April through 1 September. Rates of N were 0, 0.75 and 1.50 lb N per 1,000 sq ft (M). Plots were inoculated with gray leaf spot in July of both years. The percent of each plot affected by gray leaf spot was estimated visually. Data statistically analyzed was the calculated area under the disease progress curves (AUDPC).

There were no significant interactions between mowing heights and N fertility in either year. Otherwise, the same trends were apparent in both years of the study. Mowing height had no significant effect on the severity of the disease in either year (Table 1). Increasing N rates did significantly increase disease severity in both years (Table 1).

These results indicate that turf managers may expect the disease to occur with equal frequency and severity in both heights of cut. Additionally, applications of water-soluble sources of N should be avoided prior to or during environmental conditions that are conducive to disease development.

Table 1. Area under the disease progress curves (AUDPC) for mowing heights and N fertility treatments in 1998 and 1999. Data collected by visual estimations was percent plot area affected by gray leaf spot.

Treatment	AUDPC (%-days)	
Mowing Height (in.)	**1998**	**1999**
0.75	1090.7a	340.15a
2.50	1145.3a	277.15a
c.v. (%)	17.30	38.16
LSD (0.05)	833.64	413.77
Nitrogen Fertility (lb N/M/month)		
0.0	794.9b	202.87b
0.75	1163.7ab	351.08a
1.50	1404.4a	369.42a
c.v. (%)	20.28	11.48
LSD (0.05)	515.43	80.09

Means followed by the same letter are not significantly different (α=0.05).

Strategies for the Control of Poa annua in Golf Turf

P.B. Woosley, A.J. Powell Jr., D.W. Williams, and P.B. Burrus

Poa annua continues to be one of the most persistent and hard-to-control weeds in golf turf. There are very few alternatives for selective chemical control, and most cultural practices are either not practical or less effective.

Over the past two years, the University of Kentucky has focused research on the postemergence control and prevention of seedhead formation of annual bluegrass in golf course fairways. Various plant growth regulators (PGRs) and herbicides were evaluated. Our objectives were twofold. First, we wanted to determine what available products showed postemergent control of Poa. Secondly, if a product showed activity against Poa, we wanted to determine the rate, number of applications, and timing that would show greatest Poa control. The PGRs Turf Enhancer®, Primo®, and Embark® and the herbicide Prograss® were evaluated for Poa control in perennial ryegrass and creeping bentgrass fairways.

Fall and winter applications of Prograss have been successful in reducing Poa in perennial ryegrass fairways. In our research, summer applications of Prograss did not provide annual bluegrass control. Volatility of the chemical could explain the observed poor control. However, Prograss did exhibit control of Poa when three applications were applied in late fall and winter (Table 1). Control of Poa was greater in perennial ryegrass compared to creeping bentgrass. Perennial ryegrass is more tolerant to applications of Prograss, and therefore higher rates can be applied to perennial ryegrass fairways. Herbicide injury occurred on creeping bentgrass when Prograss was applied at a high rate (2 lb ai/A or 4 fl oz/1,000 sq ft) during late fall and early winter. Poa control in bentgrass was less at high rates of Prograss compared to lower rates. Creeping bentgrass was severely injured, and Poa recovery was not hindered. It is important to note that turf quality was lower in the winter in plots where Prograss was applied compared to the check. However, by mid-spring, quality of turf where Prograss was applied had surpassed the check. Late fall and winter applications of Prograss showed Poa seedhead suppression in both perennial ryegrass and creeping bentgrass fairways.

Spring applications of Prograss did not exhibit as much control of Poa as did late fall and winter applications. Turf Enhancer showed the greatest Poa control in creeping bentgrass fairways in spring. Both Embark and Prograss effectively suppressed seedhead production. Primo and Turf Enhancer did not

Table 1. Mean annual bluegrass control and seedhead suppression.

Product	Rate	Applications	Species	% Poa	% Seedheads
Experiment I					
Check		11/16, 12/18, 2/3	Perennial Ryegrass	43.3 a	23.2 a
Prograss	4 fl oz/M			1.1 b	0 b
Prograss	8 fl oz/M			0.8 b	0 b
Experiment II					
Check		11/16, 12/18, 2/3	Creeping Bentgrass	38.5 a	21.7 a
Prograss	1.5 fl oz/M			21.2 c	8.6 b
Prograss	4 fl oz/M			26.7 b	3.6 b
Experiment III					
Check		3/30, 5/3	Perennial Ryegrass	66.0 a	29.0 a
Turf Enhancer	0.72 fl oz/M			45.8 b	29.0 a
Prograss	4 fl oz/M			34.2 c	4.1 b
Experiment IV					
Check		3/30, 4/20, 5/3, 6/1	Creeping Bentgrass	27.4 a	17.2 a
Prograss	1.5 fl oz/M			26.5 ab	14.1 a
Prograss	3 fl oz/M			23.4 b	4.83 c
Turf Enhancer	0.36 fl oz/M			16.3 c	9.9 b

suppress seedheads, although Turf Enhancer did delay the onset of seedhead formation. Data from these experiments are summarized in Table 1.

Based on our results, for postemergent control of Poa in perennial ryegrass fairways, we would recommend three applications of Prograss at a rate of 1.5 lb ai/A (3 fl oz/1,000 sq ft) starting in November and continuing through February. If areas of turf are heavily infested with annual bluegrass, large areas of bare ground could occur, and therefore slit seeding with perennial ryegrass should be considered.

Since Prograss must be applied at lower rates in creeping bentgrass fairways, the product exhibits characteristics of a PGR rather than a herbicide. As a result, additional applications are likely needed to achieve adequate Poa control. A program of multiple applications at a rate of 0.75 lb ai/A (1.5 fl oz/1,000 sq ft) spaced three to four weeks apart starting in November and continuing through the spring may prove effective for Poa control in creeping bentgrass fairways. This program is currently being researched at the University of Kentucky. Positive results with multiple applications of Turf Enhancer have led us to conduct further research with this product. In addition, the PGR Proxy® is being evaluated for Poa seedhead suppression. In the future we hope to be able to evaluate these products under green height conditions.

Finally, research in characterizing the genetic diversity of annual bluegrass has been initiated. The goal of this research is to identify and characterize different biotypes of Poa. A great deal of variability can be observed in the phenotypes of annual bluegrass plants within one golf course, even within one golf green. Phenotypes range from very dense, fine texture and dark green to less dense, rough, and light-colored plants. We also see differences between time of flowering and seedhead production among plants. Some phenotypes tend to persist as a perennial while others do not. By using molecular techniques, we hope to be able to establish that different biotypes do exist or that these differences in phenotypes are a result of management. If multiple biotypes are present, further work will be conducted to describe where these biotypes are most likely to be found on a golf course. By increasing our understanding of annual bluegrass, we hope to be able to provide better tools to superintendents for controlling annual bluegrass in Kentucky golf courses.

The Economic Value of Better Alfalfa Varieties

J.C. Henning, G.D. Lacefield, R.F. Spitaleri, and L. Lauriault

The perennial question about using better varieties of alfalfa is whether the extra cost is really worth it. The question is highly valid, and sometimes the answers are taken for granted. However, the value of better varieties of alfalfa come from several areas. These include seed quality, consistent performance, yield, pest resistance, grazing tolerance, and forage quality. However, the most important reason for choosing an improved variety must be yield. The improvement in yield from choosing a better alfalfa variety has been estimated below using data from the past 10 years of the Kentucky Forage Variety Trials.

Table 1. Average annual dry matter yields of top five alfalfa varieties and of check varieties (Arc, Liberty, Saranac AR) for four yield trials across Kentucky.

Test Site Seeding Year (length of study)	Lexington 1990 (5 yr)	Lexington 1991 (5 yr)	Bowling Green 1992 (5 yr)	Princeton 1993 (6 yr)	Average
	Annual Yield, Tons of Hay/Acre (15% moisture content)				
Top 5 Varieties	5.1	6.44	4.91	5.95	5.61
Checks	4.07	5.6	4.04	4.8	4.63
Annual Difference Tons/Acre	1.03	0.85	0.87	0.96	0.93
	Value, Dollars per Acre (@$85/Ton)				
Annually	$88	$72	$74	$82	$79
Life of Stand	$440	$360	$371	$492	$415
Check Varieties	Liberty Saranac AR	Liberty Saranac AR	Saranac AR Arc	Saranac AR Arc	

Choosing a better alfalfa variety has a definite yield advantage (Table 1). A comparison of the top five varieties versus the checks for four different studies found that the better varieties were worth an average of almost 1 ton (0.93 tons) of 15 percent moisture content hay per acre per year for every year of the stand (including the year of seeding). If alfalfa hay is valued at $85 per ton, that makes a better variety of alfalfa worth on average $79 per year or $415 over the life of the stand.

The difference in seed cost between the checks and the best varieties is about $2 per pound. At a 20-pound per acre seeding rate, the extra cost of seeding the best alfalfa compared to the checks would be $40 per acre, which is certainly a significant figure. However, 0.93 tons of hay at $85 per ton equals $79 extra revenue per acre per year from better varieties of alfalfa. Over the average stand life of these four studies, this extra yield was worth $415 per acre. That makes the net return on investment for a better alfalfa variety worth about 938 percent. Are better varieties worth it? Absolutely.

Evaluating Varieties of Alfalfa and Tall Fescue for Tolerance to Overgrazing by Cattle

R.F. Spitaleri J.C. Henning, C.T. Dougherty, G.D. Lacefield, Department of Agronomy; B.T. Larson, Department of Animal Sciences

In the past, farmers made variety choices about alfalfa and tall fescue based on “clip and carry” yield trials. These data are certainly useful for establishing yield potential, resistance to significant diseases of the region, and adaptation. However, yield trials reveal little about persistence under grazing.

Alfalfa is the highest yielding, highest quality forage crop grown in Kentucky. It is produced mainly for hay, but its use as a pasture crop is increasing. Research at the University of Georgia found that persistence among alfalfa cultivars varied when subjected to mowing versus continuous grazing. They subsequently found that selecting for grazing tolerance during the breeding process could result in significantly more grazing tolerance compared to hay-type alfalfas. This selection resulted in the release of ‘Alfagraze.’ Since this release, many varieties of alfalfa have been released with claims of grazing tolerance. However, farmers are concerned that these new varieties (including Alfagraze) may not persist under less-than-perfect pasture management, especially continuous grazing. It is unclear if all claims of grazing tolerance among varieties are equally valid.

Tall fescue is the predominant pasture species in Kentucky. Most tall fescue in Kentucky is infected with a fungal endophyte (Neotyphodium coenophialum Morgan-Jones and Gams). Stand establishment and persistence of initial endophyte-free cultivars of tall fescue in Kentucky was disappointing. As a result, later releases of new endophyte-free tall fescue varieties have been poorly adopted. The prevailing attitude among farmers is that to be truly better, a new endophyte-free variety would have to demonstrate the “toughness” of endophyte-infected Kentucky 31 (the predominant variety). It is unclear if new endophyte-free varieties of tall fescue are as tolerant to close, continuous grazing as endophyte-infected Kentucky 31.

Identifying truly grazing tolerant varieties of alfalfa and endophyte-free tall fescue would greatly encourage their use and would therefore result in higher pasture productivity and quality in Kentucky. The purpose of these studies was to evaluate current varieties of alfalfa and tall fescue under heavy, continuous grazing pressure by cattle.

Varieties of alfalfa and tall fescue were fall-seeded in small (5 ft x 15 ft) plots in 1994 and 1996 and harvested for yield the following spring. After this first cutting, plots were allowed to regrow to approximately 6 to 8 inches in height and then were grazed by cattle continuously for the remainder of the season so as to keep stand heights at 3 inches or less. This procedure was repeated for one or two more grazing seasons, depending on stand survival. Stands were visually rated for stand in the fall and spring.

Alfalfa varieties differed significantly in tolerance to overgrazing (Table 1). There was a fairly clear separation between the grazing type and hay-type alfalfas (denoted with an H) in both the 1994 and 1996 seedings. Alfagraze was numerically the most grazing tolerant cultivar in Study 1 but was significantly different from the top variety (Feast) in Study 2.

Several endophyte-free varieties of tall fescue proved to be as tolerant of overgrazing as endophyte-infected Ky31 (Ky31+), considered the grazing-tolerant check (Table 2). Cattle Club and Richmond in Study 1 and Festorina and Dovey in Study 2 were as tolerant to overgrazing as Ky31+.

In both studies, endophyte-infected varieties were more tolerant of their genetic equal without the endophyte (Ky31+ vs. Ky31-; Ga Jesup+ vs. Ga Jesup-).

Endophyte infection is not a prerequisite for stand survival under grazing stress, at least in the central Kentucky environment (Table 2). However, both 1998 and 1999 could be characterized as drought years in Kentucky (data not shown). The latter half of the growing season in 1998 was dry, as was all of 1999. In fact, 1999 was the driest year in Kentucky since rainfall records have been kept. Therefore, these data are especially indicative of the stress tolerance of some of the newer, endophyte-free tall fescue varieties, especially Study 2 (Table 2).

Plant breeders have successfully selected for grazing tolerance in alfalfa (Table 1). Considering the severity of the grazing pressure, farmers should feel confident that varieties surviving this treatment should well tolerate occasional lapses in proper pasture rotation.

It is very encouraging that at least a few varieties of endophyte-free tall fescue have proven to be as tolerant of close, continuous grazing as Ky31+ (Table 2). Considering the severity of the drought in 1999 and the closeness of grazing of these plots, farmers can expect the top-performing cultivars in these studies to withstand even extreme stress for short periods of time.

Table 1. Percent stand ratings for alfalfa varieties sown 3 September 1994 (Study 1) and 23 August 1996 (Study 2) at Lexington, Kentucky, and continuously grazed for two growing seasons.

Study 1: Grazed 1995-96		**Study 2:** Grazed 1997-98	
Variety	**Jun 1997 Rating**	**Variety**	**Jul 1999 Rating**
Alfagraze	63 *	Feast	73 *
Wintergreen	60 *	Amerigraze 401+Z	66 *
ABT205	58 *	WL326GZ	63 *
ABT405	45 *	ABT405	59 *
Spredor-3	45 *	Spredor 3	53
Quantum	45 *	Grazeking	46
Cut-n-Graze	43 *	Alfagraze	45
Pasture-Plus	38	Stampede	35
Magnagraze	35	Saranac AR (H)	34
Apollo (H)	30	Haygrazer	33
Fortress (H)	25	Fortress (H)	28
Rushmore (H)	20	Apollo (H)	23
Legacy (H)	20	Arc (H)	9
5373 (H)	13		
Mean	39	Mean	44
CV, %	36	CV, %	28
LSD 0.05	21	LSD 0.05	15

* Not significantly different from the highest numerical value in the column based on the 0.05 LSD.
(H) = Hay-type alfalfa

Table 2. Percent stand of tall fescue varieties sown 3 September 1994 (Study 1, grazed two seasons) and 23 August 1996 (Study 2, grazed three seasons) in Lexington, Kentucky, and continuously grazed.

Study 1: Grazed 1995-96		**Study 2:** Grazed 1997-99	
Variety	**Jun 1997 Rating**	**Variety**	**Mar 2000 Rating**
Cattle-Club	84*	Festorina	62*
Richmond	73*	Dovey	57*
Ky31+ [1]	73*	Ky31+	53*
Ga Jesup +	61	Ky31-	47
Johnstone	56	Barcel	45
Ky31-	56	Stargrazer	38
DLF-5	48		
Ga Jesup -	48		
Stargrazer	35		
Mean	59	Mean	50
LSD,0.05	22	LSD,0.05	13
CV,%	32	CV,%	23

* Not significantly different from the highest numerical value in the column based on the 0.05 LSD.
[1] '+' indicates variety is endophyte infected; '-' indicates variety is endophyte free. All others are endophyte free.

Yield and Persistence of Red Clover versus Ladino (White) Clover during Drought

R.F. Spitaleri, J.C. Henning, D. Ditsch, and G.D. Lacefield

Red clover and white (ladino) clover are the primary pasture legumes for Kentucky. Seeding either alone or in binary mixture will improve grass pasture yield and quality. These legumes differ in agronomic characteristics. It is often uncertain which is more important or more useful in pasture renovation situations. Studies were established in the spring and fall of 1998 in Quicksand and Lexington, respectively, to compare the yield of red clover and ladino clover varieties. The occurrence of the severe drought in 1999 enabled some conclusions about survival under drought stress.

Quicksand was about equal in temperature but wetter than Lexington from April through November (data not shown). The yield and persistence data from both locations are shown in Tables 1 and 2. In general, ladino persisted better than red clover in both trials, but this was especially true for Lexington. Yields of red clover were greater than ladino clover in both locations, but the difference was greatest at the drier site, Lexington.

Certified versus Uncertified Red Clover. Three common medium red clovers were included in both trials (Common X, Y, Z) along with uncertified Kenland for comparison. In nearly every case, the uncertified red clovers were inferior to improved, certified varieties of red clover. Uncertified Kenland ranked at or near the bottom for red clover yield and persistence.

Due to the biennial growth habit of red clover, little growth should be expected from these varieties past the first cutting or two in 2000, while the ladino can be expected to persist longer. These studies show that red clover is a higher yielding clover that will produce more summer yield, especially under hotter conditions. During drought, ladino does not yield well but appears to have superior persistence to red clover, especially when red clover is in its second production year.

Table 1. Dry matter yields (tons/acre) and percent stand of red and white clover varieties sown 13 August 1998 at Lexington, Kentucky.

Variety	% Stand 18 Nov 1999	1999 Harvests May 25	Jun 30	Aug 18	1999 Total
Commercial Varieties - Available for Farm Use					
Kenland Certified	27.5	3.09 *	0.67 *	0.33 *	4.10 *
Cinnamon	22.5	3.25 *	0.52 *	0.26 *	4.03 *
Greenstar	12.5	3.06 *	0.61 *	0.21 *	3.87 *
Common Y	12.5	3.11 *	0.52 *	0.17	3.80 *
Solid	12.5	3.11 *	0.49	0.19	3.79 *
Kenstar	12.5	3.18 *	0.45	0.16	3.78 *
Syn 3-92	22.5	3.01 *	0.51	0.16	3.68
Common Z	3.00	2.97 *	0.54 *	0.12	3.63
Common X	0.00	2.94 *	0.5	0.14	3.58
Royal Red	12.5	2.92 *	0.43	0.21 *	3.56
Kenland Uncertified	5.00	2.68	0.57 *	0.13	3.39
Regal Ladino (white)	45.0 *	1.66	0.2	0.01	1.88
California Ladino (white)	32.5 *	1.4	0.17	0.05	1.61
Experimental Varieties - Not Available for Farm Use					
Freedom!	27.5	3.26 *	0.67 *	0.30 *	4.24 *
97L381749	17.5	3.11 *	0.41	0.23 *	3.75 *
ZR9701R	10.0	2.99 *	0.33	0.1	3.43
Mean	17.2	2.86	0.47	0.17	3.51
CV, %	61.60	8.53	23.24	54.3	10.26
LSD, 0.05	1.51	0.35	0.016	0.13	0.51

* Not significantly different from the highest value in the column based on the 0.05 LSD.

Table 2. Dry matter yields (tons/acre) and percent stand of red and white clover varieties sown 13 April 1998 at Quicksand, Kentucky.

Variety	% Stand 2 Sep 1999	1998 Total	1999 Harvests May 19	Jun 23	Jul 23	Sep 2	Oct 26	1999 Total	2-yr Total
Commercial Varieties - Available for Farm Use									
Kenland Certified	71.3	1.34 *	2.22 *	1.68 *	0.97 *	0.88 *	0.81 *	4.87 *	6.21 *
Royal Red	67.5	1.08	2.39 *	1.49	1.01 *	0.84 *	0.64	4.90 *	5.98 *
Kenstar	58.8	1.24 *	2.1	1.54 *	0.96 *	0.87 *	0.69 *	4.61 *	5.84 *
Greenstar	62.5	1.15 *	2.09	1.61 *	0.96 *	0.71	0.65	4.66 *	5.81 *
Cinnamon	63.8	1.1	2.16 *	1.42	0.97 *	0.84 *	0.68	4.56 *	5.66
Solid	66.3	1.06	2	1.53 *	0.98 *	0.80 *	0.63	4.52 *	5.58
Common Y	42.5	0.87	2.38 *	1.36	0.76	0.5	0.49	4.50 *	5.36
Common X	18.8	0.92	2.42 *	0.99	0.66	0.49	0.3	4.08	5
Kenland Uncertified	15.0	1.01	2.15 *	1.1	0.71	0.48	0.35	3.95	4.96
Common Z	12.5	0.75	2.36 *	1.2	0.64	0.4	0.34	4.2	4.95
California Ladino (white)	87.5 *	0.95	2.03	0.73	0.6	0.25	0.38	3.37	4.32
Regal Ladino (white)	87.5 *	0.99	1.91	0.88	0.52	0.18	0.41	3.32	4.31
Experimental varieties - Not Available for Farm Use									
ZR9701R	72.5	1.02	2.55 *	1.31	0.97 *	0.80 *	0.67	4.83 *	5.85 *
Freedom!	73.8	1.25 *	1.72	1.73 *	1.05 *	0.88 *	0.74 *	4.50 *	5.75 *
Syn 3-92	17.0	1.06	2.39 *	1.18	0.8	0.38	0.36	4.37	5.43
Mean	54.5	1.05	2.19	1.32	0.84	0.62	0.54	4.35	5.4
CV,%	15.8	13.14	13.97	12.47	9	12.07	15.91	7.2	6.67
LSD, 0.05	12.3	0.2	0.44	0.24	0.11	0.11	0.12	0.45	0.51

* Not significantly different from the highest numerical value in the column based on the 0.05 LSD.

Pubescence, Drying Rate, and Dustiness in Red Clover

N.L. Taylor, M. Collins, and R.E. Mundell

A series of experiments was conducted over several years to elucidate the relationship of pubescence to drying rate and dustiness in red clover (*Trifolium pratense* L.). Faster drying rates and decreased dustiness are desirable attributes, and it is possible by selection to modify pubescence. Five cycles of recurrent selection reduced pubescence on stems of Kenland red clover, resulting in the development of the experimental strain, Freedom!, so named for its freedom from dustiness.

In forage yield trials at Lexington and Quicksand, Kentucky, Freedom! was not significantly different from Kenland, its parent variety. At Princeton, Freedom! was not significantly different from Kenland in leafhopper resistance, stem diameter, and mildew resistance, but it had less pubescence than Kenland.

In seed yield trials at Lexington, Freedom! yielded 318 pounds per acre compared to 338 for Kenland. This difference was not statistically significant, but, because seed yield is very important to the success of a variety, it was decided to measure seed yields in 2000 before making a decision on release of Freedom!. Sufficient breeder seed should also be available at this time.

Vegetative Establishment of Kura Clover

D.C. Ditsch and W. Turner

Forage quality is generally improved when forage legumes are part of the livestock diet. Research has proven that the superior nutritive value and intake of legume forage often increases individual animal productivity compared to grass alone. Unfortunately, short-term persistence of legume species such as red clover requires frequent reestablishment, adding to the cost of forage production and complicating pasture management.

One legume species that has shown promise at the research level has been Kura clover (*Trifolium ambiguum* Bieb.) (Taylor et al. 1998). Kura clover is a long-lived perennial introduced from the Caucasian region of Russia. Kura clover closely resembles white clover but spreads vegetatively by rhizomes (horizontal underground stems). Kura's persistence is due primarily to its ability to spread over substantial distances by way of rhizome growth.

Unfortunately, low seedling vigor has been identified as a major limitation to successful kura clover establishment (Taylor and Henry 1989; Caradus 1994; Ehlke et al. 1994). Attempts to establish kura clover by seeding at the recommended rate of 10 to 12 lb per acre often fails due to extremely limited aboveground growth and subsequent weed pressure during the first growing season. However, research by Scott and Mason (1992) suggested that kura clover could be successfully established by planting rhizome fragments. This technique is more commonly referred to as "sprigging," whereby plant rhizomes and/or stolons (aboveground root system) are mechanically harvested by shallow cultivation, collected, and redistributed over an area that has been prepared by various degrees of tillage.

Objectives of this study were to determine the optimal sprigging rate (plants/ft^2) and transplant method for kura clover establishment.

Materials and Methods

The first year of a three-year field study was initiated at the University of Kentucky Robinson Experiment Station in the spring of 1997. The experimental site was located on a Pope silt loam soil (well-drained, alluvial soil derived from sandstone and shale) that was previously managed for no-till corn production.

Treatments

All treatments were replicated three times in a split-plot experimental design. Main plot treatments were sprig incorporation methods that consisted of surface broadcast only, cultipack only, disk only, and the combination of disk plus cultipack. Subplot treatments were sprigging rates of one, two, three, and four sprigs per square foot. This rate is equivalent to 190, 380, 570, and 760 lb of sprigs per acre, respectively. Individual plot dimensions were 7 ft x 15 ft. The soil surface was prepared for sprigging with a tractor-driven rotary tiller. Sprigging dates were 13 March 1997; 17 March 1998 and 1999. Each year, a new study area adjacent to the previous year's experiment was prepared. Sprigs for the study were collected from an established source of certified cv. "Rhizo" kura clover with the aid of a tractor-driven Bermuda King sprig digger. Sprigs (average length = 6 inches) were hand broadcast at the appropriate rate and immediately followed by incorporation treatments. Treatment effects on sprig survival were measured by counting the number of live kura clover plants twice during the growing season (early and late) using a 6.25 ft^2 (2.5ft x 2.5ft) quadrant.

Results

Kura clover sprig survival was highly dependent on the amount and distribution of rainfall during the growing season and the degree of sprig incorporation as indicated by a highly significant year and tillage effect. Table 1 shows the total rainfall for each growing season and the critical 30-day period immediately following sprigging. In 1998, excellent rainfall conditions resulted in a 90 percent, 134 percent, 126 percent, and 100 percent survival of kura sprigs at the one, two, three, and four sprigs per square foot rate, respectively, followed by the disk-only and disk-plus-cultipack treatments. Survival rates above 100 percent indicate growing conditions were adequate enough to promote spreading and the development of daughter plants. In contrast, maximum sprig survival in 1997 and 1999 was 50 percent and 18 percent, respectively (Tables 2 through 4).

In general, kura clover plant populations, measured at the end of the sprigging year, appeared to reach the 25 to 35 percent groundcover threshold recommended for optimal mixed grass/legume forage production at the 4-sprigs/ft^2 (760 lb/A) rate when followed by disking. Therefore, vegetative establishment of kura clover can be highly successful provided adequate rainfall or irrigation follows sprigging and sprigs are placed in good contact with the soil.

Table 1. Rainfall during kura clover growing season and 30-day period immediately following sprigging.

Year	Total Rainfall (in.)	30-Day Period (in.)
1997	17.5	3.5
1998	35.9	5.6
1999	20.9	1.1

Table 2. Kura clover plant counts+ as affected by sprigging rate and method of incorporation (10-14-97).

Incorporation	Sprigging Rate (plants/ft^2)			
Method	1	2	3	4
broadcast	0	0	0	0
cultipack	0.6	0.4	0.9	1.3
disk only	0.3	0.4	0.5	0.4
disk + cultipack	0.5	0.6	2	2
LSD (0.05)	0.9	1	2	1.7

+ Sprigging date: 3-13-97. Rainfall for growing season = 17.5 inches.

Table 3. Kura clover plant counts+ as affected by sprigging rate and method of incorporation (10-26-98).

Incorporation	Sprigging Rate (plants/ft^2)			
Method	1	2	3	4
broadcast	0.4	0.5	0.5	0.77
cultipack	0.5	0.8	2.3	1.4
disk only	0.5	1.3	2.4	4.3
disk + cultipack	0.9	2.8	3.9	2.9
LSD (0.05)	1.2	1.6	2.4	2.4

+ Sprigging date: 3-17-98. Rainfall for growing season = 35.9 inches.

Table 4. Kura clover plant counts+ as affected by sprigging rate and method of incorporation (10-21-99).

Incorporation	Sprigging Rate (plants/ft^2)			
Method	1	2	3	4
broadcast	0	0	0	0
cultipack	0	0	0	0
disk only	0	0.1	0.4	0.3
disk + cultipack	0.3	0.2	0.4	0.8
LSD (0.05)	0.4	0.2	0.4	0.3

+ Sprigging date: 3-17-99. Rainfall for growing season = 20.9 inches.

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The Effects of Different Amounts of Stretch Film Plastic on Alfalfa Baled Silage

D.W. Hancock and M. Collins

Silage can be described as forage material that is preserved by storage under airtight conditions. Baled silage is produced by baling a crop at moisture concentrations well above those used in hay production, then excluding oxygen by covering with plastic to achieve near-anaerobic conditions. Currently, a considerable amount of baled silage is produced using the stretch-wrap system that covers the crop with multiple layers of a stretch-wrap, low-density polyethylene plastic.

Achieving adequate coverage of plastic film is essential to success in producing silage using the stretch-wrap system. Therefore, the objectives of this study were to compare the storage of stretch-wrap baled silage with conventional round-baled hay and to determine the effects of two, four, and six layers of stretch-wrap plastic on the quality and palatability of baled silage.

Methods

Alfalfa forage from an established stand was baled in 4-ft diameter bales at 40 or 50 percent moisture and wrapped using two, four, or six layers of stretch-wrap plastic. Forage from the same field was baled as hay when it reached 20 percent moisture for comparison with silage. Samples were collected and analyzed for crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) before and after the storage period. Hay was stored outside.

Results and Discussion

Immediately after baling, hay had reduced levels of CP compared with alfalfa baled at the higher moisture levels suitable for silage production. Legume leaves are more brittle at hay moisture levels and are more susceptible to shattering during raking and baling. The amount of plastic coverage significantly influenced NDF and ADF concentrations measured at the end of the storage period (Table 1). Hay was higher in NDF than silage (46 vs. 41 percent for silage) and ADF (34 vs. 31 percent). In this trial, initial moisture did not influence silage NDF or ADF concentrations. However, silage wrapped with two layers of plastic had 43.0 percent NDF compared with only 39.4 percent in silage wrapped with six layers of plastic.

Elevated storage temperatures are typical of silage exposed to air due to holes or insufficient plastic coverage. In this trial, starting three days after baling, temperatures of the two-layer treatment were significantly higher than temperatures of bales with four or six layers. The level of acidity, or pH, of silage is another indicator of the effectiveness of preservation. In this study, silage with two layers of film had higher pH than silage with four- or six-layer bales for alfalfa near 40 percent moisture.

Table 1. Quality of alfalfa hay and silage.

Moisture (%)	Plastic Coverage (layers)	NDF	ADF	CP
50	2	42.6	32.2	16.4
	4	38.9	30.1	15.9
	6	39.8	30.4	15.4
40	2	43.3	31.5	16.9
	4	39.2	29.7	15.9
	6	39.6	30.2	16.0
Hay		46.0	33.5	16.4

After storage, hay was higher in both NDF and ADF than silage. Weathering that occurs on the exposed surface of hay stored outside removes more of the soluble sugars, minerals, and other digestible constituents than of the fiber constituents. Silage and hay were fed simultaneously to Angus cows, and silage was consistently consumed to a greater extent than hay. Among silage treatments, bales with four or six layers of stretch film were preferred over those with two layers.

Results indicate that two layers of stretch-wrap plastic film are not sufficient to adequately preserve round bale alfalfa silage at this location. Adequate preservation resulted when either four or six layers of stretch-film were used.

Cow-Calf Production on Reclaimed Surface-Mined Pastures in Eastern Kentucky

C. Teutsch, M. Collins, D. Ditsch, J. Johns, C. May, and L. Clay

Agricultural production in Appalachia is limited by a lack of suitable land. The primary limitation is the sloping topography associated with this region's landscape. Mountaintop removal is a common method of surface mining in Appalachia resulting in more level land that represents a significant resource for grazing livestock. In Kentucky alone, more than 1 million acres of surface mines have been reclaimed as hay and pastureland. The study reported here was established near Chavies, in Perry County, Kentucky, in 1997 to determine sustainable stocking densities for beef cow-calf enterprises on reclaimed mine-land pastures.

Methods

The experimental site was located on reclaimed surface-mined land. The 400-acre mountain-top-removal site was divided into two replicates of 30-, 60-, and 90-acre pastures with adjacent area fenced off and left ungrazed for comparison. Each pasture was grazed by 10 Angus-cross cows and their calves, resulting in allowances of 3, 6, or 9 acres per cow/calf unit. The reclamation mixture included orchardgrass, tall fescue, redtop, red clover, white clover, birdsfoot trefoil, sericea lespedeza, and annual.

Cows and calves were weighed at two-month intervals throughout the grazing season. Cow body condition score was rated at the start and end of the grazing season using a scale from 1 to 9, with 1 being emaciated and 9 being extremely fat. Cows were wintered on their respective pastures with supplemental hay fed as needed.

Results and Discussion

Cows at the highest stocking density (SD) weighed less than those at the medium and low stocking density at the start of the grazing season. This trend continued at the June weigh date (Figure 1). By October, cows at the highest SD weighed less than those at the medium and low stocking densities. Our observations indicate that this difference resulted from insufficient forage available late in the grazing season at the highest stocking density. Cows at the 9-acre allowance were in better condition in October than those at the medium or high SD (Figure 2). However, condition scores of cows on all stocking treatments were within the acceptable range for rebreeding.

Calf weaning weights were reduced in the 30-acre per cow/calf unit treatment in 1998 and 1999 compared with one or both of the other treatments (Table 1). In 1997, calves at the highest stocking density were heavier in June and August but not in October. In 1998, calves from the medium stocking rate were heavier throughout the grazing season.

Calf growth at the highest stocking rate was limited by reduced forage availability. The difference between the medium and low stocking rates can be attributed to maintenance of higher forage quality at the medium stocking rate. Heavier grazing pressure at the medium stocking rate resulted in a vegetative state later in the season, thereby increasing forage quality compared with the highest allowance treatment that allowed 9 acres per cow/calf unit.

These results indicate that reclaimed surface-mined land can be used to produce beef in a cow/calf system. Results to date suggest that allowances in the range of 5 to 6 acres per cow/calf may be optimal, but data collection will continue during two additional years.

Table 1. Calf weights for 1997, 1998, and 1999 grazing seasons.

Allowance per Cow/Calf Unit (acres)	Calf Weight (lb)		
	1997	1998	1999
30	486 a[†]	494 b	482 b
60	504 a	536 a	502 b
90	498 a	510 b	524 a

[†] Means followed by the same letter within a year and month are not significantly different according to LSD (P<0.10).

Figure 1. Stocking density effects on cow body weight averaged over three years.

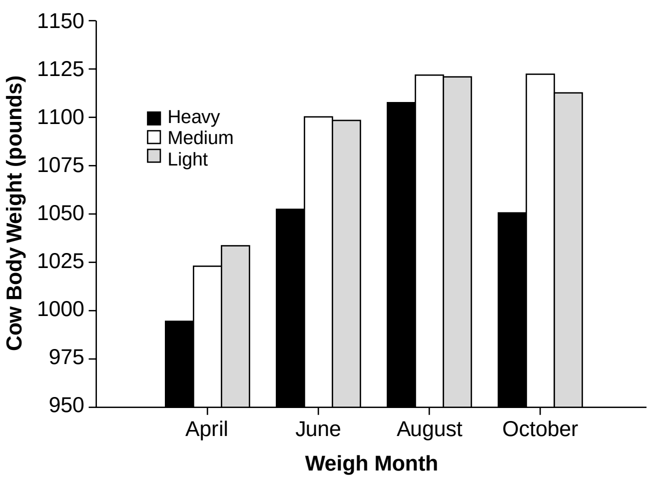
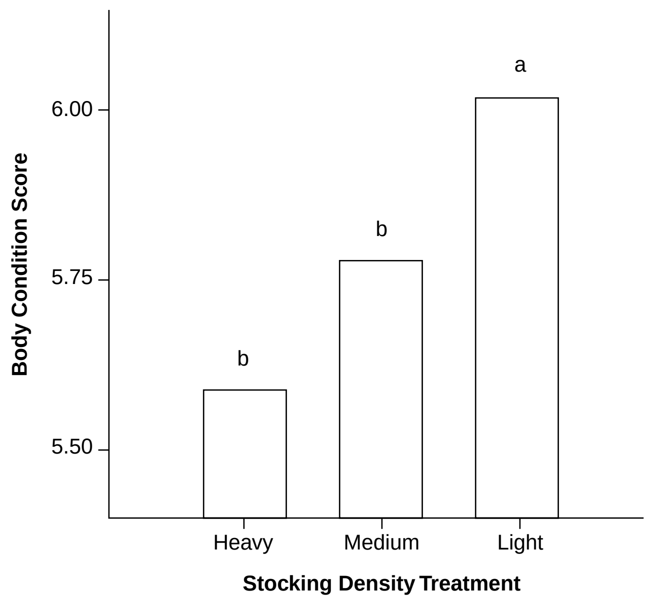


Figure 2. Stocking density effects on cow body condition score averaged over years. Bars followed by the same letter are not significantly different according to LSD (P<0.10).



A Field Survey of Weed Species Observed in Kentucky Soybeans

J.D. Green and J.R. Martin

Introduction

The most recent advances in weed control technology for field crops have been the introduction of soybean varieties and corn hybrids that are genetically tolerant to herbicides to which they were originally susceptible. For example, it has been estimated that approximately 50 percent of the soybeans planted in 1999 were planted with Roundup Ready® technology. Fewer herbicides are needed to combat weed problems, and lower weed control costs are often cited by producers who have adopted this technology. However, the potential exists for a shift in the predominant weed species that occur in field crops when this pest management technology becomes widely used by crop producers.

Therefore, a comprehensive field survey of the most frequently occurring weed species that infest Kentucky soybean fields was conducted. The long-term objective of this project is to assess the impact of herbicide-tolerant crop technology on the occurrence of weed species and to determine if these practices result in a shift in the predominant weed species present.

Procedures

Soybean fields in six Kentucky counties were surveyed in 1998, and eight counties were chosen in 1999. Four of the 10 counties participated in the survey both years. These counties represent some of the major soybean- and corn-producing areas of the state (Figure 1).

An in-field weed survey method was used to estimate the most frequently occurring weed species present in Kentucky soybean fields. Assistance was obtained from county Extension agents who played a major role in soliciting crop producers and locating field sites used for the survey. Sixty crop producers in the counties represented participated in the survey. When possible, the past field-cropping history was also determined for each field that was surveyed.

Fields were surveyed at three to five weeks after planting. Ideally this would allow time for weeds to emerge but before a field was treated with a postemergence herbicide. The method involved walking in a predetermined pattern and counting steps to help divide a field into 5-acre segments. The presence of all weed species was noted at an arbitrary site within each 5-acre area represented. For example, 10 survey sites were used for a field size of approximately 50 acres. Each site was noted on a map of the field. Some fields were mapped, and specific survey sites were noted by using Global Positioning System technology (Figure 2). The size of fields surveyed ranged from 15 to 160 acres.

The survey provided a technique for estimating the frequency of occurrence for each weed species within each field surveyed. Thus, the percent frequency was determined by calculating the number of survey sites it occupied compared to the total number of sites surveyed. Species that did not occur at the survey sites but were observed when walking between sites were also noted. The relative frequency of the predominant weed species within a county or for a statewide summary could also be estimated by using this survey method.

Figure 1. Counties surveyed (1998—Fulton, Hardin, Henderson, Hickman, Shelby , and Todd; 1999—Hardin, Henderson, Hickman, Hopkins, Shelby, Taylor, and Wayne).

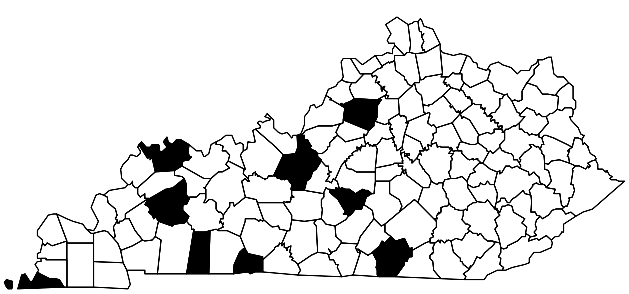


Figure 2. Example of field site surveyed.

Results

A total of 64 different soybean fields representing approximately 2,733 acres were surveyed during 1998 and 1999. Most soybean fields were grown as a full-season crop, but some fields had been subjected to double-crop production practices behind wheat. The number of weed species noted during the survey process but not present at a survey site was relatively small; consequently, the data from the survey sites were fairly representative of the species present in the field.

In soybean fields, 97 different weed species were observed (Table 1). Prickly sida, johnsongrass, honeyvine milkweed, wild garlic, and ivyleaf morningglory were among the top five

Table 1. Summary of weed species and their frequency observed in 64 soybean fields in Kentucky during 1998 and 1999.[1]

	Weed Species	Freq[2]	% Total [3]		Weed Species	Freq[2]	% Total [3]
1	Prickly Sida	208	36%	50	Milkweed, Common	10	2%
2	Johnsongrass	191	34%	51	Passionflower, Maypop	10	2%
3	Milkweed, Honeyvine	128	22%	52	Violet, Wild	10	2%
4	Garlic, Wild	124	22%	53	Volunteer Corn	10	2%
5	Morningglory, Ivyleaf	124	22%	54	Croton, Tropic	9	2%
6	Pigweed, Smooth	120	21%	55	Smartweed (Ladysthumb)	8	1%
7	Wheat, Volunteer	112	20%	56	Bindweed, Hedge	7	1%
8	Morningglory, Pitted	101	18%	57	Morningglory (Annual)	7	1%
9	Trumpetcreeper	91	16%	58	Buttercup spp.	6	1%
10	Marestail	89	16%	59	Bluegrass	5	1%
11	Nutsedge, Yellow	85	15%	60	Brome spp.	5	1%
12	Panicum, Fall	82	14%	61	Clover spp.	5	1%
13	Horsenettle	80	14%	62	Goosegrass	5	1%
14	Crabgrass, Large	78	14%	63	Orchardgrass	5	1%
15	Spurge, Nodding	78	14%	64	Purslane, Common	5	1%
16	Pokeweed, Common	73	13%	65	Sumac	5	1%
17	Nightshade, E. Black	70	12%	66	Woodsorrel, Yellow	5	1%
18	Copperleaf, Hophornbeam	69	12%	67	Groundcherry, Clammy	4	1%
19	Ragweed, Common	63	11%	68	Maple saplings	4	1%
20	Carpetweed	62	11%	69	Morningglory, Tall	4	1%
21	Dandelion	62	11%	70	Smilax spp.	4	1%
22	Foxtail, Giant	56	10%	71	Dayflower	3	1%
23	Lambsquarters	51	9%	72	Foxtails	3	1%
24	Signalgrass, Broadleaf	44	8%	73	Jimsonweed	3	1%
25	Cocklebur	43	8%	74	Mustard spp.	3	1%
26	Crabgrass, Smooth	42	7%	75	Amaranth, Spiny	2	<1%
27	Eclipta	40	7%	76	Ammania, Purple	2	<1%
28	Dock, Curly	37	6%	77	Burdock, Common	2	<1%
29	Smartweed, Pennsylvania	34	6%	78	Multiflora Rose	2	<1%
30	Ragweed, Giant	31	5%	79	Pancium, Beaked	2	<1%
31	Groundcherry, Smooth	27	5%	80	Plaintain, Broadleaf	2	<1%
32	Waterhemp, Common	27	5%	81	Bermudagrass	1	<1%
33	Morningglory, Entireleaf	23	4%	82	Bidens spp.	1	<1%
34	Copperleaf, Virginia	21	4%	83	Burcucumber	1	<1%
35	Shattercane	21	4%	84	Cinquefoil	1	<1%
36	Brambles spp.	20	4%	85	Dallisgrass	1	<1%
37	Ironweed, Tall	20	4%	86	Geranium, Wild	1	<1%
38	Thistle, Musk	17	3%	87	Knotweed, Erect	1	<1%
39	Foxtail, Green	13	2%	88	Locust, Black	1	<1%
40	Foxtail, Yellow	13	2%	89	Marshelder	1	<1%
41	Spurge spp.	13	2%	90	Mulberry sapling	1	<1%
42	Barnyardgrass	12	2%	91	Nimblewill	1	<1%
43	Velvetleaf	12	2%	92	Plaintain, Buckhorn	1	<1%
44	Dogbane, Hemp	11	2%	93	Poison Ivy	1	<1%
45	Fleabane spp.	11	2%	94	Purpletop	1	<1%
46	Lettuce, Prickly	11	2%	95	Spurred Anoda	1	<1%
47	Morningglory, Bigroot	11	2%	96	Thistle, Canada	1	<1%
48	Fescue, Tall	10	2%	97	Venice Mallow	1	<1%
49	Indian Tobacco	10	2%				

[1] Summary consisted of 570 survey sites within 64 soybean fields representing 2,733 acres.
[2] Frequency is the number of sites where a weed species was observed.
[3] The percent is based on a total of 570 survey sites.

most frequent species (22 percent or greater of the sites surveyed). The top 10 species also included smooth pigweed, volunteer wheat, pitted morningglory, trumpetcreeper, and marestail. Of all species observed, a high percentage are perennial or biennial species (more than 40 percent of the total number of species).

Current survey results reflect trends in weed management practices during the past 10 years. The high frequency of perennial species could be attributed to the high percentage of no-till and reduced tillage crop production that is practiced in Kentucky. Although several new weed management tools have been available in the past 10 years to combat johnsongrass, it was ranked as the second most frequent species observed. The presence of prickly sida in soybean is possibly linked with the widespread use of imidazolinone and sulfonylurea herbicide chemistry and the trend toward more postemergence herbicide applications.

As indicated in the objectives, a primary focus of this project is to assess the impact of herbicide-tolerant crop technology on the occurrence of weed species. Therefore, we anticipate that many of these same fields will be scouted in the future (within the next five to 10 years) to determine if weed species shifts occur as a result of the use of this new technology.

Acknowledgments

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Comparison of Weed Management Strategies with Roundup Ready® Corn

J.A. Ferrell and W.W. Witt

Introduction

Corn weed management during the past several years in Kentucky has centered around two herbicide families, the chloroacetamides (Dual, Frontier, Harness, Micro-Tech, Surpass) and the s-triazines (AAtrex, Bladex, Princep). These products have been used widely because they offer acceptable, full-season control of many common warm-season annual weeds at a reasonable price. This combination has been so popular that several mixtures that contain these types of herbicides (Bicep II, Bullet, Guardsman, Harness Xtra, Surpass 100, FulTime) are commonly used in Kentucky. The key to this efficacious and economic program is atrazine because it controls most annual broadleaf species that exist in Kentucky corn production with minimal economic investment.

Monsanto released Roundup Ready® corn, which is a transgenic crop that is tolerant to glyphosate, in the spring of 1998. Glyphosate is the active ingredient in several products, including Roundup Ultra, and has long been used as a nonselective burndown herbicide for no-till production of grain crops. The Roundup Ready® technology allows corn growers the opportunity to use Roundup Ultra as a tool for managing most annual grass and broadleaf weeds as well as johnsongrass and other perennial species.

Table 1. Entireleaf morningglory and common cocklebur control eight weeks after treatment in 1998 and 1999 at Lexington, Kentucky.

			Entireleaf Morningglory		Common Cocklebur	
		Time of	1998	1999	1998	1999
Treatment[1]	Rate/A	Treatment[2]	% Control[3]			
1. Roundup Ultra	2.0 pt	MP	90 ab	96 a	93 a	100 a
+ Roundup Ultra	2.0 pt	REG				
2. Roundup Ultra	2.0 pt	MP	90 ab	98 a	94 a	98 a
+ Roundup Ultra	2.0 pt	ASN				
3. Harness Xtra	4.8 pt	PRE	66 c	76 b	70 b	86 ab
4. Harness Xtra	3.4pt	PRE	89 ab	100 a	91 a	100 a
+ Roundup Ultra	2.0 pt	MP				
5. Harness Xtra	3.2 pt	PRE	79 b	95 a	80 ab	100 a
+ Roundup Ultra	2.0 pt	MP				
6. FieldMaster	8.0 pt	MP	94 ab	100 a	93 a	100 a
7. Bicep II	4.8 pt	PRE	65 c	71 b	68 b	73 bc
8. Bicep II	4.8 pt	PRE	97 a	100 a	98 a	100 a
+ Exceed	1.0 oz	MP				
9. Aatrex	2.0 pt	PRE	96 ab	100 a	97 a	100 a
+ Princep	2.0 pt	PRE				
+ Exceed	1.0 oz	MP				
10. AAtrex	2.0 pt	PRE	90 ab	100 a	89 a	100 a
+ Princep	2.0 pt	PRE				
+ Roundup Ultra	2.0 pt	MP				
11. AAtrex	2.0 pt	PRE	86 ab	100 a	89 a	100 a
+ Roundup Ultra	2.0 pt	MP				
12. Guardsman	4.5 pt	PRE	81 ab	71 b	80 ab	71 c
13. Guardsman	4.5 pt	PRE	93 ab	100 a	96 a	100 a
+ Banvel	0.25pt	MP				

[1] All postemergent treatments contained adjuvants recommended on the label.
[2] PRE = applied day of planting, ASN = as needed, MP = 2- to 4-inch weeds, REG = 2- to 4-inch weed regrowth.
[3] Treatment means with the same letter are not statistically different (P=0.05).

Although Roundup Ultra was known to control a wide range of weedy species, there were questions regarding the economics of this technology relative to traditional standard herbicide programs for controlling warm-season annual weeds. The technology fee of $6 per acre for the Roundup Ready® seed was an expense associated with a Roundup weed control program. Furthermore, it was not known if one or two applications of Roundup Ultra would be needed to provide weed control comparable to other products.

The objective of this research was to compare the profitability of Roundup Ready® technology with traditional herbicide programs for managing warm-season annual weeds.

Table 2. Corn yield and net return in 1998 and 1999 at Lexington Kentucky. No statistical differences among yield or net return occurred.

Treatment[1]	Rate/A	Time of Treatment[2]	Yield 1998	Yield 1999	Return[3] 1998	Return[3] 1999
			Bu/A		$/A	
1. Roundup Ultra	2.0 pt	MP	195	66	$104.84	$-159.42
+ Roundup Ultra	2.0 pt	MPR				
2. Roundup Ultra	2.0 pt	MP	225	61	166.43	-169.63
+ Roundup Ultra	2.0 pt	ASN				
3. Harness Xtra	4.8 pt	PRE	180	60	78.66	-168.79
4. Harness Xtra	3.4pt	PRE	206	64	133.99	-158.44
+ Roundup Ultra	2.0 pt	MP				
5. Harness Xtra	3.2 pt	PRE	217	72	143.36	-155.63
+ Roundup Ultra	2.0 pt	MP				
6. FieldMaster	8.0 pt	MP	198	84	112.06	-124.17
7. Bicep II	4.8 pt	PRE	188	61	99.46	-163.36
8. Bicep II	4.8 pt	PRE	226	59	160.19	-183.61
+ Exceed	1.0 oz	MP				
9. AAtrex	2.0 pt	PRE	210	56	139.73	-175.75
+ Princep	2.0 pt	PRE				
+ Exceed	1.0 oz	MP				
10. AAtrex	2.0 pt	PRE	218	66	154.13	-158.90
+ Princep	2.0 pt	PRE				
+ Roundup Ultra	2.0 pt	MP				
11. AAtrex	2.0 pt	PRE	202	66	124.65	-154.95
+ Roundup Ultra	2.0 pt	MP				
12. Guardsman	4.5 pt	PRE	192	48	107.45	-188.63
13. Guardsman	4.5 pt	PRE	213	57	144.65	-177.28
+ Banvel	0.25 pt	MP				
LSD (P=0.05)			NS	NS	NS	NS

[1] All postemergent treatments contained adjuvants recommended on the label.
[2] PRE = applied day of planting, ASN = as needed, MP = 2- to 4-inch weeds, REG = 2- to 4-inch weed regrowth.
[3] Return above fixed and variable costs = [yield(bu/A)*$2.06] – [herbicide cost + fixed and variable cost].

Methods

Experiments were conducted in Princeton and Lexington in 1998 and 1999 to evaluate and compare weed control and net returns that resulted from Roundup Ultra and several commonly used herbicide programs. Herbicide applications were made to the soil surface (PRE) the day of planting, to 2- to 4-inch weeds (MP), to 2- to 4-inch weed regrowth (REG), or as needed (ASN) to late emerging weeds. DeKalb 591RR and DeKalb 626RR were planted in late April or early May for all locations in 1998 and 1999, respectively. Plots were 10 feet wide (4 rows) by 30 feet long with four replications.

Weed control was evaluated visually two, four, and eight weeks after application. The plots were hand harvested by collecting 30 linear feet of row and yields adjusted to 15.5 percent moisture. Return above fixed and variable costs was calculated by the formula: [yield (bu/A)*$2.06] – [herbicide cost + fixed and variable cost]. Herbicide costs included cost of the herbicide(s) plus a $6 technology fee for Roundup Ready® treatments and an application charge of $4/A for each herbicide treatment. A value of $264.54/A, for variable and fixed costs, was obtained from the University of Kentucky Department of Agricultural Economics.

Results and Discussion

Several weeds were evaluated at the various study locations including giant foxtail, common lambsquarters, and giant ragweed. Control of these three species exceeded 90 percent for all treatments in both 1998 and 1999 (data not shown). In Lexington, the dominant weeds were entireleaf morningglory and common cocklebur. Data are presented for these weed species due to their common occurrence in Kentucky corn production and because they are difficult to control. For entireleaf morningglory and common cocklebur, control ranged between 66 and 100 percent during both years (Table 1). Sequential Roundup Ultra treatments were highly effective and were not significantly different from the highest control treatment in either year. The choloracetamide + atrazine treatments, not followed by postemergence applications (treatments 3, 7, 12), usually had the least control. Treatments consisting of PRE followed by MP combinations consistently were the most efficacious. For all locations and both years, the ASN treatment was required in the form of a single application to 2- to 4-inch weed regrowth. These data indicate that a single Roundup Ultra application will rarely be sufficient; however, a third application will not be required.

Although significant differences in weed control were detected between treatments, no significant differences were observed in yield or return above fixed and variable costs for any treatment (Table 2). These data clearly demonstrate that 100 percent weed control was not necessary to obtain top yields. It was also readily noticed that a great disparity between yield and net return existed between 1998 and 1999 (Table 2). This was due to the lack of rainfall during the growing season of 1999 that led to low corn yields and negative net return values.

Summary

These results demonstrated that Roundup Ultra could be used alone, or sequentially with other products, to deliver effective and consistent weed control over a range of weed species and environmental conditions. There were no differences in return above fixed and variable costs between Roundup Ultra and any of the other herbicide programs compared in this study. Roundup Ready® technology provides another weed management alternative for Kentucky corn growers.

The two years in which these studies were conducted were very different. Growing conditions in 1998 were excellent for corn production resulting in excellent yields in Lexington and Princeton, while rainfall was lacking at both locations in 1999 and corn yield was reduced greatly. The extremes in growing conditions provided an opportunity to evaluate Roundup Ready® technology under the "best" and "worst" cases that will be encountered in Kentucky. Consistent weed control was obtained with all herbicide treatments in both years.

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Italian Ryegrass Control in No-Till Corn

J.R. Martin

Italian ryegrass (*Lolium multiflorum*) is a cool-season grass that is commonly referred to as annual ryegrass. Grass waterways and field borders are often sown with a seed mixture of Italian ryegrass and tall fescue; consequently, these areas may be a potential source of spreading this weed into grain crop fields, particularly those planted to no-tillage corn. As Italian ryegrass continues to spread, the numbers of complaints about controlling it with burndown herbicides in no-tillage corn increase.

Field trials were conducted in 1997 and 1998 to evaluate and compare the efficacy of different combinations and timings of Gramoxone Extra (paraquat) and Roundup Ultra (glyphosate) applied as burndown herbicide treatments in no-tillage corn. Herbicide treatments included in these studies are listed in Table 1.

Table 1. Italian ryegrass control and corn grain yield following preplant-foliar applications of Gramoxone Extra and Roundup Ultra (Princeton, Kentucky, 1997 and 1998).

			1997		1998	
Chemicals	Rate/A	Timing[a]	Ryegrass Control[b] %	Corn Yield (bu/A)	Ryegrass Control[b] %	Corn Yield (bu/A)
Gramoxone Extra	1.5 pt/A	PRE	18	80.4	67	123.8
Non Ionic Surfactant	0.25%					
Gramoxone Extra	1.5 pt/A	PRE	48	126.1	97	126.2
Non Ionic Surfactant	0.25%					
Atrazine	3 pt/A					
Roundup Ultra	2 pt/A	PRE	63	99.4	93	113
Roundup Ultra	2 pt/A	PRE	68	141.3	90	124.6
Atrazine	3 pt/A					
Roundup Ultra	3 pt/A	PRE	88	129.6	100	123.7
Atrazine	3 pt/A					
Gramoxone Extra	1.5 pt/A	EPP	90	141.6	100	134.9
Non Ionic Surfactant	0.25%					
Gramoxone Extra	1.5 pt/A	PRE				
Non Ionic Surfactant	0.25%					
Atrazine	3 pt/A					
Roundup Ultra	2 pt/A	EPP	90	138.8	100	120.8
Gramoxone Extra	1.5 pt/A	PRE				
Non Ionic Surfactant	0.25%					
Atrazine	3 pt/A					
Non-treated check			------------	-------------	0	98.2
LSD (0.05)			38	NS	18	25.6

[a] Early preplant treatments were applied during mid-April when ryegrass plants were 14 to 22 inches in height. Preemergence treatments were applied approximately three weeks later when ryegrass plants were about 26 to 33 inches tall. Banvel (dicamba) was applied postemergence to all plots for broadleaf weed control.
[b] Visual ratings of Italian ryegrass control were made in mid-June.

Gramoxone Extra applied alone as a single spray at planting provided less than 70 percent control of Italian ryegrass both years. Including atrazine with Gramoxone Extra enhanced control in one out of two years. The results from PRE applications of Roundup Ultra at 2 pt/A, either alone or with atrazine at 3 pt/A, were similar to those observed with PRE applications of Gramoxone Extra. However, increasing the Roundup Ultra rate to 3 pt/A in the mixture with atrazine tended to improve Italian ryegrass control. The use of Gramoxone Extra at 1.5 pt/A or Roundup Ultra at 2 pt/A as an EPP treatment followed by the PRE treatment of Gramoxone Extra at 1.5 pt/A plus atrazine at 3 pt/A provided at least 90 percent control of Italian ryegrass both years.

The fact that no significant differences in corn yield were observed among herbicide treatments indicates that total season-long control of Italian ryegrass is not always crucial to achieving high yields. However, corn stands and yields can be greatly affected if no control measures are implemented.

Summary

These results confirm that achieving control of Italian ryegrass with burndown herbicides can be difficult. Obtaining maximum burndown control of Italian ryegrass in no-tillage corn may require a single spray of Roundup Ultra applied at a minimum rate of 3 pt/A in combination with atrazine or a sequential program of burndown herbicides applied as an early preplant treatment followed by a preemergence treatment.

Impact of Wheat Herbicides on Double-Cropped Soybeans

J.M. Ewing, W.W. Witt, and J.R. Martin

Introduction

Numerous weed species can infest wheat in Kentucky, and several of these are particularly troublesome and can decrease wheat yield. Cheat, hairy chess, and Italian ryegrass are especially troublesome and difficult to control with currently available herbicides. Chickweed, purple deadnettle, henbit, and several mustard species are also problems. Because of the occurrence of these weeds, wheat growers are interested in the evaluation of herbicides labeled for use in wheat. There are several herbicides labeled for wheat in states other than Kentucky, primarily in continuous wheat. Double-cropped soybeans follow essentially all of the wheat grown in Kentucky, and herbicides used for wheat weed control must not persist in soil and cause injury to soybeans.

Objective

Determine if wheat herbicides applied in the fall or spring cause injury to double-cropped soybeans.

Methods

Wheat was planted in October of 1997 and 1998 at Princeton and 1998 at Lexington. After wheat harvest in June of 1998 and 1999, soybeans were planted no-till into the standing wheat stubble. Two soybean varieties were evaluated: AG 4501, an sulfonylurea-tolerant soybean (STS) and AG 4702, a non-STS. Several of the wheat herbicides discussed in this report kill weeds (and crops) by inhibiting the acetolactate synthase enzyme (ALS). STS soybeans were developed because of their tolerance to ALS-inhibiting herbicides, and we were interested in knowing if STS soybeans would be tolerant to these wheat herbicides.

Wheat herbicides were evaluated for double-crop soybean injury at Princeton in 1998 and 1999 and Lexington in 1999. Treatments were applied to actively growing wheat in late November and in mid-March. Soybean injury was evaluated in mid-August, eight weeks after soybean planting. Listed in the following table are products evaluated in these studies:

Herbicide	Rate	Active Ingredients
Harmony Extra75 DF	0.6 oz/A	*thfensulfuron & *tribenuron
Peak 57 WDG	0.75 oz/A	*prosulfuron
Ally 60 DF	0.1 oz/A	*metsulfuron
Maverick 75 WSG	0.5 oz/A	*sulfosulfuron
Assert 2.5 E	1.5 pt/A	*imazamethabenz
Sencor 75 DF	3 oz/A	metribuzin
Curtail 2.38 E	2.5 pt/A	clopyralid + 2,4-D

* ALS-inhibiting herbicides

Results

Soybean Injury. No injury was noted in 1998 to either soybean variety from fall or spring applications of the herbicides (Table 1). Rainfall was below normal from the time of wheat planting and fall herbicide applications, until the spring herbicide applications in 1998. However, 22 inches of rainfall were received on the plots in April, May, and June. This excessive rainfall probably contributed to a more rapid herbicide loss in the spring. Substantial soybean injury was noted in 1999 at Princeton and Lexington (Table 1). Rainfall from the time of wheat planting until the spring herbicide treatments was near normal at Princeton and slightly below normal at Lexington.

Peak and Maverick caused the greatest injury in Princeton with fall and spring treatments on the non-STS variety, with the spring treatment having greater injury. However, the STS variety exhibited much less injury from Peak and Maverick. Ally applied in the fall caused 10 percent injury to the non-STS and 3 percent injury to the STS variety at Princeton. A similar response was noted with the fall treatment of Maverick to the STS variety. Assert , Harmony Extra, and Sencor caused little, if any, injury at Princeton. The spring treatment of Peak produced the greatest injury to the non-STS variety at Lexington. Maverick injury was less at Lexington compared to Princeton for the non-STS variety. Less injury was noted at both locations with the STS variety for Harmony Extra, Peak, Ally, Maverick, and Assert.

Although Curtail is not an ALS-inhibiting herbicide, it did cause injury to double-cropped soybeans at Princeton with the spring treatment and the fall and spring treatment at Lexington. The clopyralid component of Curtail is believed to have persisted in soil and caused injury to the double-cropped soybeans.

Soybean Yield. Over all locations, soybean yield was low (Table 2). Rainfall at Princeton in 1998 was very limiting during the soybean growing season, although soil moisture was excellent at the time of planting. Soybean yield in 1999 at Princeton was low and averaged about 12 bushels per acre and was attributed to the low rainfall received during the soybean growing season. The plots at Lexington were not harvested. These soybeans never produced pods with seeds, due to the severe lack of water at this location. It was difficult to draw conclusions from these yield data because of the relatively low, to very low, yields; however, the greatest soybean injury was noted in 1999 with a spring treatment of Maverick, and this treatment produced the lowest yield (Table 2). Curtail injury also reduced yield in 1999. Yield was generally greater with the STS variety compared to the non-STS variety in 1999.

Summary

This research shows the importance of following label restrictions regarding rotational crops. Some of the wheat herbicides in these studies persisted in the soil and caused injury to double-cropped soybeans during a year when the amount of rainfall was below normal. The magnitude and risk of soybean injury from

most ALS-inhibiting herbicides in this study tended to be greater for spring applications compared with fall applications. The STS variety used in these studies exhibited less soybean injury than the non-STS variety. This response is encouraging because it might allow for the use of some herbicides for wheat weed control that could not be used. However, additional research under more "normal" climatic conditions is needed.

Table 1. Soybean injury of non-STS and STS varieties at Princeton in 1998 and 1999 and Lexington in 1999. Soybean injury was evaluated in mid-August of each year.

		Percent Soybean Injury					
		Princeton 98		Princeton 99		Lexington 99	
Herbicide	**Timing**	**Non-STS**	**STS**	**Non-STS**	**STS**	**Non-STS**	**STS**
Harmony Extra	Fall	0	0	3	0	0	0
Harmony Extra	Spring	0	0	0	0	0	0
Peak	Fall	0	0	10	0	7	0
Peak	Spring	0	0	23	3	40	0
Ally	Fall	0	0	10	3	0	0
Ally	Spring	0	0	3	0	3	0
Maverick	Fall	0	0	13	7	0	0
Maverick	Spring	0	0	47	0	13	0
Assert	Fall	0	0	0	0	10	0
Assert	Spring	0	0	3	3	7	7
Sencor	Fall	0	0	0	0	0	0
Sencor	Spring	0	0	0	0	13	0
Curtail	Fall	0	0	0	0	10	0
Curtail	Spring	0	0	23	10	13	3
	LSD (0.05)	NS	NS	22	8	15	6

Table 2. Soybean yield of non-STS and STS varieties at Princeton in 1998 and 1999.

		Soybean Yield (bu/A)			
		Princeton 98		Princeton 99	
Herbicide	**Timing**	**Non-STS**	**STS**	**Non-STS**	**STS**
Harmony Extra	Fall	15	19	12	13
Harmony Extra	Spring	18	17	13	13
Peak	Fall	18	18	12	18
Peak	Spring	13	26	13	16
Ally	Fall	16	18	12	13
Ally	Spring	26	21	10	12
Maverick	Fall	28	22	14	14
Maverick	Spring	17	23	7	12
Assert	Fall	18	15	14	12
Assert	Spring	17	15	11	13
Sencor	Fall	25	19	15	15
Sencor	Spring	25	23	13	15
Curtail	Fall	24	24	13	14
Curtail	Spring	26	22	9	14
	LSD (0.05)	NS	NS	NS	NS

Tobacco Breeding and Genetics

R.D. Miller, B.S. Kennedy, and E.L. Ritchey

The University of Kentucky and the University of Tennessee have merged their tobacco breeding programs to form the Kentucky-Tennessee Tobacco Improvement Initiative. The main objective of both breeding programs has been the development of tobacco varieties that have significantly higher levels of black shank resistance, combined with improved yield potential. Recent burley releases include KY 8959, KY 907, KY 908, and KY 910 from Kentucky and TN 86, TN 90, and TN 97 from Tennessee; dark variety releases include KY 190, TN D94, and TN D950. The merged program combines the strengths of the existing genetic engineering program at the University of Kentucky with the traditional tobacco breeding program at the University of Tennessee. The joint venture will allow enhanced efforts in developing new resistant burley and dark tobacco varieties.

Black Shank Resistance

Development of varieties with increased resistance to black shank, the most devastating disease of burley tobacco, will continue to be a primary objective of the new initiative. Several breeding lines currently being evaluated have displayed medium to high black shank resistance. These lines may be released as new varieties or used to produce improved tobacco hybrids. Lines containing the L8 black shank gene, previously developed at the University of Kentucky, will be crossed with Tennessee lines having resistance genes from the flue-cured variety Coker 371 Gold. This will produce hybrids that have resistance genes derived from Florida 301, L8, and Coker 301. These new hybrid varieties should do a much better job of controlling black shank than existing varieties, particularly in fields that contain a mixed population of race 0 and race 1 black shank.

Blue Mold Resistance

A new emphasis on incorporating blue mold resistance into existing varieties will also be an integral part of the new initiative. Because of the lack of a phytotron (which is necessary to safely contain the pathogen) at either the University of Tennessee or the University of Kentucky, breeding for blue mold resistance has been impractical due to the inherent risk of causing a widespread epidemic throughout the tobacco-producing region. The successful development of blue mold resistant tobacco varieties will require offshore breeding nurseries, which have been established in Guatemala and Mexico. Since blue mold generally occurs throughout Central America each year, establishment of nurseries in these countries will increase the probability of having significant blue mold pressure to screen for resistance in breeding materials.

Fusarium Wilt Resistance

The incidence of Fusarium wilt in Kentucky tobacco crops is increasing each year. The disease, caused by a soilborne fungus, has been only a minor problem for burley growers for decades due to the widespread planting of disease-resistant varieties. However, the majority of varieties planted today have not been thoroughly evaluated for resistance to this disease; many appear to have little or no resistance to Fusarium wilt. Commercial burley varieties will be screened during 2000-2001 to give growers more information about cultivar susceptibility. Germplasm and breeding materials are also being screened for resistance to the disease. Resistant germplasm will be used to incorporate fusarium wilt resistance into existing varieties. However, it will be several years before new resistant varieties will be available.

Release of KT 200

KT 200, a new black shank resistant burley hybrid, was released by the Kentucky-Tennessee Tobacco Improvement Initiative in April 2000. Black shank is prevalent throughout the burley-producing region of the United States and is responsible for millions of dollars in lost profits for tobacco farmers. The disease is becoming more widespread throughout Kentucky each year. Burley varieties are rated for black shank resistance on a scale of 0 to 10, with higher values indicating better resistance. At the present time, only three varieties have a resistance rating of 6 for both races of black shank. All three varieties have a yield potential rating of 3 or less, on a 10-point scale and are susceptible to tobacco etch (TEV) and tobacco vein mottling virus (TVMV). TN 90, TN 86, and KY 910 have a race 1 black shank resistance rating of 4, while TN 97 has a rating of 5. KT 200 has a resistance rating of 6, and data collected in numerous trials suggest that a yield rating of 6 is appropriate. In addition to black shank resistance, KT 200 has high resistance to black root rot, wildfire, tobacco mosaic virus, tobacco vein mottling virus, and tobacco etch virus. The release of KT 200 should provide a burley variety with good resistance to black shank, combined with good yield potential and resistance to TVMV and TEV.

KT 200 is a late-maturing variety, flowering approximately five days later than TN 90 and 14 days later than MS KY 14 X L8. KT 200 is not significantly different from TN 90 for plant height, leaf number, or leaf size. The growth habit of KT 200 is semi-upright, similar to TN 90. Although the plant is very compact during early growth, it grows rapidly as it approaches flowering and is large at harvest. Leaf color is darker green than standard burley varieties. KT 200 produces cured leaf that is medium-bodied and is tan to reddish-tan under normal curing conditions. Because KT 200 has produced variegated tips under poor curing conditions and has shown a tendency to sunburn more quickly than check varieties in some test plots, it is not recommended for production in fields where black shank is not a potential problem.

KT 200 was compared with standard burley varieties in nine trials from 1996 through 1999 (Table 1). In the absence of black shank, it has yielded as well or better than other black shank resistant varieties but not as well as susceptible varieties such as

Hybrid 403. Although the grade index (which is indicative of cured leaf quality) of KT 200 has been substantially lower than standard varieties under some curing conditions, the mean grade index over six trials was comparable to KY 17, KY 14, and Hybrid 403. KT 200 was also evaluated as GR 171 at seven locations in Kentucky, Tennessee, Virginia, and North Carolina as part of the 1997 Regional Variety Test. The average per acre yield of KT 200 was 68 pounds higher than KY 14 and 342 pounds higher than VA 509. The average grade index of KT 200 was four points lower than KY 14 and 12 points lower than VA 509. The performance of KT 200 was relatively consistent in all states participating in the Regional Test Program, indicating that it is well adapted throughout the burley region. Based on data from the Regional Test and Tennessee and Kentucky variety trials, KT 200 has been assigned a yield rating of 6; however, this rating may change as more data are obtained.

KT 200 has consistently performed better than standard black shank-resistant varieties when evaluated under disease pressure (Table 2). This is particularly true when Ridomil is not used to help control black shank. Percentage of survival of KT 200 has been equal to or better than KY 17, which is presently one of the burley varieties with the highest level of resistance. In four-year comparisons without Ridomil, KT 200 yielded 2,197 lb/A, compared to 1,301 for TN 90 and 1,671 for TN 97. In two years of comparison with KY 17, KT 200 averaged 2,418 lb/A without Ridomil, versus 1,838 for KY 17. KY 17 has a black shank resistance rating of 6, TN 97 has a rating of 5, and TN 90 has a rating of 4. Based on the available data, KT 200 has been given an initial black shank-resistance rating of 6.

Table 1. Yield and quality of KT 200 and selected burley varieties*

Variety	Yield (lbs/A)	Grade Index**
KT 200	3168	58
TN 90	3065	62
TN 86	3098	67
TN 97	3141	63
KY 17	2927	58
VA 509	3191	66
KY 14	3177	57
Hybrid 403	3413	60

* Average values for nine trials conducted in Tennessee and Kentucky from 1996 through 1999; all trials were free from black shank.
** A numerical indicator of quality based on federal grades; higher values indicate better quality.

Table 2. Comparative black shank resistance of KT 200 and selected burley varieties.

	Percent Black Shank Survival		Yield (lbs/A)	
Variety	No Ridomil	Ridomil*	No Ridomil	Ridomil*
1996 through 1999				
KT 200	80	95	2197	2860
TN 90	50	91	1301	2605
TN 97	65	92	1671	2744
1997 and 1998				
KT 200	74	96	1976	2973
TN 86	52	87	1386	2431
VA 509	50	92	1182	2688
1996 and 1999				
KT 200	86	94	2418	2747
KY 17	79	93	1838	2477

*Ridomil Gold: 1 pt/A pretransplant, plus 1 pt/A at first cultivation, plus 1 pt/A at layby.

Regional Burley Tobacco Variety Test

J.R. Calvert, B.S. Kennedy, and R.D. Miller

For more than 20 years, advanced experimental breeding lines of burley tobacco have been grown at multiple sites as part of a cooperative testing program involving university-based researchers at Kentucky, Tennessee, North Carolina, and Virginia. Data and cured leaf have been collected annually from at least seven (and in some years as many as 11) field sites since the testing program began in 1978. Advanced breeding lines from public agencies and commercial companies are accepted for testing by the Regional Burley Variety Evaluation Committee. In Kentucky, test plots are grown at three locations each year, on the University of Kentucky Experiment Station Farms at Lexington, Woodford County, and Eden Shale Farm in Owen County.

Agronomic traits, including yield, plant type, leaf quality, and disease resistances, are determined for each entry. To be acceptable for release as a new variety, a test entry must compare favorably to two standard or "check" varieties. Because burley tobacco has value only as a component of cigarettes, it is essential that tobacco-product manufacturing companies evaluate and approve new breeding lines before they are made available to burley producers. Therefore, four to six major cigarette manufacturing companies participate in leaf quality evaluations and receive small quantities of leaf from all test plot entries and locations. The sample leaves are made into cigarettes and are smoked by company test panels to determine if the breeding lines exhibit normal burley tobacco characteristics. Burley breeding lines that diverge significantly from check varieties for certain chemical constituents and/or smoke flavor are automatically rejected and are not recommended for release. In the recent past, all new burley varieties being offered for sale have been tested and approved by the regional committee.

In 1999, 11 advanced burley breeding lines were tested. Eight passed minimal standards established by the committee. Twelve burley breeding lines are being evaluated in the 2000 Regional Quality test. Additionally, 16 burley breeding lines are undergoing preliminary testing.

Maleic Hydrazide (MH) Residues in Burley Tobacco

G. Palmer and R. Pearce

Maleic hydrazide (MH) residue in burley tobacco has been an issue since the chemical was introduced. Considerable research and education efforts continue to attempt to find ways to improve the residue levels in cured leaf. Over the last five years a new approach to sucker control offered growers improved sucker control and higher yields while reducing residue. The program is a two-phase approach targeting application technique and chemical selection. The change in application technique is away from fine spray nozzles to a coarse spray that creates larger droplets that hit the leaf and roll to the stalk where they contact the suckers directly. The chemical change is a reduction of MH from 2 to 1.5 gal/A and the addition of either Prime+ or Butralin at 0.5 gal/A. Although producers praise the improved sucker control and have noticed increases in yield, the question remains as to the effects on MH residue.

Table 1. Average MH residue from the burley belt.

Year	KY	IN	MO	NC	OH	TN	VA	WV	Other	All
1997	71.21	112.35	70.10	5.01	69.36	57.32	17.95	0	98.37	65.04
1998	79.47	37.89	61.75	11.00	59.38	48.48	16.56		26.33	69.66
1999	80.13	95.89	78.80	21.80	53.13	45.07	36.00	15.00		71.54

Table 2. Frequency of distribution of MH residue levels in ppm in Kentucky.

	ppm MH											
Year	0	1-40	41-80	81-120	121-160	161-200	201-240	240-300	301-400	401-500	501-600	601-700
1997	16	48	56	39	20	7	1	3				
1998	29	75	82	38	20	7	11	4	6	0	2	1
1999	40	52	70	58	14	12	3	5	5	0	2	

To try to answer this question, samples were collected in 1997, 1998, and 1999 by the Burley Tobacco Growers' Cooperative Association and analyzed for MH residue. These years can be categorized in terms of difficulty of sucker control as moderate, difficult, and very difficult, respectively. Samples were collected randomly from all burley tobacco warehouses. A total of 300, 378, and 381 samples were collected over the three-year period. These samples included tobacco from 11 states in 1997, 10 in 1998, and eight in 1999. Of the total samples, Kentucky produced the following percentages over the three years: 63.3, 72.8, and 72.2. Tennessee produced 21.0, 15.3, and 14.7. These figures loosely represent the percentages grown in these states.

Although average MH residues increased over the three years, they did not reach levels seen in previous years when weather factors created difficult conditions for sucker control (Table 1).

A residue level of 80 ppm is considered a target level with some countries requiring less on finished products. For this reason a distribution of MH residue levels may be more meaningful than average levels (Table 2). Although there are a few samples that indicated overapplication, especially in 1998 and 1999, the trend indicates a shift of most samples into the 0, 1-40, and 41-80 ppm ranges. Therefore, more producers must be making changes that have shifted the MH residues to levels that are more acceptable. The control difficulties associated with weather problems in both 1998 and 1999 are indicated by those outliers in the 301-700 ppm range. No samples were found to contain these levels in 1997. The high levels are an indication of poor control that producers tried to remedy by overapplication and/or high application rates. The tobacco was most likely harvested within a short time frame of the last application. A switch to coarse nozzles and a combination of MH and Prime+ or Butralin would have most likely produced good sucker control under poor weather conditions while reducing these astronomical residues to more acceptable levels.

Effects of Foliar Fertilization on Dark Tobacco Yield and Value

B. Maksymowicz

The use of foliar fertilizers in tobacco production has increased significantly in recent years. While there is little data to support the benefits of foliar fertilizers if soil pH and fertilizer recommendations are followed, there is a perception by many growers that benefits of foliar feeding programs far outweigh the costs.

Small plot studies were initiated at the University of Kentucky Research and Education Center in Princeton in 1999 to study the response of dark fired tobacco to a basic foliar fertilization program. The results reported do not imply that other programs or application timings would give similar results. The foliar fertilization programs currently being used are too numerous to fairly evaluate in one growing season.

Two treatments were compared: a dry fertilizer program formulated according to soil test recommendations and the same program with five supplemental foliar applications of 7-14-14 liquid fertilizer applied in 50 gallons of water per acre. The variety used was Narrow Leaf Madole. Each plot was 3,000 sq ft and treatments were replicated four times. All plots received 300 units of nitrogen, as ammonium nitrate, applied pre-transplant.

Soil Test Recommendations	Dry Fertilizer Application (preplant)
32 lb/A phosphorous	15 lb/A phosphorous
241 lb/A potassium	250 lb/A potassium
pH: 6.5	250 lb/A pelleted lime

Dry fertilizer was applied on May 15. Tobacco was transplanted on May 19, and the foliar fertilizer applications were made on June 24, July 9, July 16, July 23, and August 1.

All pesticide and sucker control recommendations were made according to recommendations.

Results

Sixty sticks per plot were harvested. Tobacco was cured and stripped into three grades.

	Yield (lb/A)	
Leaf Grade	Dry Fertilizer Only	Dry + Foliar Fertilizer
Lugs	406	444
Seconds	866	795
Leaf	1410	1245
Total	2682	2484

Statistical analysis showed no differences between grades or total yield.

Observationally, the plots receiving the foliar treatments appeared “greener” and “healthier” during the course of the growing season, but the above data show that visual appearance in the field does not always translate into increased returns.

These studies will be expanded as a part of a cooperative effort between the University of Kentucky and the University of Tennessee to further evaluate the responses of dark tobaccos to foliar fertilizer programs.

No-Till Wheat

L.W. Murdock, J.H. Herbek, J.R. Martin, and J. James

No-till wheat production has been practiced in Kentucky for many years. Currently, between 25 and 30 percent of the wheat acres in Kentucky are no-till planted. Many farmers remain skeptical of the practice and feel significant yield is sacrificed with the practice.

Previous research in the 1980s by the University of Kentucky showed favorable results. With these conflicting reports and experiences, the Kentucky Small Grain Growers Association entered into a cooperative effort with the University of Kentucky to take an intensive look into no-till wheat.

Research Approach

A replicated trial was established on a Huntington silt loam soil at Princeton, Kentucky, in the fall of 1992. Two small adjacent fields were placed in a three-crop, two-year rotation of corn, wheat, and double-cropped soybeans. Both no-till and conventionally tilled (chisel-disk) wheat were planted and compared with different nitrogen, fungicide, and herbicide treatments. The corn and double-cropped soybean crops were planted no-till. Stand counts, weed control ratings, disease, and insecticide ratings, as well as yield and compaction results, were obtained for wheat. The long-term effects of the two different wheat tillage practices on the succeeding soybean and corn crops and on soil changes were also measured and are included in another report.

Results

Seven years of results (1993-99) are presented in this report.

Yields. The seven-year average yields have been high (Table 1). The conventional till-planted wheat averaged about 5 bu/A more than the no-till wheat. The yields of no-till wheat have been significantly lower than wheat planted with tillage three of the seven years, due to compaction one year (1993) and freeze damage in 1996 and 1998. The yields of no-till wheat have been similar or exceeded that of conventionally tilled wheat the other four years.

Stands. The number of emerged plants was lower with no-till. Planting at the rate of 32 viable seeds/sq ft, the final stands averaged 26 and 29 plants/sq ft for no-till and conventional till, respectively. Both stands were high enough for maximum yields. Seeding rates may need to be increased by 10 percent as one moves from conventional till to no-till seeding.

Nitrogen Rates. No-till wheat may require more nitrogen than conventional-tilled wheat. Nitrogen in this trial was managed for intensive production with one-third applied at Feekes stage 3 (February) and the remainder at Feekes stage 5 (mid-March). The no-till wheat sometimes appeared to be slightly nitrogen deficient before the second application, but in most years this had little effect on yield. Increasing the nitrogen rate from 90 to 120 lb/A had only a small effect on yield for the seven years (Table 1). Although more nitrogen is recommended for no-till plantings, it may not always be justified. The years that the high rate of nitrogen resulted in higher yields were when late winter freezes resulted in wheat damage and when excessive amounts of rain fell after the first application of spring nitrogen.

Table 1. Summary of seven-year wheat results (1993-99).

Treatment Comparison	Yield (bu/A)	Wheat Stands (plants/sq ft)
Tillage Effect		
Conventional	93	26
No-Till	88	29
Nitrogen Rate (lb/A)		
No-Till (90)	86	
No-Till (120)	88	
Conventional (90)	91	
Conventional (120)	93	
Weed Control		
No-Till Fall Gramoxone + Spring Harmony Extra	90	
No-Till Fall Harmony Extra	90	
No-Till Spring Harmony Extra	88	
No-Till Check	77	

Weed Control. Good weed control was obtained in no-till wheat by three treatments: 1) Harmony Extra applied in the fall, 2) a contact herbicide at planting plus Harmony Extra in the spring, and 3) Harmony Extra in the spring (Table 1). Yields were equivalent for all three herbicide treatments. Wild garlic, which is sometimes associated with no-till wheat, was not a significant problem when Harmony was used. Without fall or spring herbicides, weed competition was a problem (especially with common chickweed and henbit) and resulted in lower yields (no-till check).

Nitrogen Application Time. The last four years (1996 and 1999) have included treatments with different rates of nitrogen applied at different times. The first two years, the highest yield has been obtained with a 120 lb/A nitrogen rate, with half of the nitrogen applied in February and the remaining half applied in late March just prior to jointing. The last two years there has been no effect related to time of nitrogen application.

Fungicides. Preventative disease control applications of fungicides were managed for intensive production. A control treatment receiving no fungicide treatment was included the first five years of the study in both tillage systems. Diseases that can be controlled by a fungicide were of no significance during the five years of this study. Therefore, fungicide applications had little effect on either tillage system (data not shown).

Insects. Insects were monitored by use of scouting and traps. No significant insect infestations occurred. A few aphids, true army worms, and cereal leaf beetles were present but never approached the economic threshold. The wheat seed was treated with Gaucho before planting for Barley Yellow Dwarf protection from 1993 through 1996, and all treatments have received a fall foliar insecticide after 1996. In the first year, Barley Yellow Dwarf was present and was vectored by a small number of aphids.

Diseases. There was no significant disease on any treatments during the seven years except for Barley Yellow Dwarf during the first year. This is consistent with no yield increases from the use of fungicides found during the first five years. Also, head scab, which is sometimes associated with no-till, was practically absent. The Barley Yellow Dwarf Virus symptoms were significantly higher in the no-till treatments the first year of the trial (1993). This was probably one of the factors that reduced yields in the no-till plots that year.

Soil Compaction. Corn harvest on a wet soil prior to wheat planting left a compacted and depressed zone in each plot the first year (1993). This was removed with tillage in the conventionally tilled wheat but caused decreased yields in the no-till planted wheat. There has been no evidence of its continued effect after the first year.

Summary

No-till wheat can produce as well as conventionally tilled wheat when properly managed. Stand establishment and weed control appear to be where the greatest changes in management are necessary.

Making No-Till Wheat Production Profitable: On-Farm Testing

L.J. Grabau, J.H. Grove, and C.C. Steele, University of Kentucky; P. Needham (Opti-Crop); D.S. Jones and K.S. Van Sickle (Wheat Tech)

In 1997, the Kentucky Small Grain Growers Association established the goal of having 75 percent of the state's wheat acreage managed using no-till methods by the year 2005. Before that dramatic change can occur, producers must be convinced that they will not have to sacrifice short-term economic viability in order to gain the long-term benefits of topsoil conservation attainable using no-till methods. Hence, this project's goal was to compare some tillage (ST) and no-tillage (NT) wheat-production systems, both under intensive management, for profitability.

Table 1 compares the two tillage systems. Yields, on average across the seven tests, were 3.0 bu/A higher for ST, resulting in $8.60 greater value per acre. Tillage and stalk chopping cost an average of $25/A for ST, while extra seed, herbicide, and N fertility cost an average of $14.80/A for NT. On the whole, this resulted in a slight economic advantage ($1.60/A) for NT methods.

The footnotes for Table 1 discuss some assumptions made in this analysis. Most importantly, no dollar benefit was assigned to the topsoil saved by NT methods. Of course, another year's data could dramatically change the above profit comparison. Market price changes could help to some extent; for example, if the market price had been $4/bu across the 1998 and 1999 seasons, the comparison would have shown a $1.80 advantage for ST.

We plan to repeat this study at four locations in the 1999-2000 growing season to assess this tillage comparison under different environmental conditions. To this point, our results appear to provide some incentive for growers to consider moving toward a no-till system. However, we do note this caution: The previously funded on-farm tillage comparisons in the 1996-97 growing season resulted in an average of 65 bu/A for ST and 58 bu/A for NT. These grower-managed tests produced 12 percent less grain under NT management, while our 1997-99 consultant- (or researcher-) managed tests only produced 4 percent less grain under NT management. It appears that no-till may respond to more careful management than some growers have been willing to implement.

Based on our work to this point, it looks as if the slight yield loss for NT wheat production is more than covered by the savings producers would have in tillage costs. We are planning to continue this work for the 1999-2000 wheat production season.

Table 1. Economic summary of on-farm tillage comparisons funded by KySGGA/KySGPB in 1997 through 1999.

		ST Advantage		Additional ST Costs		Additional NT Costs			
Test	Managed by	Yield (bu/A)	Value	Residue Mgmt	Tillage	Seed	Herbicide	N Fertility	Net ST Benefit
			$/A						
1998 Daviess	OC	+0.2	+0.6	6	22	0.9	15	0	-11.5
1998 Fayette	UK	+4.9	+14.2	0	22	9.1	0	5.6	+6.9
1998 Logan	WT	+6.1	+17.7	0	22	10.7	0	0	+6.4
1999 Caldwell	UK	+5.6	+15.7	6	25	4.4	0	3.2	-7.7
1999 Daviess	OC	-3.7	-10.4	6	22	5.8	15	0	-17.6
1999 Fayette	UK	+1.5	+4.2	0	22	7.1	2.2	4.2	-4.3
1999 Logan	WT	+6.4	+17.9	0	22	12.4	7.9	0	+16.2
Means	UK/OC/WT	+3.0	+8.6	2.6	22.4	7.2	5.7	1.9	-1.6

Notes and Assumptions for Table 1

1. Abbreviations: ST, some tillage; NT, no-tillage; OC, Miles Opti-Crop; UK, University of Kentucky; and WT, Wheat Tech.
2. Expenses that were in common were not considered in this analysis, as the goal of the project was to compare economic advantages of the two tillage systems.
3. No economic credit was given for the long-term economic advantage likely to result from use of no-tillage methods (through the conservation of topsoil).
4. No economic credit was given for the potential benefits of no-tillage methods to rotated corn and soybean crops.
5. We assumed that neither test weight nor harvest moisture was influenced by tillage system.
6. Both ST and NT were managed to optimize their profitability rather than to obtain the highest possible yields.
7. Specific practices employed (for example, the type and number of tillage passes) at test locations are available from the author.
8. Each location included two varieties and two replications. Calculated yield differences between tillage systems are assumed to represent real differences.
9. In five of the above tests, the later maturing variety produced higher yields than did the earlier maturing variety (within a given location). Rather than picking the better variety to paint this economic collage, we averaged across the two (to make our conclusions more supportable).
10. These data should be interpreted with some caution, as environmental conditions in coming seasons could clearly affect the outcomes of the two tillage systems. (However, some management considerations may have already helped buffer NT wheat from winterkill; for example, none of these seven tests were planted in early October, and that may have helped account for the similar survival of most NT tillers in the face of a severe spring freeze in early March 1998.)
11. In 1998, we used a market price of $2.90/bu. The income deficiency payment for 1999 tests brought the value of the 1999 crop to $2.80/bu.
12. No adjustments were made for differing speed of operations; for example, ST was not penalized for slightly slower combining, nor was NT penalized for slower speeds while drilling the crop.

Nitrogen Management for No-Tillage Wheat Following Corn or Full-Season Soybean

J.H. Grove

The objective of this research is to determine whether the optimal N fertilizer rate for no-tillage wheat will be different among several fertilizer N sources or due to the residues of the previous crop. No-till wheat was grown after both full-season soybean and corn. The fertilizer N sources were urea, ammonium nitrate, and urea-ammonium nitrate solution (UAN). The UAN was applied with either broadcast or "stream jet" nozzles.

The experiment was located at the Spindletop experimental farm, located outside Lexington, Kentucky. The soil was a Loradale silt loam, which is a well-drained soil high in organic matter and general fertility (Mollisol). The wheat (cv. Pioneer 2540) was seeded in the fall of both 1997 and 1998 at a rate of 40 seeds per square foot using a Lilliston 9680 no-till drill. A burndown herbicide was applied prior to planting both corn and soybean. The fertilizer N sources were applied at rates ranging from 0 to 135 pounds of N per acre. The N was all applied in the spring and was split into two applications (33 percent at greenup and 67 percent just prior to formation of the first node). Fungicides were applied to control fungal diseases each year. The grain was harvested in late June of both 1998 and 1999.

Yield trends were similar for both 1998 and 1999, but yields were greater in 1999 because of an earlier fall planting date and better seasonal conditions. In 1999, fertilizer N addition and soybean, as opposed to corn, as a previous crop (Table 1) positively influenced yield. Wheat following soybean averaged 11 bu/A greater yield than wheat following corn in this year of the study. Averaged across all N rates, and regardless of previous crop, little difference due to N source management was observed. The optimal N rate was little affected by N source management but was strongly related to the previous crop. The optimal fertilizer N rate was about 27 pounds N/A for wheat following soybean and 81 pounds N/A for wheat following corn. UAN solution application management, whether broadcast or streamjet, had little effect on the yield results for wheat grown in the two rotations.

The results suggest that wheat producers need not worry about differential performance among N sources for winter wheat production. Their first consideration should be the N source price per pound of actual N. Their second priority should be to do a good job of fertilizer application, minimizing any skips or overlapping areas within their fields.

It is clear that wheat following soybean gave superior yields than that following corn, although the mechanism for this is not clear. Certainly, the greater amounts of corn residue hinder crop establishment and slow crop development. Higher levels of fertilizer nitrogen were needed to raise optimal yields of wheat following corn, but improved N nutrition was not sufficient to eliminate the yield gap between wheat yields in the two rotations.

Table 1. Effect of previous crop, N source management, and N rate on yield of no-tillage wheat in 1999.

Previous Crop	Fertilizer N Rate lb N/A	Wheat Yield - by N Source Management (bu/A) UAN Streamjet	Urea Broadcast	AN Broadcast	UAN Broadcast	N Source Average (bu/A)
corn	0	49.2	47.6	56.2	46.0	49.8
	27	55.8	60.9	53.0	60.4	57.5
	54	62.1	66.8	57.0	58.7	61.2
	81	60.3	67.2	65.1	64.4	64.3
	108	65.9	60.7	55.5	58.5	60.1
	135	61.1	56.3	63.2	57.3	59.5
	Average	59.1	59.9	58.4	57.5	58.7
soybean	0	66.6	65.6	65.3	65.8	65.8
	27	72.7	73.0	67.3	69.2	70.6
	54	72.9	67.4	68.0	75.8	71.0
	81	71.9	73.7	67.5	72.3	71.4
	108	72.7	71.8	68.9	72.1	71.4
	135	73.3	66.8	68.4	67.4	69.0
	Average	71.7	69.7	67.6	70.4	69.9

No-Tillage Wheat—Long-Term Effects

L. Murdock, J. Herbek, J. Martin, J. James, and D. Call

Objective

The objective of this experiment was to verify the effects of no-till wheat and tilled wheat on the subsequent yield of soybeans and corn planted after wheat in a wheat, double-cropped soybean and corn rotation and measure differences in fertility and physical effects on the soil on a long-term basis.

Methods

The experiment is at Princeton, Kentucky, on a Pembroke silt loam soil that is moderately well drained. Wheat was planted no-tilled and with tillage, and the tillage plots were chisel plowed and disked twice. The plots were 10 ft x 30 ft. The soil test was pH - 6.0, P - 39, and K - 247, and 0-60-30 lb/A of N-P_2O_5-K_2O was applied before planting. Soybeans are planted no-till immediately after wheat harvest, and no-till corn is planted the following year, and wheat (tilled and no-tilled) is again planted after corn harvest.

Results

Yields of Succeeding Crops. The data (Table 1) indicate that both no-till corn and no-till soybeans tend to yield more (3.3 percent for soybeans and 8.6 percent for corn) where the wheat is planted no-till. However, the differences are not always statistically significant, but the trend has remained consistent since the second year of the experiment.

These yield differences indicate that changes between the two systems have taken place with time, and the changes favor the system that has only no-tillage plantings in it. The reason for the difference is not clear at this time but might include residue cover, soil moisture, soil physical changes, or others.

Soil Changes. The amount of soil organic matter found in the two systems was very similar. There is also no difference in the soil test pH, phosphorus, or potassium between the two systems. The total no-tillage system has 0.24 percent more organic matter in the top 3 inches of the soil than the one with tilled wheat.

Table 1. Effect of wheat tillage systems on the yield of succeeding crops.

Year	Wheat Tillage System (bu/A) No-Till	Conventional
Soybeans		
1999	14.9	15.4 N.S.*
1998	16.5	15.8 N.S.
1997	45.1	42.7 N.S.
1996	54.5	50.8 N.S.
1995	24.4	22.2 N.S.
1994	49.5	51.6 **
Average	34.2	33.1
Corn		
1999	196.0	165.7 **
1998	203.7	190.2 **
1997	211.9	199.3 **
1996	Harvest Data Lost	
1995	186.0	191.0 N.S.
1994	206.0	178.0 **
Average	200.7	184.8

* N.S. means no significantly statistical differences.
** Statistically different at the 0.1% level.

There was also no difference in the soil density between the systems. This indicates that there was no compaction of significance in either system. The soil strength, as indicated by penetrometer measurements, was higher in the exclusively no-tillage system. This indicates that the soil structure has changed and probably has larger aggregates than the system that is tilled every second year for wheat planting.

Moisture measurements taken during the 1999 growing season on the no-till corn found more moisture available for plant growth in the treatments where tillage was not used for wheat. This resulted in an 18 percent higher grain yield for these plots.

Summary and Conclusions

A true no-tillage system seems to have a favorable effect on the crops grown on the yields of soybeans and corn. When no-till wheat was grown, the no-till corn and soybeans had 8.6 percent and 3.3 percent greater yields, respectively, than when these crops were grown after tilled wheat. The changes that are taking place are unclear at this time, but it appears that they result in more plant-available moisture for these crops. Research is continuing to try to better understand the differences.

Comparative Performance of Wheat Varieties in No-Till and Conventional-Till Trials

C. Tutt, S. Swanson, and D. Van Sanford

Research Objective

To determine whether wheat varieties that are superior under conventional tillage are also superior under no-tillage.

Location	Harvest Year	Cooperator	Previous Crop	Conventional Tillage	Stubble Condition (No-Till)	Planting Date
Logan County	1998	W. G. Farms	Corn	Disk-ripper, disk, cultipacker	Flail-mowed	10/8/97
Caldwell County	1999	Gilkey Farms	Corn	Disk-ripper, disk, cultipacker	Flail-mowed	10/9/98
Shelby County	1998-99	Ellis Farms	Corn	Chisel plow, disk	Standing	10/1/97; 10/12/98

Methods

Entries consisted of 46 commercial and public soft red winter wheat varieties in 1998 and 43 in 1999. Twenty-eight varieties were common to both years. Each variety was replicated four times at each location in both years. Conventional tests were planted with a six-row cone seeder with double-disk openers in 7-inch rows. Plot area was 60 sq ft. No-till plots were seeded with a seven-row cone seeder equipped with John Deere 750 openers in a row spacing of 7.5 inches. Plot area was 240 sq ft. Seeding rates were approximately 325 seeds/sq yd for conventional tillage and 365 seeds/sq yd for no-till. Inputs such as fertilizer and pesticides were similar to those used by the cooperating farmers on their commercial wheat fields.

Results

Variety yield means are presented in the following three tables.

Conclusions

There was very good agreement between no-till and conventional-till performance in terms of variety mean yield. For example, the correlation between no-till and conventional-till performance over two years in Shelby County was 0.85 (Table 1). Perfect agreement would have yielded a correlation coefficient of 1.0. When comparing no-till versus conventional-till performance in Logan County in 1998 and Caldwell County in 1999, the correlation was 0.74 (Table 2). When data from all three locations in both years were considered, the correlation was 0.88 (Table 3). The take-home message at present is that, in general, superior varieties will perform well under either tillage system. However, we will continue to test wheat varieties under conventional and no-till management in the foreseeable future.

Table 1. Shelby County no-till and conventional variety trial, 1998-99.

	Conventional			No-Till		
	Yield (bu/A)			Yield (bu/A)		
Variety	1999	1998	Mean	1999	1998	Mean
2540	87.2	61.6	74.4	82.9	63.5	73.2
2552	98.3	65.1	81.7	100.4	64.2	82.3
2568	90.6	51.9	71.3	89.9	55.7	72.8
25R26	88.4	57.4	72.9	89.3	56.0	72.7
AG FOSTER + GAUCHO	81.0	43.5	62.3	77.6	50.7	64.2
AGRIPRO ELKHART	78.6	45.8	62.2	87.6	44.5	66.1
AGRIPRO FOSTER	79.4	43.2	61.3	72.7	46.7	59.7
AGRIPRO MASON	86.5	53.1	69.8	84.0	49.6	66.8
AGRIPRO PATTON	94.9	62.3	78.6	99.5	59.0	79.3
BECK 103	73.3	46.6	60.0	81.4	45.7	63.6
BECKER	66.8	41.9	54.4	79.2	46.2	62.7
CALDWELL	61.2	34.1	47.7	54.1	29.7	41.9
CLARK	76.1	48.5	62.3	82.1	40.6	61.4
COKER 9474	70.0	40.5	55.3	79.6	41.1	60.4
COKER 9663	83.0	52.2	67.6	93.7	57.4	75.6
FFR 522	75.8	45.8	60.8	75.2	42.1	58.7
FFR 555	80.6	42.1	61.4	83.0	47.9	65.5
FFR 558	75.2	44.6	59.9	79.7	50.0	64.9
GLORY	87.3	57.2	72.3	86.3	60.5	73.4
HYTEST W9850	80.5	53.4	67.0	79.3	57.9	68.6
JACKSON	84.1	40.7	62.4	87.2	42.6	64.9
KAS JUSTICE	66.5	45.2	55.9	75.7	49.5	62.6
KAS PATRIOT	66.2	45.9	56.1	81.4	41.7	61.6
KY 86C-61-8	84.0	48.8	66.4	85.3	50.6	68.0
MADISON	78.9	47.8	63.4	90.1	54.3	72.2
PATTERSON	75.4	48.4	61.9	83.1	45.7	64.4
POCAHONTAS	78.3	37.4	57.9	92.8	35.1	64.0
TERRA SR 204	81.2	48.4	64.8	79.2	46.2	62.7
MEAN	79.6	48.3	64.0	83.3	49.1	66.2

Correlation of Conventional, No-Till, 1998-99: 0.85

Table 2. Logan County (1998) and Caldwell County (1999) no-till and conventional variety trial.

	Conventional			No-Till		
	Yield (bu/A)			Yield (bu/A)		
Variety	1999	1998	Mean	1999	1998	Mean
2540	81.8	58.9	70.4	74.3	46.5	60.4
2552	95.3	41.2	68.3	96.8	41.8	69.3
2568	89.0	45.8	67.4	76.5	34.5	55.5
25R26	91.8	40.3	66.1	78.8	29.3	54.1
AG FOSTER + GAUCHO	83.0	41.1	62.1	100.3	29.7	65.0
AGRIPRO ELKHART	90.5	42.6	66.6	84.5	34.5	59.5
AGRIPRO FOSTER	84.3	36.4	60.4	81.8	26.2	54.0
AGRIPRO MASON	88.0	44.2	66.1	79.8	40.0	59.9
AGRIPRO PATTON	88.5	53.1	70.8	80.8	35.8	58.3
BECK 103	86.3	43.8	65.1	96.8	36.3	66.6
BECKER	80.5	31.2	55.9	79.0	15.6	47.3
CALDWELL	71.5	40.6	56.1	67.8	25.1	46.5
CLARK	67.5	35.8	51.7	60.5	25.4	43.0
COKER 9474	81.5	43.8	62.7	74.5	39.4	57.0
COKER 9663	103.8	48.1	76.0	87.0	46.5	66.8
FFR 522	85.0	35.7	60.4	74.0	32.6	53.3
FFR 555	87.0	26.5	56.8	89.3	21.6	55.5
FFR 558	86.5	43.3	64.9	76.5	28.3	52.4
GLORY	83.3	47.8	65.6	77.8	29.5	53.7
HYTEST W9850	86.3	52.7	69.5	82.3	41.0	61.7
JACKSON	100.3	33.7	67.0	89.8	30.7	60.3
KAS JUSTICE	79.8	56.3	68.1	71.5	38.3	54.9
KAS PATRIOT	93.8	40.0	66.9	89.5	30.3	59.9
KY 86C-61-8	87.0	32.7	59.9	80.3	25.3	52.8
MADISON	90.3	34.1	62.2	78.3	31.2	54.8
PATTERSON	77.8	44.2	61.0	70.0	29.1	49.6
POCAHONTAS	75.3	32.4	53.9	84.3	23.3	53.8
TERRA SR 204	76.3	35.3	55.8	72.0	28.7	50.4
MEAN	85.4	41.5	63.5	80.5	32.0	56.3

Correlation of Conventional, No-Till, 1998-99: 0.74

Table 3. Conventional vs. no-till, 1998-1999.*

Variety	1998-1999 Yield (bu/A) Conventional	1998-1999 Yield (bu/A) No-Till
2540	72.4	66.8
2552	75.0	75.8
2568	69.3	64.2
25R26	69.5	63.4
AG FOSTER + GAUCHO	62.2	64.6
AGRIPRO ELKHART	64.4	62.8
AGRIPRO FOSTER	60.8	56.9
AGRIPRO MASON	68.0	63.4
AGRIPRO PATTON	74.7	68.8
BECK 103	62.5	65.1
BECKER	55.1	55.0
CALDWELL	51.9	44.2
CLARK	57.0	52.2
COKER 9474	59.0	58.7
COKER 9663	71.8	71.2
FFR 522	60.6	56.0
FFR 555	59.1	60.5
FFR 558	62.4	58.6
GLORY	68.9	63.5
HYTEST W9850	68.2	65.1
JACKSON	64.7	62.6
KAS JUSTICE	62.0	58.8
KAS PATRIOT	61.5	60.7
KY 86C-61-8	63.1	60.4
MADISON	62.8	63.5
PATTERSON	61.5	57.0
POCAHONTAS	55.9	58.9
TERRA SR 204	60.3	56.5
MEAN	63.7	61.2

Correlation of Conventional, No-Till, 1998-1999: 0.88

* 1998: LOGAN AND SHELBY counties; 1999: CALDWELL AND SHELBY counties

Corn Residue Management for No-Till Wheat

J. Herbek, L. Murdock, J. James, and D. Call

Introduction

A major obstacle of no-till wheat is obtaining an optimal, uniform stand. Most wheat in west Kentucky is planted following corn, which results in a large amount of residue that hinders planting. Producers debate the best method for managing corn residue for no-till wheat planting. A corn residue management study was initiated with the following no-till wheat stand establishment objectives: 1) To determine if mechanical shredding of corn residue is necessary; and 2) compare different methods of mechanical shredding of corn residue (and corn maturities) to non-shredded and no corn residue.

Methods

The experiment was established in 1997 at the University of Kentucky Research and Education Center in Princeton, Kentucky. Two corn maturities were used: a full-season corn (123 GDD) and an early-season corn (110-112 GDD). Excellent corn yields both years resulted in a large amount of residue. Corn residue management treatments included: 1) no residue (corn residue removed), 2) residue flail mowed after harvest, 3) residue rotary mowed after harvest, 4) residue after harvest as is (plant parallel to corn rows), 5) residue after harvest as is (plant at angle to corn rows), and 6) residue after harvest as is (plant parallel to corn rows with 15 percent increase in wheat seeding rate). Mechanical shredding was completed immediately after harvest of each corn variety. Wheat was no-till planted with a Lilliston 9670 no-till drill in 7-inch rows at a rate of 35 seeds/sq ft, except for the increased seeding rate (40 seeds/sq ft). Data taken included wheat yields and fall stand counts.

Results

Results for 1998 and 1999 are presented in the table below. Wheat stand establishment was less for 1998 than for 1999 and is attributed to excellent establishment conditions for 1999. As expected, stands were high both years if residue was removed. Flail shredding of corn residue resulted in some of the better stands in 1998 but was not as apparent in 1999. Rotary-mowed residue achieved lower wheat stands than flail-mowed residue (particularly for 1998) and may be attributed to a more uniform distribution of residue with a flail mower. Planting into non-shredded corn residue achieved the worst stands in 1998, but results were inconsistent in 1999. Planting at an angle to the corn rows in non-shredded residue appeared to achieve better wheat stands than planting parallel to corn rows. Increasing the seeding rate in non-shredded residue achieved the highest stands in 1999. Although the early corn variety appeared to have less residue and more decomposition prior to planting than the full-season corn variety, wheat stands were not consistently better. The excellent wheat stands in 1999 resulted in no statistical differences between shredded and non-shredded corn residue. Wheat yields were lower in 1998 due to a spring freeze and high May temperatures. Excellent tillering in 1999 (mild fall/winter) resulted in high yields for all corn residue treatments. There were small differences in yield and almost no statistical differences among the corn residue treatments both years. There was little correlation between wheat stand and yield.

Table 1. Effect of corn residue management on no-till wheat stand and yield.

Corn Residue Treatment	Corn Maturity	Wheat Stand (plants/ft^2)		Wheat Yield (bu/A)	
		1998	1999	1998	1999
Removed all corn residue	Full	26.8 a	35.2 ab	55.4 ab	104.6 b
Flail mowed residue	Full	24.2 b	32.1 bc	60.9 ab	112.3 ab
Flail mowed residue	Early	22.4 bc	32.2 bc	59.4 ab	107.8 ab
Rotary mowed residue	Full	21.3 cd	31.9 bc	57.4 ab	107.9 ab
Non-shredded residue (parallel planted)	Full	16.8 e	34.1 bc	53.3 b	106.7 ab
Non-shredded residue (parallel planted)	Early	20.0 d	31.2 c	62.2 a	101.6 b
Non-shredded residue (diagonally planted)	Full	21.4 cd	32.9 bc	59.8 ab	118.6 a
Non-shredded residue (15% seed increase)	Full	---------	37.8 a	--------	111.2 ab

Greenhouse and Field Evaluation of Resistance to Fusarium Head Blight in Soft Red Winter Wheat

D.A. Van Sanford, B. Kennedy, M. Hall, and C. Swanson

Objectives

- To identify resistance to Fusarium Head Blight (FHB) in greenhouse and field-screening trials.
- To evaluate apparent versus actual FHB infection by plating out seeds on selective media.

Materials and Methods

Entries in the 1999 Uniform Winter Scab Nursery along with a number of advanced breeding lines were planted in the field in a randomized complete block design with four replications on 29 October 1998. Each plot consisted of a single 4-ft row. The previous crop was corn, and the seedbed had been chisel plowed and disked. Entries in the greenhouse were planted in a completely randomized design with a variable number of replications.

Field Inoculation

Mason jars containing approximately 500 g of autoclaved corn seed were inoculated with the head scab fungus *F. graminearum* on April 5, 1999. On April 27, wheat plots were inoculated just prior to heading by spreading 35 to 40 g of the inoculated corn mixture per plot. Plots were mist irrigated daily beginning May 7 for approximately one hour during the early part of the morning, midday, and late evening throughout anthesis into early grain fill. Because of extremely dry weather and a delay in irrigation, wheat plots were inoculated a second time with more corn inoculum on May 17. Incidence of scab was reported as the percentage of scab-infected heads per total number of heads per row. Severity was determined by counting the number of infected spikelets and dividing by the total number of spikelets on diseased heads only.

Greenhouse Inoculations

Several advanced breeding lines were evaluated in the greenhouse for Type I (preventing initial infection) and Type II (reducing spread within the head) resistance.

To measure Type II resistance, at flowering, 3 µl containing approximately 1,200 spores was injected into a single floret in the middle of the head. After inoculation, plants were placed directly into humidity chambers for three consecutive nights. The final percentage of infected spikelets per spike was recorded on day 21. Type I resistance was measured by spraying a spore suspension onto heads at flowering and placing the pot in a humidity chamber for three nights. Twenty-one days after inoculation, plants were rated for disease development using a 0 to 4 scale: 0 = no disease, 1 = 1 to 25 percent, 2 = 26 to 50 percent, 3 = 51 to 75 percent, and 4 = 76 to 100 percent of spikelets infected.

Seed Assessment: Wheat seed was collected from both injection and spray test entries. Total seed number plus the number of visually scabby seed were recorded for each seed lot. Plates were incubated for seven to 10 days at 20 C. Each plate was visually inspected for *F. graminearum*-contaminated seed. Seed from the injection test was also assessed for the presence of *F. graminearum*. In this particular test, seed was visually inspected and placed in the following three categories according to appearance: l) normal, 2) small, wrinkled, and 3) tombstone. The location and category of each seed was recorded on the top of each petri plate. After incubation, those seed that were positive for the presence of *F. graminearum* were recorded.

Results and Discussion

Field Screening: For the first time in three years of field screening, incidence and severity in our inoculated, irrigated nursery were rather low (Table 1). Nonetheless, the resistant checks, Ernie and Freedom, actually showed some signs of resistance in our nursery, which was not the case in the previous two years. Thus, the scab pressure that we observed this year may have been closer to what would be expected under a natural infection.

Greenhouse Screening: Even with a large number of replications (15 plants), repeatability of assessment of type II resistance was low (Table 2). The most promising entry, KY 91C-022-36, ranged from 6 to 26 percent scabby spikelets. With only three plants, however, it is difficult to have confidence in this estimate.

Selective Media: We tend to regard an evaluation of scabby seed after harvest as a confirmation of our assessment of scab on the intact spike. Although visual assessment of seed seems straightforward, plating out the seed on a selective medium revealed some surprises (Tables 3 and 4). Seed of Freedom, for example, was visually rated at 17 percent scabby, yet plating the seed revealed that 82 percent was actually infected with *F. graminearum*.

Table 1. Uniform winter wheat scab screening nursery, Lexington, Kentucky, 1999.

Cultivar	Average Severity %	Average Incidence %	FHB Index	Height (in.)	Yield (bu/A)	Heading Date (Julian)	DON Levels (ppm)
NY87048-7387	1.75	0.65	0.46	40	61.25	134	0.60
Ernie	3.50	1.34	0.09	32	57.82	125	0.78
IL94-1909	4.38	0.68	0.06	41	89.05	129	0.55
OH 544	6.42	1.10	0.10	41	93.68	134	0.55
NY86003-106	8.50	1.75	0.19	37	71.89	133	0.80
M94-1069	11.13	5.63	0.91	35	75.49	128	0.20
Freedom	15.95	4.11	0.72	35	77.90	129	0.63
Geneva	17.08	5.02	1.71	36	56.62	131	0.93
OH 522	17.19	9.92	1.88	35	93.51	127	0.80
NY6003-27	18.79	4.50	2.23	41	68.29	132	1.88
Foster	19.25	2.18	0.93	36	77.90	128	0.50
2545	22.95	9.02	2.00	35	57.99	132	1.70
OH 657	23.38	3.55	1.03	41	80.64	132	0.65
IL96-24078	27.08	1.73	0.49	34	63.48	126	0.75
NY87048W-7405	27.08	8.16	0.98	34	66.23	129	1.00
P92823A1	27.50	5.39	2.58	35	91.28	128	0.55
VA96-54-216	29.45	8.63	2.68	33	102.60	126	0.45
Goldfield	30.21	2.36	0.88	38	107.75	129	0.33
OH 609	30.40	4.98	1.63	36	97.11	127	0.33
Cayuga	31.48	3.97	1.72	42	78.75	135	1.00
Patterson	33.25	5.92	2.15	38	82.36	126	0.88
P88288C1	34.49	7.57	2.94	34	72.23	129	0.55
VA96W-348	38.71	15.27	5.75	32	71.72	127	0.90
M95-3349	43.13	3.15	1.11	37	109.12	128	0.53
IL95-4162	47.50	2.74	1.26	37	101.06	127	0.48
P86958RC2	47.54	3.92	2.35	36	81.33	129	0.95
KY89-895-14	51.20	11.51	5.78	34	88.88	129	0.58
Roane	53.45	18.44	10.06	33	81.84	126	2.38
Location Mean	16.68	4.27	1.06	37	82.29	130	0.80
L.S.D.	21.90	4.24	2.06	2.00	23.63	1.35	0.62
C.V.	71.90	65.99	89.81	4.69	24.91	0.89	59.20

Table 2. Evaluation of 14 advanced breeding lines in the greenhouse for Type II [a] resistance to scab.

Entry	N	AUDPC[b]			% Diseased Spikelets[c]		
		Min	Max	Mean	Min	Max	Mean
91C-092-3	5	0.7	2.3	1.7	6	32	22
91C-092-5	12	0.5	6.5	1.6	5	100	18
91C-092-7	3	0.7	2.8	1.9	6	36	16
91C-092-72	14	0.1	9.1	3.9	5	100	53
91C-092-105	6	0.7	8.2	3.9	7	100	37
91C-092-111	3	1.2	5.3	4.5	17	94	48
91C-019-17	4	0.6	3.2	2.9	5	39	24
91C-022-34	4	0.7	3.2	2.1	6	41	16
91C-022-36	3	0.3	2.5	2.2	6	26	17
91C-022-42	4	0.3	5.0	4.2	6	100	53
91C-046-2	4	0.9	4.9	4.4	7	64	43
91C-261-13	6	0.2	3.4	2.6	5	100	35
91C-261-24	15	0.7	8.8	3.3	6	100	46
92C-432-62	14	0.7	7.4	3.3	6	100	46

[a] Reduction of spread within the spike. [b] Area under the disease progress curve.
[c] Percent of infected spikelets per spike recorded 21 days after injection.

Table 3. Mean number of seed collected and percent of seed infected with *F. graminearum* from 14 advanced breeding lines screened in the greenhouse for Type II resistance to scab.

	Mean Number of Seed[a]			Percentage of Infected Seed		
Entry	Normal	Small/ Wrinkled	Tombstone	Normal	Small/ Wrinkled	Tombstone
91C-092-3	32.8	3.8	4.2	5.7	7.7	41.7
91C-092-5	26.6	3.6	1.5	0.3	1.6	33.3
91C-092-7	18.3	0	0	0	0	0
91C-092-72	15.2	15.4	5.5	5.2	14.8	26.1
91C-092-105	15.8	5.5	2.8	5.7	12.2	47.0
91C-092-111	1.0	24.3	7.3	0	3.0	34.2
91C-019-17	24.5	0	4.3	1.8	0	61.9
91C-022-34	12.5	14.3	0.3	4.4	0	0
91C-022-36	8.8	19.6	4.4	2.3	1.0	30.5
91C-022-42	18.8	3.0	3.0	1.0	0	12.5
91C-046-2	12.8	9.0	1.8	0	7.4	11.1
91C-261-13	15.2	5.0	3.1	15.4	7.2	48.4
91C-261-24	10.2	8.3	9.2	9.2	10.2	33.4
92C-432-62	12.0	5.4	2.9	5.1	13.9	50.3

[a] Visual assessment of seed by appearance. [b] Percent of *F. graminearum* contaminated seed per total number of seed by category, recorded 7 to 10 days after plating on selective media.

Table 4. Evaluation of 15 advanced breeding lines screened in the greenhouse for Type I resistance to scab.

Entry	N	Disease Score[a]	Total Seed	Percent Visual Scabby Seed[b]	Percent of Seed Infected with *F. graminearum*[c]
Glory	3	2.7	19	77	87
KAS EX 108	1	4	6	100	83
FFR 555	5	3.6	21.2	66	70
Foster+Gaucho	4	2.8	16.3	40	92
2552	3	1.7	13.3	34	76
KY 89C-744-44	3	2.3	19.3	37	60
92C-432-62	3	0.3	13	30	18
92C-433-77	1	1	32	19	72
91C-261-3	5	1.2	38.2	15	43
91C-261-3	3	2.7	3	99	100
90C-383-18	1	1	27	100	81
91C-260-6	3	0.7	34.6	6	15
91C271-74	3	1.7	18	51	53
Freedom	2	2	29	17	82
Ernie	3	1	13.4	25	17

[a] 21 days after inoculation plants were rated for disease development using a 0-4 scale: 0 = no disease, 1 = 0-25%, 2 = 26-50%, 3 = 51-75%, and 4 = 76-100% of spikelets infected.
[b] Visual assessment of seed by appearance.
[c] Percent of *F. graminearum*-contaminated seed per total number of seed, recorded 7 to 10 days after plating on selective media.

Hybrid Corn Performance Test

W.L. Pearce, C.G. Poneleit, and P. Shine

The Hybrid Corn Performance Test provides unbiased performance data of commercially available corn hybrids sold in Kentucky. Each year, more than 125 hybrids are evaluated for agronomic performance at seven locations in the state. At each location, separate tests are grown for early (112 days to maturity or earlier), medium (113 to 117 days to maturity), and late (118 days to maturity or later) hybrids.

In 1999 a TC blend high oil test was grown for agronomic evaluation at three Kentucky locations. Data were made available to seedsmen, county agents, and farmers on the Agronomy Web site along with the customary progress report (PR-421). The Web site has an HTML version (used as a search mechanism) and a PDF file, which is the printable version.

Also, evaluations of protein, oil, and starch were obtained from one replication of all regular corn hybrids from each location (Tables 7E, 7L, and 7M). The evaluations for protein, oil, and starch were also done on every replication of the TC blend high oil test (Table 15F). All chemical analyses were provided by the Grain Quality Laboratory. In 1998 a new combine was provided by the Kentucky Corn Growers Association. This combine uses a data collection system that provides test weight data along with yield and moisture. Other data provided in the progress report are percent stand and lodging.

Value-Added Corn Breeding

C.G. Poneleit, R.C. Green, G. Swango, and W.L. Pearce

What is the benefit of examining variations of starch or protein or oil in corn grain? The answer varies from a few extra cents per bushel for grain growers or additional energy per bushel for animal feeders to several dollars of product per bushel for specialty grain processors. Most of the answers will not be available, however, until hybrids with the distinctive characteristics are available for direct testing. That is the objective of the Corn Breeding testcross trials: to select white endosperm inbreds with value-added starch, protein, and oil characteristics. Hybrids can then be made from the inbreds. White endosperm corn grain with waxy starch may provide the unique composition needed by a special industry. New waxy hybrids are now being tested for agronomic ability, i.e., yield and standability, as well as for amylose and amylopectin composition. A diallel test of white endosperm grain populations that are high in amylose, because of the amylose extender gene, is being tested for combining ability and possible use in future breeding programs.

White endosperm grain selections with hard kernels that have high lysine content, called Quality Protein Maize (QPM), are also being tested for agronomic worth. These QPM hybrids are an improved version of high lysine hybrids that were grown by many Kentucky farmers several years ago but had poor quality grain for storage. Additionally, all hybrids in the Hybrid Corn Performance Test program are routinely screened for percent composition of starch, oil, and protein through the Grain Quality Laboratory, to find those with unusually high or low values for any of the composition materials. Each of these selection programs using testcross evaluations or screening tests may provide a future value-added hybrid for Kentucky.

Grain Quality Laboratory

C.G. Poneleit and G. Swango

The Kentucky Corn Grain Quality Laboratory provides an analysis service for farmers, industry, and University of Kentucky researchers using Near Infrared Reflectance Spectroscopy (NIRS) for protein, oil, starch, and fiber. Other testing includes amino acid composition, test weight, moisture, specific density, stress cracks, kernel size, and broken corn and foreign materials (BCFM). Additionally, ELISA quick tests are done for aflatoxin and fumonisin. All tests are done free of charge to Kentucky residents.

During the 1999 harvest season we processed 370 samples for farmers and industry, 220 for special research studies, 1,500 for the Hybrid Corn Performance Test program, and 3,500 for corn breeding research. The laboratory is supported by funds provided by the Kentucky Corn Growers Association.

1999 Kentucky Corn for Silage Yield and Quality Performance Trial

M.J. Bitzer, D.J. Grigson, and D. Herbst

Each year a corn hybrid silage trial is conducted on one or more farms in Kentucky. In 1999, these tests were located in Lincoln and Adair counties. The test included 17 different corn hybrids which were grown in three replications. The plots were hand harvested for yield and chopped in a chipper shredder to obtain samples for moisture and silage quality. These tests are conducted to provide unbiased performance information for corn hybrids for silage commonly sold in Kentucky. Every effort was made to conduct the test in an unbiased manner according to accepted agronomic practices. Yields were affected by the dry weather more in Adair County than Lincoln County.

The yield and quality data are presented in Table 1. TDN is an energy value that is very important for milk production and cattle gains. NEL percentage is an energy value that is important for milk production. The ADF percentage is a measure of the plant material that is highly indigestible by the animal. A low ADF percentage is desirable. Several hybrids were the highest yielders in both counties, whereas other hybrids did somewhat better under the more stressed environment of Adair County.

Table 1. Yield and quality data of corn hybrids for silage.

	Yield (T/A)		Combined Counties			
			Crude	Percent		
Hybrid/Brand	Lincoln	Adair	Prot.%	ADF	TDN	NEL
Novartis N79-L3 Bt	23.6	17.7	8.25	29.6	63.9	0.64
Pioneer 31B13	23.3	16.5	8.25	30.8	61.6	0.62
Novartis N7639 Bt	22.7	14.4	8.00	29.0	63.9	0.65
ABT HTX 7639 Bt	21.3	13.3	8.23	31.2	61.1	0.62
Southern States SS849 IT	20.4	15.0	8.18	31.0	61.3	0.62
DeKalb DK720 S	20.3	15.3	8.62	30.5	62.0	0.63
DeKalb DK697	20.3	15.7	7.88	32.0	60.1	0.61
Agripro AP9829	20.1	14.5	8.10	34.2	57.5	0.58
Pioneer 3156	20.0	13.7	8.73	28.6	64.0	0.65
Pioneer 33J56	20.0	13.2	8.10	27.0	67.6	0.70
ABT HT 4138	19.7	15.6	8.27	30.7	61.6	0.62
Caverndale Silage A	19.6	13.9	8.50	33.5	58.1	0.58
Southern States SS943	19.2	13.7	8.20	31.0	61.4	0.62
Garst 8222 IT	18.9	11.4	8.17	30.1	62.4	0.64
ABT HT 4927	18.7	13.8	7.80	29.3	63.6	0.65
Garst 8220	18.3	16.4	7.78	29.8	62.8	0.64
Mycogen TMF 114	16.6	14.9	7.73	30.3	61.3	0.62

Correlation of Corn Yield Variability as Affected by Soil Characteristics

L. Murdock, P. Howe, and K. Wells

Combine yield monitors are commonly used by many farmers. As farmers see the yield vary across the field, they question the reasons for this and wonder if the different yield zones could be managed differently to improve yields or reduce costs. To answer these questions, the reasons for the yield variability must first be determined. The yield variability within fields can be attributed to many factors. The objective of this study is to precisely map soil morphological characteristics and soil fertility factors within a field and determine if such variability is associated with yield variability of corn.

Methods

Work was conducted on two fields in the western part of the state on soils derived from limestone parent material. The two fields are located in Caldwell and Trigg counties in the Pennyrile area. The fields were typically upland sites with ridge, side slope, and basin positions. These fields had a three-year history of yield maps that showed consistent differences. Sites chosen for the study in the fields were representative of the yield ranges within the fields and were selected on a combination of factors that included past yields, topography, and soil type. There were 24 sites on the field in Caldwell County and 18 sites on the Trigg County field. Soil characteristics measured were yield, topsoil depth, Ap horizon, depth to clay accumulation, internal drainage, penetrometer measurements, slope and aspect, site position, soil type, organic matter, pH, buffer pH, phosphorus, and potassium. A correlation between yields and soil characteristic across sites in each field was performed to determine its effect on yield. For comparison of all years in both fields, the yields were normalized and correlated to soil characteristics.

Results and Discussion

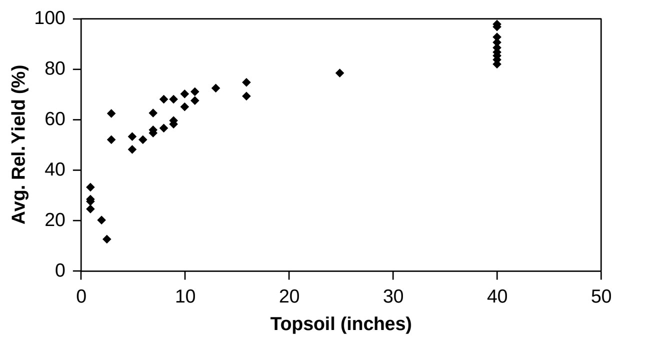
It appears that topsoil depth may be the most important yield-determining characteristic on these types of soils. It alone described more than 70 percent of the yield variability in corn yield in 1996 and 1997 in the two fields in the Pennyrile area (Table 1). On the average, yields increased 10.1 bu/A for each inch of topsoil up to 8 inches of topsoil (Figure 1). Increase of topsoil depth above 8 inches resulted in only a 1.2 bu/A yield increase per inch. The depth to clay accumulation in the soil, which is closely related to topsoil depth, was also highly significant and will correlate to the yield in the fields. Both of these factors are related to water availability to the plant. The

Table 1. Correlation coefficients of soil characteristics to yield.

Soil Characteristics	R^2 Values
Topsoil	0.73
Depth to clay accumulation	0.63
Slope	0.56
Penetrometer	0.34
Phosphorus	0.17
pH	0.01
Potassium	0.01
O.M.	0.0001

slope percentage was also significant and correlated to the yield. This is probably a reflection of erosion history because it negatively correlates to topsoil depth and is again related to plant water availability. There was a weak correlation of soil strength (penetrometer measurements) to yield variability. With only one exception, there was no correlation of yield variability to any of the fertility parameters (phosphorus, potassium, pH, buffer pH, or organic matter). Within the sites tested, the range was pH (5.6 to 6.8), P (11 to 65 ppm), and K (214 to 366 ppm). Phosphorus correlated to yields on the field in Trigg County, but this may have been at least partially due to past erosion effects.

Figure 1. Effect of topsoil depth on 1996 and 1998 corn yields.



Conclusions

At this point in the study, it appears that yield variability on these types of soils is primarily related to plant available water that is controlled by top soil thickness (which is related to erosion or accumulation) and soil type.

Effect of Row Width, Plant Population, and Hybrids on Corn Grain Yields

M.J. Bitzer and J.H. Herbek

In the 1990s, corn row width studies were conducted in many corn-producing states. Responses to row widths narrower than 30 inches have occurred mostly in areas from central Illinois northward. Studies in southern Illinois, Missouri, Tennessee, and Kentucky have not shown any advantage for rows narrower than 30 inches. There has been a trend toward higher yields for plant populations up to 30,000 plants per acre. Most studies have been conducted with only one or two hybrids, but even when more hybrids were used, no difference was found between hybrids. After completing three years of data in Kentucky, which showed no advantage to rows narrower than 30 inches but an increase of yields from 22,000 to 30,000 plants per acre, a new study was initiated in 1998 that included two corn hybrids, two row spacings, and three plant populations.

Description of the Studies

A two-year study was conducted in 1998 and 1999 to determine the effect of row width, plant population, and corn hybrids on corn grain yield. Two row widths (20 and 30 inches) with three plant populations (24,000, 28,000 and 32,000 plants per acre) and two corn hybrids were studied at two locations in Kentucky. The plots were located on Bob Wade's farm in Hardin County and on Doug Wilson's farm in McCracken County. The two corn hybrids that were compared were Pioneer 33Y18 (114 day hybrid) and Southern States SS828 (118 day hybrid). These two hybrids were the among the highest yielding hybrids in the Kentucky Hybrid Corn Performance Trials in 1997 and 1998.

Results and Summary

In 1998, the yields averaged 151 bu/A in Hardin County and 191 bu/A in McCracken County, whereas in 1999, the yields averaged only 113 bu/A in Hardin County and 143.5 bu/A in McCracken County. The lower yields in 1999 were due to the extreme drought conditions that were prevalent especially in Hardin County. Across years there were no significant differences for row width or plant population (Table 1). There was a significant hybrid by row width interaction. In 1998, the hybrid Pioneer 33Y18 yielded significantly higher in 20-inch rows, whereas Southern States SS828 was higher yielding in 30-inch rows. In 1999, both hybrids were slightly higher yielding in 30-inch rows. Pioneer 33Y18 is the first hybrid that we have studied that was higher across locations in 20-inch rows in any one year. Although there was no significant difference in plant populations, slightly higher yields were obtained at 28,000 plants per acre. In 1999, the dry weather had a greater effect on the yields of the later maturing hybrid.

In conclusion, after five years of studying the effect of row width and plant population on corn grain yields in Kentucky, there does not appear to be any advantage for 20-inch rows over 30-inch rows. For fields that have the potential of producing more than 180 bu/A, a final population of 26,000 to 28,000 plants per acre should be adequate.

Table 1. Effect of hybrid, row width, and plant population on corn grain yields across years (1998 and 1999).

	Yields (bu/A)		
Hybrid/Brand	**1998**	**1999**	**Ave.**
Pioneer 33Y18	174.9a	135.9a	155.4a
Southern States SS828	167.1b	120.7b	143.9b
Row Width			
20-inch	171.0a	125.8a	148.4a
30-inch	171.0a	130.8a	150.9a
Plant Population			
24,000	167.2a	130.1a	148.7a
28,000	173.9a	129.1a	151.5a
32,000	171.8a	125.6a	148.7a

Compaction on No-Till Corn and Soybeans

L. Murdock and J. James

Soil compaction has become more of a concern with producers as the size of equipment has increased. Some of the questions that producers ask are: 1) how much will compaction decrease my yield?, 2) are penetrometers a good measure of compaction?, 3) will deep tillage restore all of my yield potential?, and 4) how long will the effects of compaction last? To help answer some of these questions, a compaction experiment was established at Princeton, Kentucky, on an experimental area that had tilled and no-tilled areas.

Method

A replicated trial was established on a Zanesville silt loam at Princeton, Kentucky, in the fall of 1996 on an area that had both no-tillage and tilled areas. There were six treatments; one no-till and one tilled treatment were not compacted. Two no-tilled and two tilled treatments were compacted. In the fall of 1999, one of the compacted no-till treatments and one of the compacted tilled treatments were subsoiled.

The compaction was accomplished by trafficking the entire plot with a 7-ton per axle large front-end loader. This was done twice in the fall of 1996. In the spring of 1997, the entire plot was trafficked four times with a 10-ton John Deere 7700 tractor with dual rear tires and extra added weight. All compaction traffic was done when the soil moisture was about 17 percent. This was found to be the optimal moisture for compaction by Dr. Larry Wells using a Proctor test method.

Severe compaction was found to exist to about a 12-inch depth on all compacted plots. This was confirmed by soil strength measurements made with a penetrometer at field capacity. All compacted plots exceeded 300 psi in the top 12 inches.

Corn was planted in 1997 and 1999 and soybeans in 1998. The tilled plots were disked to a depth of 6 inches prior to planting, and the no-till plots were planted directly into the compacted soil.

Results

The yields for the different treatments are found in Tables 1 and 2 as relative yield (percentage of highest yielding treatment) and actual yields. The uncompacted treatments were the highest yielding, with the no-till treatment being consistently and slightly higher than the tilled treatment for both corn and soybeans. The tilled/compacted treatment yielded consistently 20 percent to 25 percent less over the three-year period than the uncompacted treatments. The no-till compacted treatment yielded very low the first year (2 percent), and then dramatic gains were made the next two years. Relative yields were 82 percent and 89 percent for the second and third years.

The difference between yields in the tilled and no-tilled compacted treatments over the three years is thought to be due to tillage and in the ability for the increased biological activity of the no-till treatments to ameliorate compaction. The extremely low yield in the no-till treatment the first year was due to compaction of soil into the soil surface. Roots had extreme difficulty becoming established, so plants and yields were very small. The tilled compacted treatment was disked to 6 inches, so plant growth and yields were greater. After the first year, compaction was completely removed by natural means in the top 3 inches of the compacted no-till treatment.

The relative yields have continued to increase in the no-till compacted plots. It seems that this is probably due to a high level of biological activity in no-till that is actively correcting the soil compaction. This is seen in root observations made in 1999 by taking soil cores below the plants. Small channels were found in the compacted layer that were of granular structure that had a dark organic stain with a high concentration of larger active roots that traversed through the compacted zone into the uncompacted soil below. Some evidence of this can be seen in the soil penetrometer readings in Table 3. The soil strength in the no-till compacted treatment is beginning to decrease with no evidence of this in the tilled compacted treatment.

Table 1. Effect of soil compaction on corn and soybean yields with and without compaction.

Treatment		Relative Yields* (%)		
Tillage	Compaction	1997	1998	1999
		Corn	Soybeans	Corn
Conventional	Yes	76	74	80
Conventional	No	95	95	97
No-Till	Yes	2	82	89
No-Till	No	100	100	100

* Percent of highest yielding treatment.

Table 2. Effect of soil compaction on corn and soybean yields with and without compaction.

Treatment		Yield (bu/A)		
Tillage	Compaction	1997	1998	1999
		Corn	Soybeans	Corn
Conventional	Yes	79	31	143
Conventional	No	98	40	174
No-Till	Yes	20	35	161
No-Till	No	104	42	180

Table 3. Effect of time on the percentage of soil penetrometer readings over 300 psi in compacted tilled and no-tilled treatments.

	Percentage of Measurements over 300 psi			
Treatment	1997	1998	1999	2000
No-Till Compacted	94	97	94	75
Tilled Compacted	94	94	97	100

Conclusions

This experiment indicates that there is a difference in severe soil compaction between tilled and no-tilled systems. Some of the conclusions are:

1. Both tilled and no-tilled fields can be severely compacted, and yields are significantly reduced.
2. Yields of no-till plantings are greatly reduced the first year.
3. Yields of compacted no-tilled fields will rebound rapidly without tillage, due probably to a high rate of biological activity in the root zone.

Using Poultry Litter as a Nutrient Source for Corn

M. Rasnake, L. Murdock, and F. Sikora

Currently, Kentucky poultry operations produce about 300,000 tons of litter each year. The nutrient content of this litter compares roughly with 75,000 tons of 10-10-10 fertilizer. However, the nutrients in litter are less available to crops than nutrients in fertilizer. This is especially true for nitrogen since most of the nitrogen is in an organic form that must be broken down before the nitrogen can be released. This study was designed to evaluate the availability of nutrients in litter to corn in comparison with nutrients in fertilizer.

Materials and Methods

An experiment was initiated in 1998 on a Zanesville silt loam soil at Princeton, Kentucky, to evaluate the use of poultry litter on corn. The experiment was repeated in 1999 on the same plots. The 1998 results were low due to late planting, so only the 1999 results are reported in this paper. The treatments used are shown in Table 1 and were the same in both conventional and no-till planting systems compared in adjacent plots. All the poultry litter and the 150 pounds nitrogen treatments were applied near planting time (April 26) with incorporation in the conventional-tilled plots. Nitrogen for the split treatments (3 and 4) was applied broadcast on June 11. Nitrogen was applied as ammonium nitrate. Rainfall was good until the first of July, but no rain occurred after that date. Yields were limited by the late drought.

On-farm tests were also conducted in Hopkins and Webster counties in 1999.

Results

Average yields for the various treatments at Princeton are shown in Table 1. In the conventional tilled plots, the 10-ton rate of poultry litter produced higher yields than nitrogen alone, or combinations of litter and nitrogen fertilizer. The 5- and 10-ton rates were not significantly different; however, the results suggest that treatments with less available nitrogen may not have had sufficient nitrogen for the corn crop.

Yields in the no-till plots were higher, although no statistical comparisons are made between no-till and conventional. The 5-ton litter rate produced the highest yields in comparison with the nitrogen or combination treatments. The 5- and 10-ton litter rates were not significantly different in corn yields produced. Nitrogen may have been limiting in treatments three through five.

Results of on-farm tests conducted in Hopkins and Webster counties are shown in Tables 2 to 4. The study in Hopkins County (Table 2) with no-till white corn showed no consistent patterns. Whether 3 or 5 tons of litter were used, it appears some extra nitrogen was needed. This field was planted later than the others (May 14) and probably suffered more from the dry weather in July and August.

Table 1. Corn yield response to poultry litter and nitrogen fertilizer — Princeton, Kentucky, 1999.

Treatments				Yields (bu/A)*	
	Litter		Nitrogen		
No.	(T/A)	(lb N/A)	(lb/A)	Conventional	No-Till
1	10	590	0	137 a	149 ab
2	5	295	0	125 ab	153 a
3	1.3	77	112	114 b	137 c
4	3.1	183	56	120 b	145 b
5	0	0	150	115 b	135 c

* Yields within a column followed by the same letter are not significantly different (% = .05)

Table 2. White corn response to poultry litter — Osburn Farm, Hopkins County, Kentucky, 1999.

Treatments		
Litter (T/A)	Nitrogen (lb/A)	Yields (bu/A)
3	0	109 ab
3	50	112 ab
3	100	122 a
5	0	102 b
5	50	122 a
5	100	111 ab

Table 3. Corn response to poultry litter — Duncan Farm, Webster County, Kentucky, 1999.

Treatments		Yields (bu/A)*	
Litter (T/A)	N (lb/A)	Conv.-Till	No-Till
4	0	136	132
4	20	140	136
4	40	141	133
4	60	152	133
4	80	152	130
0	180	-	132

* Yields not significantly different.

Yields on the Duncan farm in Webster County showed no significant differences due to treatments, although there was a trend toward higher yields with extra nitrogen in the conventional tilled plots. Apparently, there was sufficient nitrogen in 4 tons of broiler litter per acre to grow a high-yield corn crop. The late-season drought may have limited yields and an opportunity to see differences due to nitrogen treatment levels.

The Carlisle farm yields (Table 4), although higher, show trends similar to those discussed for the Duncan farm. One difference on this farm was a large increase in yields with the 20-lb nitrogen rate on the no-till plots. This suggests that more nitrogen was lost from the litter on the no-till plots, or the decomposition of litter and release of organic nitrogen was less.

Table 4. Corn yield response to poultry litter — Carlisle Farm, Webster County, Kentucky, 1999.

Treatments		Yields (bu/A)*	
Litter (T/A)	N (lb/A)	Conv.-Till	No-Till
4	0	160 a	137 a
4	20	161 a	175 b
4	40	169 a	170 b
4	60	165 a	176 b
4	80	175 a	182 b
0	180	-	178

* Yields within a column followed by the same letters are not significantly different (% <0.1)

Conclusions

These results indicate that poultry litter is a good source of nutrients for corn production. However, it is more difficult to predict the breakdown of litter and the release of nutrients to the crop. This is more of a problem in no-till since the surface-applied litter is more prone to nitrogen loss via ammonia volatilization and breakdown of the litter is more dependent on weather conditions. For these reasons and other problems, such as the difficulty in getting a uniform distribution of litter, poultry litter probably should not be used to supply all the nutrient needs of a crop. Using lower rates of litter to supply phosphorus for the crop, then balancing nitrogen and other nutrient needs with fertilizer will be more economical and effective in most cases. It may also help from an environmental standpoint in the long run.

Nutrient Concentration Changes in Poultry Litter with Storage Time and Method

M. Rasnake, F. Sikora, and L. Murdock

Poultry litter sometimes must be stored for varying times before it can be applied to land. Changes in nutrient concentration during storage are expected, but how soon they occur and how much they change is not known. This paper reports the results of a study on poultry litter storage that was initiated in December 1998 at Princeton, Kentucky.

Methods and Materials

Broiler litter cake (the material removed from broiler houses between flocks by a machine that picks up the litter and screens out the larger particles) was delivered to Princeton on December 21, 1998. The litter was placed in nine 8-ft x 8-ft bins to a depth of 4 feet. Three bins were covered with a roof, three with plastic directly on top of the litter, and three were left uncovered. Each bin was sampled at one week after storage and periodically for six months with the last sample taken on June 29, 1999. The samples were analyzed by the University of Kentucky Regulatory Services testing labs.

Results

Changes in concentration of nutrients in poultry litter with storage time and method are shown in Figures 1 through 5. The method of storage had very little impact on nutrient concentration except possibly on nitrogen. Therefore, in Figures 2 through 5, the data for all methods are combined and show only the results of time of storage. Nutrient concentrations are reported on a percent dry matter basis.

Nitrogen concentrations (Figure 1) tended to decrease after two weeks of storage until 10 weeks. Then they increased over the next 16 weeks. Nitrogen losses were probably due to ammonia volatilization. Significant differences due to storage method occurred only during the last 16 weeks, with the plastic-covered litter being higher in nitrogen concentration compared to the other two treatments.

Phosphate concentrations tended to increased with storage time (Figure 2). Overall, phosphate increased from 4.8 to 5.7 percent of dry matter over the six-month storage time. Since phosphate is not expected to be lost from the system, this increase can be attributed to a loss in mass of the litter due to organic matter decomposition.

Potash concentration (Figure 3), although more variable, showed the same trends as phosphorus. The overall change

Figure 1. Changes in Nitrogen Concentration in Stored Poultry Litter.

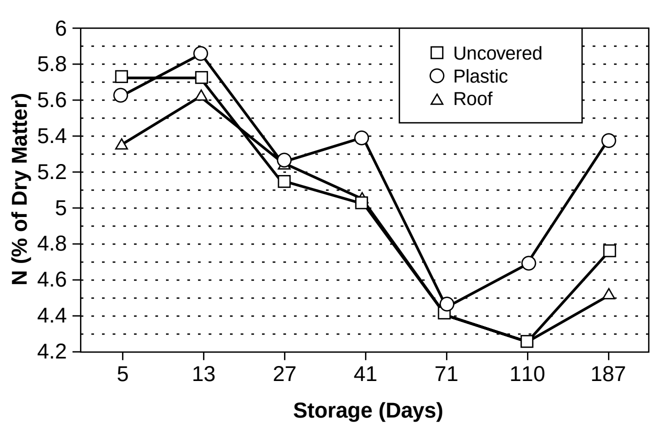


Figure 2. Change in Phosphate Concentration in Poultry Litter with Storage Time.

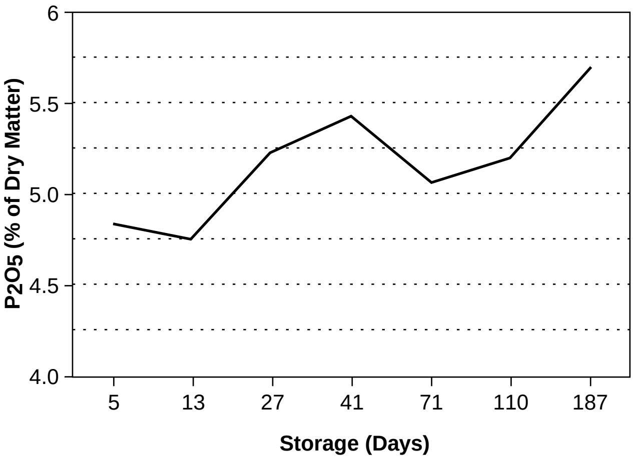


Figure 3. Potash Concentration Changes with Litter Storage Time.

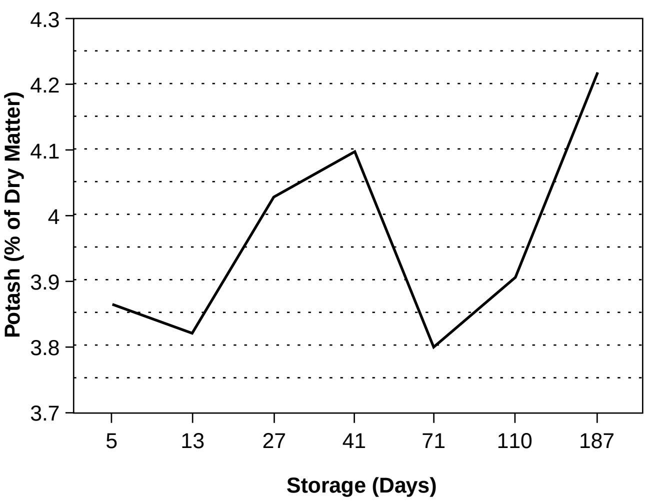
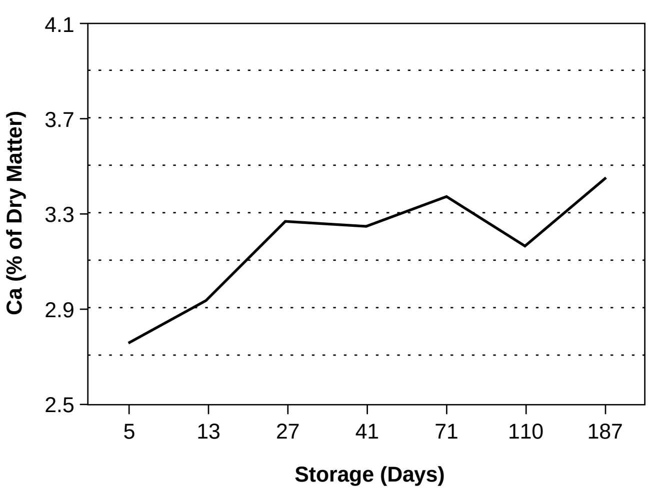


Figure 4. Calcium Concentration Changes with Litter Storage Time.



was from about 3.9 to 4.2 percent of dry matter after six months of storage.

Calcium and zinc concentrations (Figures 4 and 5) followed similar trends to phosphate and potash. Calcium increased from 2.8 to 3.4 percent of dry matter, while zinc increased from 440 to about 520 ppm. As with phosphorus, these increases are due to a decomposition of organic matter rather than increases in the total amounts of calcium and zinc.

Internal temperatures of litter stacks are shown in Figure 6. Litter stacks under roof and uncovered reached a maximum temperature of 120°F two weeks after stacking. Stacks under roof cooled to about 110°F after about six weeks and maintained that temperature for six months. The uncovered stacks continued to cool to near ambient temperatures two months after storage. The plastic-covered stacks maintained a temperature between 100 and 110°F throughout the experiment.

These results indicate that stored poultry litter continues to be microbially active for long periods of time. This results in a loss of mass and an increase in concentration of nutrients with the exception of nitrogen.

Figure 5. Zinc Concentration Changes with Litter Storage Time.

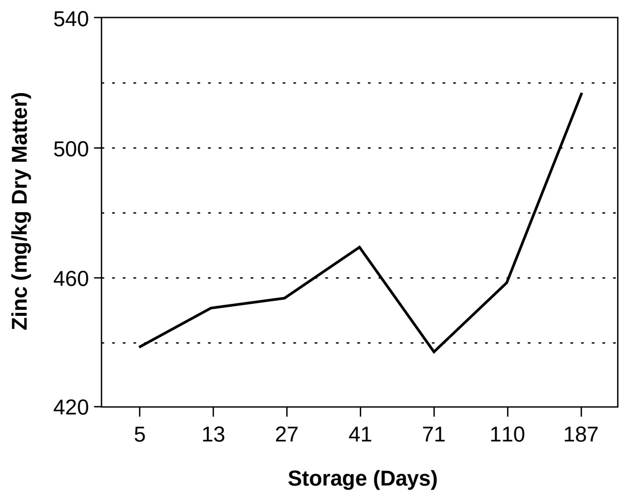
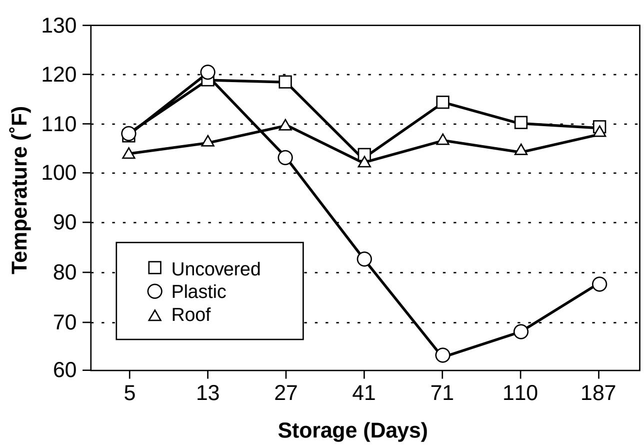


Figure 6. Effect of Broiler Litter Storage Method on Internal Temperatures.



Kentucky Soybean Performance Tests

E. Lacefield, C. Tutt, and T. Pfeiffer

The Kentucky Soybean Performance Tests annually evaluate soybean varieties being marketed in Kentucky to provide farmers and seedsmen information to use in making variety selections. Over the last three years the Kentucky Soybean Performance Tests have expanded to meet the needs of Kentucky soybean producers. In 1997 about 80 varieties from commercial companies and 25 varieties from public institutions were tested in six locations. Eight of the commercial varieties were Roundup Ready® (RR). This year (2000) 119 commercial varieties, 12 public varieties, and a number of novel soybean varieties are being tested. The number and acceptance of RR varieties has also greatly increased. Last year for the first time in Kentucky all RR soybean varieties entered by companies were tested in the five conventional tests and the double-crop test and were compared directly to non-RR soybeans. Twenty-one companies entered 78 RR varieties that now comprise more than two-thirds of the commercial varieties entered in the newly revamped tests.

A selection key was available for the first time last year at the Kentucky Soybean Performance Test Bulletin's Web site: http://www.ca.uky.edu/agc/pubs/pr/pr424/pr424.pdf. This new feature creates subsets of the summary table. The sorting of the data provides alternative views, showing those varieties selected by basic questions a soybean producer might ask and encourages the use of the summary data. The publication Web site, which was activated December 1, 1999, has been accessed more than 2,000 times.

The Kentucky Soybean Performance Tests provide multiple environments for the latter stages of testing of soybean lines considered for release by the University of Kentucky soybean breeding project; for example, the newly released soybean variety 7499 was tested in 10 environments during two years within these tests prior to its release.

Many novel soybean varieties with value-added specialty traits are emerging from both the public and private sectors. Some novel varieties will supply relatively small market niches, while others may be of much broader market value. A number of novel varieties will be tested this year to provide soybean producers with reliable data on grain yield of these value-added soybean types. These data will enable producers of novel soybeans to evaluate whether the premiums offered for a given trait offset possible yield lag/drag.

Wheat Cultivar Effect on Double-Crop Soybean Growth and Yield

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Soybean double-cropped after wheat accounts for, depending on the year, 20 to 40 percent of the soybean acreage in Kentucky. Double-crop soybean yield, is on average, 75 percent of full season soybean. There are numerous factors that contribute to this reduced yield, including later planting date with reduced soil moisture reserves following the wheat crop, shorter day lengths during seed filling, and more frequent dry periods during the seed filling period. Several soybean producers have commented to us that the prior wheat crop directly affected double-cropped soybean in ways such as reduced stand establishment, soybean plant growth, and soybean yield. Mike Garland, a private soybean breeder, conveyed to us that in his experience soybean cultivars were differentially affected by double cropping behind wheat. Furthermore, in a science fair project that his daughter conducted, soybean growth was reduced by watering with wheat straw leachate compared to using only water. In the 1970s Dr. C.E. Caviness at the University of Arkansas conducted research on the phytotoxic effects of wheat residue on soybean growth. He reported on greenhouse pot studies which showed 18 to 38 percent reduced soybean growth due to the addition of 20g wheat straw/kg soil (Crop Science 26:641-643, 1986). Grain crop farmers in Kentucky will continue to follow the wheat/soybean double-cropping system. We want to determine if wheat and/or soybean cultivar selection can overcome some of these obstacles inherent in double cropping. Our first question was whether, in field production tests, straw residue from wheat cultivars grown in Kentucky had differential effects on double-cropped soybean growth and yield.

Research Approach

This experiment was conducted at the Kentucky Agricultural Experiment Station farm at Lexington, Kentucky, in 1997 - 1999. Data are reported for 1997 and 1998 as no soybean plots were harvested in 1999 due to the severe drought. Tests in all years were conducted on a Maury silt loam soil. The University of Kentucky routinely conducts a wheat cultivar performance test which includes released cultivars and promising breeding lines. These tests are conducted with four replications planted in six row plots 10 ft long and 4 ft wide. The wheat performance test in 1997 consisted of 48 entries and in 1998 consisted of 53 entries. Thirty entries were common in the two years. Wheat was harvested when all cultivars in the trial reached maturity. Wheat cutting height was approximately 6 inches, and all straw residue from the combine remained in the field, mostly lying on the plot from which it came or in the alley between plots. Soybean cultivar Asgrow A4715 was planted with a no-till planter in 15-inch rows with a seeding rate of six seeds/ft. Planting dates were 8 July 1997 and 2 July 1998. Gramoxone and Dual were applied pre-emergence. Soybean plots were 10 ft long, and alleys between the soybean plots corresponded to the alleys between the previous wheat plots. Depending on the alignment of the no-till planter and the straw rows in the prior wheat plots, three or four soybean rows were situated entirely within a wheat plot, and three rows were harvested from each plot with a small plot combine. Three inches of irrigation water were applied in September 1998. Soybean matured before the first freeze in both years.

Data were collected on plant stand by counting the number of plants in one meter of two adjacent rows. Plant height was measured at R1 (first flower) and at R8 (maturity). Plots were harvested with a small plot combine, and yields were expressed as bu/A at 13 percent moisture.

Results

The two-year means of soybean growth as affected by the straw residue from 30 wheat cultivars are shown in Table 1. Soybean yields ranged from 27.4 to 20.0 bu/A with a two-year mean yield of 23 bu/A. The yields differed significantly in the two years, averaging 25.8 bu/A in 1997 and 18.2 bu/A in 1998. There was no significant effect of wheat cultivar on soybean yield averaged over the two years ($p>0.10$), and there was no significant cultivar x year interaction (Table 2). The two-year average of soybean plant height at flowering ranged from 43 to 39 cm depending on the wheat cultivar in the plot with a two-year mean height of 41 cm. There was a statistically significant difference due to the wheat cultivar. The average soybean plant height at flowering differed significantly in the two years, 46 cm in 1997 and 33 cm in 1998, but the year x cultivar interaction was not significant (Table 2). The two-year soybean plant height at maturity ranged from 70 to 66 cm with a mean of 68 cm but did not differ significantly depending on the prior wheat cultivar in the plot. The plant height at maturity differed significantly between the two years, 79 cm in 1997 and 50 cm in 1998. The wheat cultivar in the plot did not affect the soybean plant stand, and there was no year effect or year x cultivar interaction (Table 2). The average plant stand for the 30 cultivars grown in the two years was 159,000 plants/A.

Table 1. Two-year (1997 and 1998) means of soybean yield, stand, and plant height at flowering (R1) and maturity (R8) as affected by wheat cultivar straw residue from prior wheat plots.

Wheat Cultivar	Soybean Yield (bu/A)	Soybean Stand (plants/A)	Soybean Plant Height at R1 (cm)	Soybean Plant Height at R8 (cm)
Wakefield	27.4	168,000	43	70
25R26	25.6	204,000	42	66
25R57	25.1	155,000	42	67
Ernie	25.1	188,000	42	70
Terra SR204	25.1	158,000	43	69
Patterson	24.8	181,000	43	68
FFR 558	24.5	167,000	43	69
NK Coker 9803	24.5	158,000	39	68
Glory	24.5	154,000	40	69
KY86C-61-8	23.8	179,000	43	68
2552	23.2	135,000	41	67
Caldwell	23.0	167,000	41	66
Becker	23.0	143,000	40	68
Madison	23.0	149,000	43	68
KAS Patriot	23.0	158,000	40	68
Verne	22.7	127,000	40	68
2540	22.5	133,000	43	69
FFR 555	22.5	176,000	43	68
NK Coker 9663	22.4	177,000	41	68
Jackson	22.2	167,000	40	67
Agripro Foster	22.1	146,000	40	67
KY86C-127-3	22.1	177,000	40	67
2568	22.1	175,000	43	68
NK Coker 9543	21.7	155,000	42	68
Agripro Elkhart	21.7	138,000	40	68
Clark	21.4	143,000	39	68
Beck 103	21.3	155,000	40	67
FFR 523	21.1	202,000	39	67
NK Coker 9704	20.1	158,000	41	66
KAS Justice	20.0	183,000	41	68

Table 2. The levels of statistical significance are indicated for the year, wheat cultivar, and year x cultivar interaction sources of variation for soybean yield, stand, and plant height of soybean cultivar A4715 planted double-crop following 30 different wheat varieties in 1997 and 1998 at Lexington, Kentucky.

Source of Variation	Soybean Yield	Soybean Stand	Soybean Plant Height at R1	Soybean Plant Height at R8
Year	**	NS	**	**
Wheat cultivar	NS	NS	**	NS
Year x cultivar	NS	NS	NS	NS

** Significant at the p=0.01 probability level.

NS=not significant at the p=0.05 probability level.

Summary

We were not able to measure a significant differential effect of wheat cultivar straw residue on soybean yield. However, the mean yields were low and were particularly affected by the dry August and September in 1998. This was followed by the extremely dry summer and fall in 1999 in which irrigation was regulated, and the experiment was not harvested. We did measure a significant difference in soybean plant height at flowering depending on the wheat cultivar straw residue in which the soybean was planted. Plant height measurements are more repeatable than yield measurements, and in this experiment the CV (a measure of relative variability) for plant height was 8 percent compared to the CV for yield of 19 percent. A CV of this magnitude is common for yield measurements in double-crop soybean experiments. There was a significant correlation between the two-year means for soybean height at R1 and soybean yield (r–0.44, $p<0.05$). This indicates that a small differential effect of wheat cultivar straw residue that affects plant growth early may affect soybean yield. Our experimental techniques are not precise enough to quantify this effect if it actually exists. The research by Caviness et al., which showed differential soybean cultivar responses to wheat straw in greenhouse pot experiments, was also not verifiable in field-scale experiments (Crop Science 26:641-643, 1986).

Soybean has genes which produce a wide range of pubescence densities. Densities higher than normal reduce feeding by aphids and thus reduce the spread of soybean mosaic virus transmitted by the aphids. Experimental soybean lines with increased pubescence densities were developed which eliminated the yield depression associated with the genetic donors of the pubescence-increasing genes. High-yielding soybean that avoids SMV infection should be possible.

Isolates of two different soybean viruses were collected from soybean fields across Kentucky. These isolates varied in their potential to reduce soybean yields, a range of 0 - 40 percent yield reduction for the BPMV isolates and a range of 0 - 50 percent for the SW isolates. Depending on the virus isolates prevalent in an area, virus protection can be valuable.

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