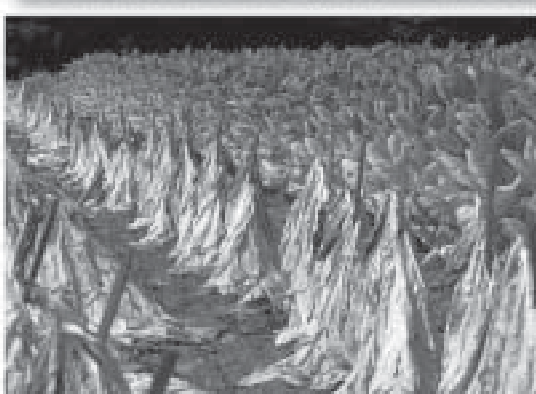
PR-464

AGRICULTURAL EXPERIMENT STATION

UNIVERSITY OF KENTUCKY—COLLEGE OF AGRICULTURE

2002

AGRONOMY RESEARCH REPORT



Kentucky Agricultural Experiment Station • University of Kentucky • College of Agriculture
Department of Agronomy • Lexington, Kentucky 40546

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Agronomy Research 2002

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.

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. The report contains brief updates on continuing projects and initial reports on recently completed studies. *Agronomy Research* 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.

Research Highlights

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

New Crops: As more and more types of novel soybean varieties become available, Kentucky growers will need information on which, if any, management practices they may need to modify to successfully produce a given novel type. Food-grade tofu soybean may need to be planted at lower rates; planting rates that are too high may decrease soybean size and quality. Although seed protein concentration does not usually increase in soybean with nitrogen fertilization, the replacement of nitrogen from nitrogen fixation with mineral nitrogen has increased seed protein concentration. We found that additional mid- to late-season nitrogen is not needed to produce tofu or high-protein specialty soybean with acceptable protein concentrations. Also, standard planting rates should be maintained when growing these specialty 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. Currently, 25 to 30 percent of the wheat acres in Kentucky is no-till planted. 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 soybean, when included in a cropping system with wheat, achieve higher yields (6 percent and 3 percent, respectively) when planted after no-till wheat as compared to tilled wheat.

Working with both primary wheat consulting groups in the state and with the support of the Kentucky Small Grain Growers Association and the Kentucky Soybean Board, we are conducting on-farm, side-by-side comparisons of tilled and no-tilled wheat and its effects on the double-cropped soybean and corn in the cropping system. Over the first year of this study, we have found the wheat yields and the following double-cropped soybean yields to be almost identical. Any long-term effects of the no-till wheat system on the soybean and corn yields would be expected to express themselves in the third or fourth year of the study.

Corn: A corn planting date study was initiated to substantiate optimum planting date periods for highest yield potential with recently developed corn technologies. A Bt corn hybrid and its non-Bt isoline are being compared in planting dates beginning in early/mid-April and ending in mid-June. From initial results after three years, it appears that the highest yield potential for corn is obtained if corn is planted prior to mid-May. There was no yield advantage for Bt corn at earlier planting dates. Use of Bt corn at later planting dates (mid-May or later) was also an economically viable management approach.

Soybean: Soils from a no-till rotation in Argentina were analyzed to examine microbial diversity by patterns of community substrate use. Higher soybean yields were correlated with higher microbial diversity. This may help explain rotation effects on soil microbial community structure.

Tobacco: The use of fatty alcohol compounds (e.g., Off-Shoot-T and Royaltac) at topping, followed by maleic hydrazide (MH) and/or combinations of MH and a dinitroanaline have proven to be effective strategies for controlling suckers in dark tobacco. Dark tobacco sucker control programs utilizing all three types of chemicals have been shown to provide excellent sucker control while minimizing bronzing and browning effects observed when MH was applied immediately after topping at rates sufficient to control suckers until harvest.

Forage Grasses: Sixty-five experimental endophyte-free tall fescue populations are being tested in forage yield trials at two locations in Kentucky. Several new varieties of tall fescue, orchardgrass, and timothy will be released during the summer of 2002. Our work with wide hybrids continues, with 3,500 new genotypes of hybrids between ryegrass and fescue planted in the field in 2001.

Red Clover: The value of certified Kenland red clover seed greatly exceeds the extra cost of the seed. The gross value of 3 tons of extra forage per acre can equal $240 per acre, which greatly exceeds the extra cost for the better seed (approximately $12 per acre at the time of seeding). Therefore, uncertified Kenland red clover is not a bargain at any price.

Freedom! red clover was bred for reduced pubescence to reduce dust and promote faster drying, and this variety was released in 2001. Certified seed may be available in the market in late 2002. Additional mildew and potato leafhopper resistance is being added to the variety by selection. Release date is tentatively set for 2003.

Five cycles of selection for low phenolic red clover (leaves cure green) have resulted in a partially green-leaved type. Further selection is under way to increase the intensity of the character. Plans are to investigate feeding value when development is complete. No release date has been established.

Grazing Corn: A SARE Producer Grant was awarded to study the agronomic, economic, and animal performance of beef cattle grazing standing mature corn. Results from Year 1 indicate that beef cattle utilize approximately 80 percent of the grain with an average daily gain of 1.8 pounds. Cost per pound of gain averaged $0.34. This study will continue in 2002.

Nitrogen Management: Using yield maps to vary the N rate within a field with highly variable yield areas is not agronomically sound. A single rate would be more economically and agronomically sound. N is mineralized at high rates in these soils and needs to be taken into account when making N recommendations. N recommendations that are proven with research based on tillage type, soil drainage class, and previous crop are still the most accurate.

Water Quality: Phosphorus (P) is an essential nutrient regulating plant growth and water quality, whose concentration and availability in soils is governed by many soil chemical properties and hydrologic factors. Soils with low P fertility and high amounts of oxalate extractable iron and aluminum retained the greatest amounts of P, suggesting that these may be useful measurements for identifying soils with the greatest P retention capacity and also for monitoring soils for agricultural production and environmental purposes.

Animal Waste Management: The broiler industry in Kentucky currently produces about 300,000 tons of litter per year. Research has shown that this provides enough nitrogen to fertilize up to 75,000 acres of corn. If litter application rates are limited to the phosphorus fertilizer needs of the crop, as they are likely to be in the long run, more than 300,000 acres of corn per year would be needed to utilize the litter that is currently produced.

The effectiveness of grass filters at trapping poultry litter runoff from no-till soils has not been previously examined. We determined that the concentration of fecal bacteria in runoff from litter-amended no-till soils exceeded that of incorporated litter. However, the total fecal bacteria loss was reduced because greater infiltration occurred. Excessive residue cover promoted fecal bacteria loss. Litter application to no-till soil was overall a better management practice to control fecal bacteria runoff than was incorporation by tillage.

Weed Management: Our research demonstrated the importance of following label restrictions regarding the planting of rotational crops. Certain sulfonylurea wheat herbicides were capable of persisting in the soil long enough to cause injury to double-cropped soybeans in Kentucky; however, this injury was less of a risk where STS soybeans were planted.

We showed that dense stands of Italian ryegrass are capable of limiting wheat yield by at least 70 percent. Applying the appropriate postemergence herbicide in a timely fashion can provide a net gain of $36 to $73 per acre.

Other Research: Differences in yield levels of crop varieties and their ranking with respect to crop yield are highly dependent on the environment in which they are tested. Work continues on development of new statistical methods for analyzing and identifying patterns in data from multi-site yield trials and using this information to increase the accuracy of estimates of variety performance.

No-Till Wheat

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

Introduction

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 believe 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.

Methods

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 soybean. Both no-till and conventionally tilled (chisel-disc) wheat were planted and compared with different nitrogen and herbicide treatments. The corn and double-cropped soybean crops were planted no-till. Stand counts, weed control ratings, disease and insect ratings, and yield 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

Nine years of results (1993-01) are presented in this report.

Yields. The nine-year average yields have been high (Table 1). The conventional till planted wheat averaged about 4.5 bu/ac more than the no-till wheat. The yields of no-till wheat have been significantly lower than wheat planted with tillage four of the nine years, due to compaction one year (1993) and freeze damage in 1996, 1998, and 2001. The yields of no-till wheat have been similar or exceeded that of conventionally tilled wheat the other five years.

Stands. The number of emerged plants was lower with no-till. Planting at the rate of 32 viable seeds/ft^2, the final stands averaged 26.6 and 28.9 plants/ft^2 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 conventionally 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/ac had only a small effect on yield for the nine 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/early spring freezes resulted in wheat damage or when excessive amounts of rain fell after the first application of spring nitrogen.

Table 1. Summary of nine-year wheat results (1993-01).

Treatment Comparison	Yield (bu/ac)	Wheat Stands (plants/sq. ft.)
Tillage Effect		
Conventional	95.1	28.9
No-Till	90.6	26.6
Nitrogen Rate (lb/ac)		
No-Till (90)	88.8	
No-Till (120)	92.4	
Conventional (90)	93.9	
Conventional (120)	96.2	
Weed Control		
No-Till Fall Gramoxone + Spring Harmony Extra	92.5	
No-Till Fall Harmony Extra	92.1	
No-Till Spring Harmony Extra	90.8	
No-Till Check	78.8	

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. Yields were similar for all three herbicide treatments (Table 1). Wild garlic, which is sometimes associated with no-till wheat, was not a significant problem when Harmony was used. Without fall or spring herbicide treatments, weed competition was a problem (especially with henbit and common chickweed) and resulted in lower yields (no-till check).

Nitrogen Application Time. For five years (1996-2000), the trial included treatments with different rates of nitrogen applied at different times. The first two years, the highest yield was obtained with a 120 lb/ac nitrogen rate with half of the nitrogen applied in February and the remaining half applied in late March just prior to jointing. For the last three years, there was 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 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. The wheat seed was treated with Gaucho before planting for Barley Yellow Dwarf protection from 1994 through 1996, and all treatments have received a fall foliar insecticide after 1996.

Diseases. There was no significant disease on any treatments during the nine years except for Barley Yellow Dwarf during the first year. This is consistent with no yield increases obtained from the use of fungicides during the first five years.

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.

Agronomic Research in Forage-Livestock Systems

M. Collins, C.T. Dougherty, and J.C. Henning

Introduction

Grassland agriculture is the most suitable land use for 8 million acres of the 13 million acres of agricultural land of Kentucky due to climate, topography and soils. Livestock convert forages that cannot be used directly by people into high-quality animal products. Forages make up more than 90 percent of the diet of beef cows, the major forage consumer in the state, and about 50 percent of the diet of high-producing dairy cows.

Grassland-based livestock enterprises (horses, beef and dairy cattle, and sheep and goats) generated $2.3 billion of the $3.6 billion farm income in 2000. Kentucky's grasslands supported the largest beef cow-calf herd east of the Mississippi and the eighth largest beef cow herd (1,075,000) in the United States. Equine sales topped $1 billion, and Kentucky ranked first in the United States. In addition, Kentucky producers harvest more than 5 million tons of hay each year for feeding, and cash sales of hay add $50 million each year.

Kentucky grasslands are a vast, renewable natural resource. Expansion of beef cattle and hay enterprises offers an opportunity for Kentucky's farmers facing declining incomes from tobacco.

Goals of Forage Research

Forage livestock research programs at the University of Kentucky have the overall goals of addressing constraints that currently limit profitability and productivity of grassland-based livestock systems. Forage research in the Department of Agronomy emphasizes grazing systems, breeding and evaluation of improved forage varieties, and harvested hay and silage, in addition to expanding areas of nutrient management and GIS technologies. Research and Extension agronomists work closely with their counterparts in the departments of Animal Sciences, Veterinary Science, Biosystems and Agricultural Engineering, Entomology, and Plant Pathology as well as with county Extension personnel plus faculty at the regional universities.

Infrastructure

In 2000, the USDA CREES initiated a program titled "Forage for Enhanced Livestock Production" to help address constraints limiting productivity of forage/livestock systems. Forage research capabilities in Kentucky will be further enhanced by establishment of a forage livestock research unit of the USDA Agricultural Research Service within the College of Agriculture. Geneticists, biochemists, and nutritionists in this unit will conduct basic biology research to support applied research in grassland agriculture.

Areas of Emphasis

Forages support livestock enterprises by providing the least expensive source of nutrients. Agronomic research aims to increase productivity, extend the grazing season, and stabilize supplies of quality forage. There are essentially two thrusts: one directed at improving the amount and quality of herbage available to grazing animals and the other directed toward the economical provision of quality hay and silage for feeding during winter and other periods of limited pasture growth.

Grass Breeding. Cool-season grasses form the base of Kentucky pastures. The Department of Agronomy's grass breeding efforts are aimed at providing better grass cultivars for the pasture base. New, well-adapted cultivars of tall fescue, orchardgrass, timothy, and eastern gama grass are being readied for market. Endophyte-free tall fescue lines have been selected for seedling vigor, persistence, compatibility with pasture legumes, and yield in Kentucky grassland situations. Hybrids between fescue and ryegrass species have useful traits for adapted grasses.

Agronomists continue research in many aspects of tall fescue toxicosis. Essentially toxicant-free and "livestock-friendly" endophytes have been introduced into adapted tall fescue cultivars and are being tested. Ecological research is under way to determine the impact of endophyte absence and novel endophytes on tall fescue vigor and competitiveness of tall fescue.

Clovers. Among adapted species, legumes provide the highest quality forage. The Department of Agronomy maintains the Clover Germplasm Center with 1,900 accessions of 205 species of wild and cultivated clovers. It also includes genetic and breeding stocks of red, white, crimson, kura, and zigzag clovers. Breeding of red clover, kura clover, other *Trifolium* species, and hybrids aims at improving yield, quality, hay characteristics, persistence, and compatibility with pasture grasses. Freedom! red clover that dries more rapidly and makes less dusty hay will become available by the end of 2002, and a mildew- and potato leafhopper-resistant version is anticipated in 2003. North America's first tetraploid red clover cultivar that is high yielding and persistent is in seed multiplication. A red clover genotype that resists browning during hay curing is also being tested.

Processed and Stored Forage. Stored forages are essential to Kentucky livestock enterprises to meet animal needs during winter and other periods of low pasture productivity. Losses during outside hay storage commonly exceed one-third of the initial dry matter, and quality is also greatly reduced. Preservation systems are being refined to improve quality and minimize losses of stored forage. Baled silage shows promise as a harvesting system to minimize dry matter losses and to maintain forage quality during storage. Studies are under way, in cooperation with the Department of Animal Sciences, to compare forage intake and weight gains of cattle on hay and baled silage. This information is aiding producers in making informed decisions regarding forage preservation systems.

Integrated Systems. Grassland agronomists are also concerned with integration of new technologies and management practices into existing farming enterprises. Technologies include GPS, remote sensing technology, and GIS for assessment of alfalfa and tall fescue management practices. Integrated systems are being evaluated on beef cow-calf grazing systems on grasslands established on reclaimed mined land in eastern Kentucky and on summer stocker grazing systems using bermudagrass pastures.

Variety Testing. The Department of Agronomy operates a statewide testing program for evaluating forage species, cultivars, and plant breeding materials. Newly released and experimental grass and legume lines are subjected to overgrazing by cattle and horses to determine persistence under grazing. Agronomists, along with conservationists, wildlife biologists, and biofuel engineers, are also engaged in the introduction, agronomic, and grazing management of native and introduced warm-season grasses including switchgrass, eastern gamagrass, little and big bluestems, and bermudagrass.

Environmental Issues. Perennial forage species conserve and improve soil quality and fertility and form the basis for sustainable cropping systems on sloping land. Forage crops effectively utilize nutrients in animal waste to produce and offer the potential for effective use of these materials. Research programs within the Department of Agronomy are evaluating poultry litter effects on forage productivity, forage quality, and water quality.

Current Issue: Mare Reproductive Loss Syndrome (MRLS). Grassland agronomists are involved in investigating the cause of MRLS. In 2002, soils, pastures and fringes, and mares of "sentinel" farms are being sampled to establish background levels of potential toxicants and conditions that may contribute to MRLS. Agronomy laboratories are analyzing plant samples for plant alkaloid mycotoxins and soils and biological materials for toxicants and mineral imbalances that may disturb reproduction.

Future of Grassland Research

The Department of Agronomy has a long history in research, teaching, and extension in grassland agriculture. Future programs will emphasize improving forage quality and nutrient utilization by animals as well as matching seasonal distribution of pasture production with livestock needs.

Phosphorus Sorption Behavior in Kentucky Soils and Potential Impacts on Water Quality

E. D'Angelo

Phosphorus (P) is an essential nutrient regulating plant growth and water quality, whose concentration and availability in soils is governed by many soil chemical properties and hydrologic factors. This study was conducted to (i) determine the major forms of P in representative soils of Kentucky (e.g., amount of P bound with iron, aluminum, and calcium minerals and organic matter), (ii) determine the maximum P retention capacity of the soils, (iii) find out which soil component is primarily responsible for retaining P, and (iv) discover whether P retention was related to easily measurable soil properties. It is expected that results will be useful for identifying soil chemical properties that govern P retention and for quantifying the amount of P (e.g., from manure sources) that can be added to soils to optimize soil fertility and minimize P impacts on water quality.

Total P in the soils ranged between 139 to 3861 mg/kg and was highest in soils from the Bluegrass region (Table 1). Using a chemical fractionation procedure, it was found that most of the soil P was bound with iron and aluminum minerals, organic matter, and other highly resistant inorganic and organic P forms. Soils from the Bluegrass also contained considerable amounts of P associated with calcium minerals.

In batch sorption isotherm experiments with the soils, it was discovered that inorganic P added at 300 mg P/kg was rapidly removed from solution by iron and aluminum minerals in the soil (47 to 100 percent in 48 hours). Phosphorus was not removed by calcium minerals, which was likely explained by acidic pH values of the soils used in the study (pH 4 to 7). Dissolution of calcium phosphate minerals and decomposition of organic matter were the main sources of readily available P in the Kentucky soils.

Figure 1. Relationship between oxalate extractable iron and aluminum and P sorption behavior of 20 soils in Kentucky. Smax is the soil's maximum P retention capacity, and k is the soil's P sorption affinity. Soils with higher log Smax/k values have increased P retention capacity.

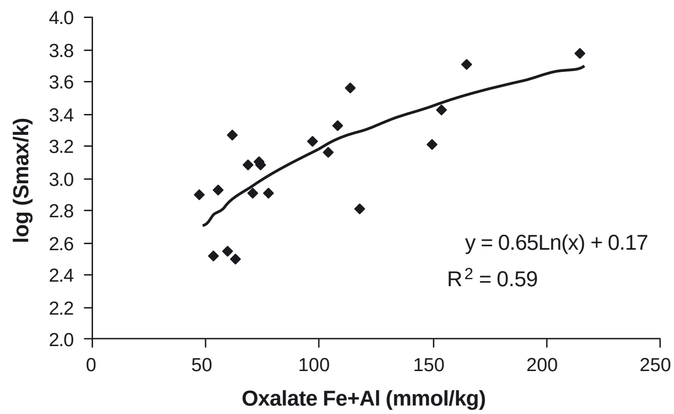


Table 1. Phosphorus distribution in native soils from four physiographic regions of Kentucky.

Soil	Inorganic P: Water+Weakly Exchangeable (Labile-P_i)	Inorganic P: Fe+Al (NaOH-P_i)	Inorganic P: Ca+Mg (HCl-P_i)	Organic P: Fulvic+Humic (NaOH-P_o)	Residual P	Total P
Bluegrass			mg P kg soil^{-1}			
Eden	1	127	78	381	295	882
Lowell 1	9	272	61	440	431	1213
Lowell 2	3	570	146	298	401	1418
Maury 1	9	1230	1107	769	746	3861
Cumberland Plateau						
Shelocta 1	1	109	0	223	226	559
Trappist	1	151	11	191	274	528
Highland Rim						
Mountview	1	132	0	158	126	417
Nolin	1	176	0	193	180	550
Pembroke	2	197	18	104	159	480
Vertrees	1	51	0	75	148	275
Shawnee Hills						
Frondorf	1	33	3	62	40	139
Grenada 1	1	65	11	146	138	361
Newark	1	73	1	155	118	348
Sadler	1	20	0	111	134	266
Tilsit	1	99	0	169	97	366

The maximum P retention capacity of the soils, as determined from the isotherm studies, ranged between 193 and 1300 mg P/kg. When 23 to 63 percent (median 41 percent) of the soil's maximum P retention capacity was reached, the soil solution contained elevated levels of P (>1 mg P/liter), which exceeded plant requirements (~0.2 mg P/liter) and may threaten water quality. Therefore, it is critical to maintain P levels below this level for economic and environmental reasons.

Two factors were primarily responsible for determining the soil's P retention capacity: P fertility and the amount of iron and aluminum extractable with oxalate solution (e.g., amorphous iron and aluminum oxyhydroxides). Soils with low P fertility and high amounts of oxalate extractable iron and aluminum retained the greatest amounts of P, suggesting that these may be useful measurements for identifying soils with the greatest P retention capacity and also for monitoring soils for agricultural production and environmental purposes. Studies are planned to investigate whether these relationships are valid for predicting P retention and losses from agricultural fields with different P fertility and other chemical characteristics.

Acknowledgments

This research was partially supported by Senate Bill 271 Water Quality Grant to the author. The author wishes to thank Drs. Bill Thom, Frank Sikora, and Martin Vandiviere for their contributions to the study.

The Value of Certified Red Clover Seed: Certified versus Uncertified Kenland Red Clover

R. Spitaleri, J.C. Henning, N.L. Taylor, G.D. Lacefield, D.C. Ditsch, and G.L. Olson

Red clover is one of the primary renovation legumes for pasture in Kentucky. Kenland red clover is a release of the University of Kentucky Agricultural Experiment Station and is still marketed in Kentucky. However, most of the Kenland sold is uncertified. Because of confusion about the value of certification, farmers think that uncertified Kenland is an “improved” variety of red clover. Uncertified Kenland red clover is always cheaper than certified, and so most purchases are of the uncertified type.

Experiments were established in spring of 1998 and 2001 at the Robinson Forest Substation at Quicksand in eastern Kentucky to compare the yield of several varieties of red clover, including certified and uncertified Kenland red clover. Several common red clovers (designated by letters X, Y, Z, and A) were also included.

Certified Kenland outperformed uncertified Kenland in both the 1998 and 2001 seeding (Tables 1 and 2). Over three harvest seasons from the 1998 seeding, certified Kenland produced over 3 tons more dry matter yield per acre than uncertified (Table 1). In the year of seeding (the 2001 seeding), certified Kenland produced 1.5 tons more yield than uncertified (Table 2). Uncertified Kenland clover performed much more like common entries than the improved counterparts like Kenland, Kenstar, and others.

The value of certified Kenland red clover greatly exceeds the extra cost of the seed. The gross value of 3 tons of extra forage per acre can equal $240 per acre, which greatly exceeds the extra cost for the better seed (approximately $12 per acre at the time of seeding). Therefore, uncertified Kenland red clover is not a bargain, at any price.

Table 1. Dry matter yields (tons/acre) of red clover varieties sown 13 April 1998 at Quicksand, Kentucky.

Variety	1998 Total	1999 Total	2000 Harvests May 5	2000 Harvests Jun 30	2000 Total	3-yr. Total
Commercial Varieties—Available for Farm Use						
Kenland, certified	1.34 *	6.55 *	1.50 *	1.19 *	2.69 *	10.59 *
Kenstar	1.24 *	6.17 *	1.60 *	1.12 *	2.71 *	10.12 *
Cinnamon	1.10	6.09	1.22	1.04	2.26	9.45
Greenstar	1.15 *	6.02	1.18	1.05 *	2.22	9.39
Solid	1.06	5.96	0.89	0.91	1.80	8.82
Common Y	0.87	5.48	0.49	0.70	1.19	7.53
Kenland, uncertified	1.01	4.78	0.73	0.78	1.51	7.30
California Ladino	0.95	3.99	1.36 *	0.94	2.29	7.24
Regal Ladino	0.99	3.91	1.30	0.98	2.28	7.18
Common X	0.92	4.86	0.37	0.77	1.14	6.92
Common Z	0.75	4.93	0.43	0.73	1.15	6.83
Mean of trial (not all varieties shown)	1.05	5.51	1.04	0.94	1.99	8.55
CV, %	13.14	6.46	25.83	11.54	17.15	6.84
LSD, 0.05	0.2	0.51	0.38	0.16	0.49	0.83

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

Table 2. Dry matter yields (tons/acre) of red clover varieties sown 29 March 2001 at Quicksand, Kentucky.

Variety	2001 Harvests Jul 3	2001 Harvests Aug 6	2001 Harvests Oct 10	Total 2001
Commercial Varieties—Available for Farm Use				
Kenland certified	1.86	2.13	2.18	6.17 *
Sienna	1.80	1.88	2.04	5.73 *
Duration	1.89	1.89	1.87	5.64 *
Emarwan	1.73	1.85	1.96	5.54 *
Vesna (tetraploid)	1.60	1.77	2.04	5.41 *
Rojo Diablo	1.73	1.75	1.74	5.22
Red Gold Plus	1.60	1.82	1.74	5.16
RedlanGraze II	1.63	1.69	1.67	4.99
Kenland uncertified	1.51	1.52	1.60	4.63
Common A	1.41	1.31	1.40	4.12
Mean of trial (not all varieties shown)	1.67	1.81	1.81	5.29
CV,%	10.75	12.21	17.58	11.27
LSD, 0.05	0.25	0.31	0.45	0.84

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

The Effect of Variety on Yield of Native Warm-Season Perennial Grasses

R. Spitaleri, J.C. Henning, G.D. Lacefield, and T.D. Phillips

Kentucky's pasture and hay acres are largely cool-season species. Therefore, there is a natural decline in production in midsummer. This decline limits livestock production in many cases. A high-yielding, summer perennial grass would be beneficial to Kentucky livestock enterprises. Little is known about the performance of different varieties of the primary native warm-season grass species in Kentucky, which are switchgrass (SG), big bluestem (BB), indiangrass (IG), and eastern gamagrass (EG).

Small (5 by 15 feet) plots of switchgrass, big bluestem, indiangrass, and eastern gamagrass were established in the spring of 2000 by transplanting small plants raised in greenhouse float trays from seed or from sprigs. Plots were allowed to become established during the remainder of 2000. In 2001, plots were harvested for yield on July 6 and August 7 for all species but indiangrass, which was harvested only once on the second date. The date for approximate 50 percent heading as well as plant height at this stage was observed.

Table 1. Dry matter yield (tons/acre) and maturity measurements of native warm-season perennial grasses planted 18 July 2000 at Lexington, Kentucky.

		Harvests		Total	Maturity	
Species	**Variety**	**Jul 6**	**Aug 7**	**2001**	**Date of 50% Heading**	**Height (in.) at Heading**
Big bluestem	Pawnee	3.43	1.4	4.83	July 13	46
	Kaw	3.41	1.37	4.78	July 10	53
	Rountree	3.27	1.40	4.67	July 13	48
	KYAG 9601*	3.05	1.32	4.37	July 20	42
			Mean	4.66		
Eastern gamagrass	Meade Co.*	3.45	4.46	7.91	June 28	45
	PMK 24 (Pete)	2.56	3.82	6.38	June 28	41
	Rider Mills Farm	1.52	3.47	4.98	July 1	33
			Mean	6.42		
Indiangrass	NE54		7.12	7.12	Aug 8	59
	Cheyenne		6.44	6.44	Aug 15	65
	Rumsey		6.25	6.25	Aug 18	64
	Osage		6.24	6.24	Aug 11	59
			Mean	6.51		
Switchgrass	Alamo	5.6	3.08	8.68	July 5	51
	Cave-In-Rock	4.89	2.37	7.26	June 28	46
	KYPV 9504*	3.98	1.55	5.53	July 2	44
	KYPV 9505*	3.83	1.68	5.52	July 2	35
	KYPV 9506*	3.49	1.58	5.08	July 1	35
	Trailblazer	3.84	0.56	4.41	July 1	41
			Mean	6.08		

* Indicates that the variety is an experimental or a collection and is not commercially available.

Ranking the species by overall dry matter yield, IG>EG>SG>BB (Table 1). However, IG was so late in maturity that it allowed only one harvest (August 7). The species earliest to mature were SG and EG, followed by BB and IG.

Varieties of native grasses are limited, and the overall supply of seed varies annually. The commercial varieties shown here appear to be adapted to Kentucky but will vary in yield potential (Table 1). These studies indicate that native grasses can contribute significantly to pasture and hay systems in Kentucky.

Several concerns remain about these species, the most notable being establishment. At the time of initiation of this project, no herbicides were labeled for the establishment of these grasses except for those applied to suppress the existing vegetation such as paraquat or glyphosate. This situation is changing, but it is likely that Kentucky farmers will never have many options for residual weed control for these grasses.

In addition, these materials are slow to germinate and emerge and are susceptible to weed competition during the seeding year. Therefore, producers should plan for cultural weed control options such as mowing or light grazing. Finally, these species must be rotationally grazed and allowed to rest in the fall to build up energy reserves to overwinter.

However, the yields of these species are high and come in midsummer to late summer when cool-season grasses are not productive. They can play a role in Kentucky hay and pasture systems provided that producers are prepared to manage these through the establishment phase and also will supply proper management for persistence.

Productivity of Annual Ryegrasses for Kentucky

R. Spitaleri, J.C. Henning, G.D. Lacefield, and T.D. Phillips

Recent mild winters in Kentucky have enabled trial seedings of annual ryegrass to provide significant amounts of fall and “winter” forage across the state. Much more forage is produced when this species is clear seeded following a summer annual or tobacco crop rather than when interseeded into overgrazed sod. However, some have had success with these sod interseedings as well. However, the yield on these fields comes later than in clear seedings.

A major question with annual ryegrasses is winterhardiness. Marshall is an older variety and has the reputation of being the most winterhardy. New varieties are being released faster than they can be tested for Kentucky performance. The University of Kentucky established its first annual ryegrass trial in several years in the fall of 1999. This trial (located in Lexington) provided four harvests in the mild winter and summer of 1999-2000. Two more annual ryegrass trials were seeded in 2000 (at Princeton and at the Western Kentucky University Farm near Bowling Green). Yields in the 2000-2001 growing season were between 3 and 4 tons of dry matter per acre with most coming in the first two spring harvests (Tables 1 and 2). These yields were half that observed from similar tests the previous year. No harvestable yield was achieved in the fall or winter of 2000-2001 with annual ryegrass. A clear prerequisite for success with annual ryegrasses is rainfall. This requirement is doubly important when ryegrass is seeded into sod.

Table 1. Dry matter yields (tons/acre) for annual ryegrass varieties sown 22 September 2000 at Bowling Green, Kentucky.

	Harvests				Total
Variety	**April 6**	**April 27**	**June 11**	**July 24**	**Yield**
Zorro	1.18	1.46	0.82	0.41	3.88
Marshall	1.32	1.46	0.56	0.05	3.39
Big Daddy	1.19	1.29	0.58	0.04	3.09
Floralina	1.27	1.35	0.43	0.04	3.08
Rio	1.21	1.33	0.45	0.06	3.05
Cis Florida	1.07	1.26	0.57	0.07	2.97
Fantastic	1.35	1.07	0.42	0.03	2.87
Common	1.15	1.20	0.44	0.02	2.81
Gulf	1.10	1.01	0.43	0.03	2.56
Spark	1.01	0.90	0.52	0.10	2.53
Mean	1.18	1.23	0.52	0.08	3.02
LSD, 0.05	0.23	0.13	0.17	0.08	0.39
Percent of yield	39%	41%	17%	3%	100%

Table 2. Dry matter yields (tons/acre) for annual ryegrass varieties sown 21 September 2000 at Princeton, Kentucky.

	Harvests				Total
Variety	**April 5**	**April 26**	**June 12**	**July 17**	**Yield**
Zorro	1.34	1.81	1.03	0.49	4.66
Hercules	1.05	1.51	0.81	0.42	3.80
Avance	1.03	1.50	0.83	0.40	3.76
Marshall	1.15	1.84	0.48	0.04	3.52
Rio	1.29	1.63	0.51	0.02	3.45
Andy	0.88	1.37	0.84	0.33	3.42
Big Daddy	0.93	1.54	0.60	0.03	3.10
Fantastic	1.31	1.36	0.38	0.05	3.09
Common	1.07	1.41	0.42	0.03	2.93
Cis Florida	0.66	1.53	0.58	0.05	2.82
Gulf	0.91	1.44	0.42	0.01	2.79
Mean	1.05	1.54	0.63	0.17	3.39
LSD, 0.05	0.16	0.16	0.12	0.09	0.33
Percent of yield	31%	45%	19%	5%	100%
Average percent across both studies	35%	43%	18%	4%	100%

The Novel Endophyte Situation and ‘Max Q’

R. Spitaleri, J.C. Henning, G.D. Lacefield, and T.D. Phillips

Since the discovery of the endophyte in tall fescue, scientists have hoped for a tall fescue plant with the fungus that would give all the good agronomic characteristics of tall fescue but not cause the animal performance problems.

A unique strain of the endophyte, termed a “novel” endophyte, was identified that did not cause the fescue plant to produce the animal toxins of the “traditional” E+ tall fescue. This first novel strain was identified by Ag Research scientists in New Zealand. The objective was to allow the friendly endophyte to give the tall fescue plant the toughness and persistence of toxic tall fescue and the animal performance of nontoxic tall fescue.

To obtain this unusual combination, Dr. Joe Bouton at the University of Georgia and Dr. Gary Latch of Ag Research in New Zealand reinfected a reportedly nontoxic fungal endophyte into the endophyte-free Jesup and Georgia 5 varieties.

The first commercial combination was named Max Q, which was tested at the University of Kentucky as Jesup 542. This novel endophyte material has been in yield and grazing trials since 1999. Yields of Max Q (Jesup 542) have been comparable to Jesup without the endophyte (Table 1) and to other commercial endophyte-free tall fescues (Table 2). Grazing tolerance data at Lexington have shown that Max Q is slightly more tolerant than Jesup without the endophyte after three years of abusive grazing (data not shown).

Therefore, Max Q appears to be adapted to and productive in Kentucky, at least under the conditions of these trials. Its persistence in the grazing tolerance trials is encouraging and is consistent with data in other states that find Max Q to be more persistent under grazing stress than other endophyte-free varieties. Since there are endophyte-free tall fescues that persist as well as Jesup 542 (Max Q) in the Lexington trials (data not shown), more work is needed to see if the novel endophyte is required for producers to have a persistent tall fescue that also supports good livestock gains.

In the near term, Max Q appears to be a sound option for those producers who have fields that are free of endophyte-infected tall fescue at present and can manage them to prevent contamination from seed of tall fescue plants infected with the "wild" or toxic endophyte.

Table 1. Dry matter yields (tons/acre) of tall fescue varieties and a perennial ryegrass (PRG) sown 12 October 1998 at Princeton, Kentucky.

Variety	Maturity[1] May 15, 2000	1999 Total	2000 Harvests May 15	Jun 22	Jul 21	2000 Total	2-yr. Total
Commercial Varieties—Available for Farm Use							
KY 31+ [2]	61.50	4.89 *	3.61 *	0.95 *	0.97 *	5.53 *	10.43 *
Jesup - [2]	66.75 *	4.23	3.16	0.78	0.85	4.78	9.01
Select	64.00	3.88	3.33 *	0.90 *	0.84	5.06 *	8.95
Vulcan	58.25	3.36	3.01	0.93 *	0.98 *	4.92	8.28
TF 33	61.00	2.59	1.58	0.93 *	0.88 *	3.38	5.97
Experimental Varieties—Not Available for Farm Use							
KY31- [2]	65.00 *	4.78 *	3.34 *	0.86	0.93 *	5.12 *	9.90 *
Jesup EI	66.25 *	4.63 *	3.15	0.97 *	1.09 *	5.21 *	9.84 *
Jesup 542 (Max Q)	64.50 *	4.19	2.94	0.81	0.88 *	4.63	8.82
Mean of trial (not all varieties shown)	63.07	4.12	3.21	0.89	0.90	5.02	9.14
CV, %	2.94	11.12	9.64	17.17	22.97	7.42	8.13
LSD, 0.05	2.65	0.66	0.44	0.22	0.30	0.53	1.06

* Not significantly different from the highest value for tall fescue entries in the column, based on the 0.05 LSD.

1 Maturity rating scale: 37 = flag leaf emergence, 45 = boot swollen, 50 = beginning of inflorescence, 58 = complete emergence of inflorescence, 62 = beginning of pollen shedding.

2 "+" indicates variety is endophyte infected; "-" indicates variety is endophyte free.

Table 2. Dry matter yields (tons/acre) of tall fescue and festulolium (FL) varieties sown 23 August 1999 at Lexington, Kentucky.

Variety	2000 Harvests May 9	Jun 14	Jul 27	Aug 28	Oct 18	Nov 24	2000 Total
Commercial Varieties—Available for Farm Use							
Duo (FL)	5.49 *	1.87 *	1.29	0.93	0.94	0.52	11.04 *
Atlas	2.96	1.49 *	1.92 *	1.53 *	1.63 *	0.77 *	10.30 *
Select	3.62	1.54 *	1.85 *	1.25	1.26	0.52	10.03 *
Ky31+ [1]	3.20	1.45	1.81 *	1.31 *	1.33	0.50	9.60 *
Fuego	3.29	1.41	1.41	1.25	1.34	0.63 *	9.33 *
Bar 9 TMPO	2.97	1.34	1.58	1.18	1.45 *	0.63 *	9.15 *
Seine	2.57	1.23	1.71	1.27	1.52 *	0.63 *	8.93 *
Johnstone	3.09	1.38	1.66	1.19	1.13	0.44	8.89
Maximize	2.64	1.28	1.70	1.28	1.39	0.59	8.88
DLF-B	3.00	1.26	1.47	1.23	1.32	0.58	8.86
Experimental Varieties—Not Available for Farm Use							
Jesup 542 (Max Q)	3.01	1.25	1.80 *	1.36 *	1.29	0.57	9.29 *
Ky31- [1]	1.17	1.45	1.91 *	1.50 *	1.50 *	0.56	8.09
Mean of trial (not all varieties shown)	3.29	1.47	1.62	1.27	1.31	0.55	9.50
CV, %	33.99	19.01	16.22	12.42	15.75	18.23	15.85
LSD, 0.05	1.58	0.39	0.37	0.22	0.29	0.14	2.12

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

1 "+" indicates variety is endophyte infected; "-" indicates variety is endophyte free.

Bermudagrass for Livestock Forage Production in Kentucky

D.C. Ditsch, J. Henning, and J.W. Turner

Bermudagrass (*Cynodon dactylon*) is a warm-season perennial that produces ample forage during the summer when cool-season grass production is low. Following the drought of 1999, considerable interest in the use of bermudagrass in Kentucky emerged along with several new varieties that claimed to be high yielding and high quality. Therefore, a field study to evaluate several new sprigged and seeded bermudagrass varieties was initiated in Morgan County, Kentucky.

This study was conducted on a well-drained, deep silt loam soil formed from alluvium. The plot area was conventionally prepared for sprigging of Quickstand and World Feeder at the rate of 20 bu/ac and seeding of Wrangler and CD90160 at the rate of 10 lb/ac. Fertilization during the establishment year followed World Feeder recommendations. Sprigging and seeding date was April 14, 2000. Dry matter yield was measured by mechanically harvesting the center section of each plot and correcting for moisture content. Nutritive quality was determined by near infrared reflectance (NIR) (data not presented). During the spring of 2001, green-up and winter injury ratings were taken.

Table 1. 2000/2001 Morgan County bermudagrass variety trial.

	Variety	8/21/00 Harvest*	10/13/00 Harvest	Total DM
			lb/ac	
2000	Quickstand	2825 b***	1359 b	5198 ab
	World Feeder	2652 b	1413b	4065 b
	Wrangler**	2825 b	675 c	3500 b
	CD90160**	4550 a	2142 a	6693 a

	Variety	6/20/01 Harvest	7/31/01 Harvest	10/9/01 Harvest	Total DM
			lb/ac		
2001	Quickstand	4141 a	5295 a	7509 a	17580 a
	World Feeder	3054 a	5720 a	5718 b	14490 a
	Wrangler	4735 a	6043 a	5896 b	16640 a
	CD90160	winter killed - no measurable bermudagrass harvest			

Green-Up and Winter Injury Rating

Variety	% Winter Survival	Vigor (0 - 9 scale)****	Color (0 - 9 scale)****
Quickstand	81 a	5 b	4 b
World Feeder	53 b	4 b	5 b
Wrangler	78 a	7 a	8 a
CD90160	0 c	0 c	0 c

* 100 lb N per acre applied after each harvest in the form of ammonium nitrate.
** Seeded varieties. Seeding rate: 10 lb/ac. Sprigging rate: 20 bu/ac. Seeding and sprigging date: 4/14/00.
*** Values within a column followed by the same letter are not significantly different at the 95% level of probability.
**** (0 = worst, 9 = best).

Only two harvests were taken during the establishment year. The highest yield variety was CD90160 although it was not statistically different from Quickstand (Table 1). Spring ratings, following a moderately hard winter, resulted in total winter kill of CD90160. Quickstand and Wrangler had the highest winter survival. During the 2001 growing season, there was not a significant difference in dry matter yield between the remaining three varieties, which averaged 8.1 ton/ac.

In conclusion, bermudgrass can be a valuable forage crop for livestock producers in Kentucky. However, the results from this study indicate that variety selection should be based on research conducted under Kentucky's growing environment.

Performance of Bermudagrass Cultivars at Princeton, Kentucky

M. Rasnake

Nine bermudagrass cultivars that were selected for potential adaptability to Kentucky climatic conditions were established at Princeton in May 1998. Sprigs were placed in two rows that were spaced 4 ft. apart in 10-ft.-by-20-ft. plots. Two replications were established in a randomized complete block design. Growing conditions were good during the summer of 1998, and all cultivars developed excellent stands. The plots were harvested twice in 1998 and four times each year thereafter. Fertilizer was applied according to soil test results. Nitrogen was applied at the rate of 300 pounds per acre split into three separate application times.

Yields were measured in tons per acre at the hay equivalent moisture of 12.5 percent. The growth of Quickstand shown in the following table was best in the first two years, although not significantly different from Tifton 44. Tifton 44 has remained at the top throughout the study. However, the experimental cultivars 74 x 12-6 and 74 x 21-6 were equal to Tifton 44 in 2000 and 2001, which were excellent growing seasons. Stands were visually evaluated in the fall of 2001 since some of the cultivars had shown injury from the previous winter. Stand ratings shown in the table indicate that Tifton 44, Quickstand, 74 x 12-6, and 74 x 21-6 were better able to survive Kentucky winters than the other five cultivars. Both Russell and Midland were severely damaged.

The experimental strain 74 x 21-6 was released as “Midland 99” in 1999. Limited supplies of sprigs should be available this year. The 74 x 12-6 has recently been released as “Ozarka” through the University of Missouri. A limited supply of Ozarka foundation sprigs should be distributed this year.

These new cultivars will add significantly to the selection of cold hardy bermudagrasses available to growers in Kentucky and other states in the northern range of bermudagrass adaptability.

Bermudagrass cultivar yields, Princeton, Kentucky.

	1998	1999	2000	2001	Stands
Cultivars	Tons/Ac at 12.5% Moisture				(10/01)
Tifton 44	2.1 ab*	7.7 ab	8.4 a	8.4 ab	Excellent
Quickstand	2.7 a	8.5 a	7.0 abc	7.8 abc	Excellent
74 x 12-6	1.7 abc	7.1 bc	7.7 ab	9.2 a	Very Good
74 x 21-6	2.4 a	6.6 bc	6.9 abc	8.8 a	Very Good
Hardie	2.1 abc	6.3 c	6.6 bc	8.0 ab	Fair
Russell	2.2 a	6.1 c	5.9 c	5.8 c	Poor
16 x 66	1.1 bc	6.1 c	6.6 bc	7.9 abc	Good
19 x 16	1.0 c	6.1 c	6.4 bc	7.8 abc	Good
Midland	1.1 bc	6.3 c	5.9 c	6.4 bc	Poor

* Means within a column followed by the same letter are not significantly different. $\alpha = 0.05$.

Numbered cultivars (e.g., 16 x 66) are experimentals from Oklahoma and Kansas.

Forage Grass Breeding at the University of Kentucky Comes of Age

T.D. Phillips, P. Wu, and P.S. Shine

The tall fescue/forage grass breeding project has been active for the past decade, concentrating on endophyte-free tall fescue. We have continued work with wide hybrids among ryegrasses and other relatives of tall fescue, but most of our efforts have focused on variety development. To date, we have produced more than 100 experimental populations of tall fescue, ryegrass, orchardgrass, timothy, Kentucky bluegrass, and smooth bromegrass. More than 80 percent of these populations are endophyte-free tall fescue. We entered six experimental tall fescue populations and several orchardgrass and timothy lines in the official University of Kentucky Forage Variety Testing Program over the past several years. We will be releasing two new tall fescue varieties, as well as an orchardgrass and timothy during the coming year. Our new orchardgrass has been named ‘Prairie’ and will be marketed by Turner Seed. The other new cultivars will take a few seasons to become available for Kentucky’s forage producers.

We anticipate introducing strains of nontoxic endophyte into our most promising tall fescue populations, in partnership with Ag Research and Pennington. These endophytes allow the grass to persist and survive stress better than endophyte-free tall fescue but do not cause the serious animal health problems associated with the normal (toxic) endophyte strain in Kentucky 31 and other infected cultivars.

During May 2001, more than 3,500 wide hybrid genotypes were established in the field for evaluation of agronomic performance and subsequent vernalization. These plants represent a range of wide hybrids between ryegrass and tall fescue, meadow fescue x tall fescue, and other crosses among relatives of tall fescue. Methods for restoring fertility to these sterile F1 hybrids are being studied. Preliminary results from the greenhouse in April 2002 have revealed that colchicine treatment succeeded in doubling chromosome number much more frequently than treatment with oryzalin. Hybrids and their derivatives will be used to introgress favorable genes into forage-type tall fescue.

In September 2001, four yield trials were established to measure yield potential and agronomic performance of 65 experimental synthetics of tall fescue, ryegrass, and festulolium, along with eight commercial check cultivars. Plots will be harvested and evaluated for two growing seasons at Lexington and Princeton, Kentucky. Additional yield trials will be established for orchardgrass, timothy, and miscellaneous cool-season forage grass species in the fall of 2002. Based on these early yield trials, we will enter six or more of our best experimentals in the University of Kentucky Forage Variety Testing Program to obtain sufficient information to decide if these should be released as new cultivars. We need a minimum of four production location-years to be able to release new, improved varieties of forage grasses.

Environmental and Biological Factors of Perennial Weed Establishment in Kentucky No-Tillage Fields

C.L. Brommer and W.W. Witt

Introduction

Over the last few decades, conservation tillage practices have increased in row crops in Kentucky where no-tillage now accounts for more than 50 percent of the total row crop acreage. These conservation tillage practices have many benefits; however, there are problems associated with no-till fields in Kentucky. These problems can include a higher population of perennial weeds. Perennial weeds can increase primarily because of the lack of pre-plant tillage to disrupt the root systems of broadleaf perennial weeds.

Extension personnel and producers have noticed that perennial weed communities establish in similar areas in many different fields. These areas may include low or bottom portions of fields and places where water would be more available. Producers also face the problem of having to manage larger farms, which decreases the amount of time a producer has to scout fields and make herbicide applications. A system that would decrease scouting time or that would predict weed occurrence in a portion of a field would be beneficial. With these observations in mind, a study was established to correlate the terrain attributes of no-till fields with occurrence of perennial weed colonies.

Materials and Methods

A cooperator field was located in Calloway County for the study. The field selected had been in no-till production for several years and was currently planted to corn. Populations of hemp dogbane, trumpetcreeper, and hedge bindweed were located and their positions documented using a Starlink® GPS backpack unit. These weed colonies were located six weeks after corn planting. Colonies were identified by walking through the entire field in 10- to 20-meter passes in a north to south orientation. Colonies of these weed species were used if the colony contained at least four plants within a 5-meter radius. Identified colonies were then marked by walking around the diameter of the colony with the GPS unit, and the approximate center of the colony was also marked.

Digital Elevation Map Creation. A Digital Elevation Map (DEM) was used to calculate the terrain attributes. The DEM was produced by digitizing a previously created landform elevation map, at a 10-meter resolution, using ARCINFO®. The landform survey map was created using survey equipment, with measurements taken on a north-south oriented transect of the entire field. A universal kriging program was used to interpolate the approximately 1,500 irregular points to a regular grid of 1,978 points (43 by 46).

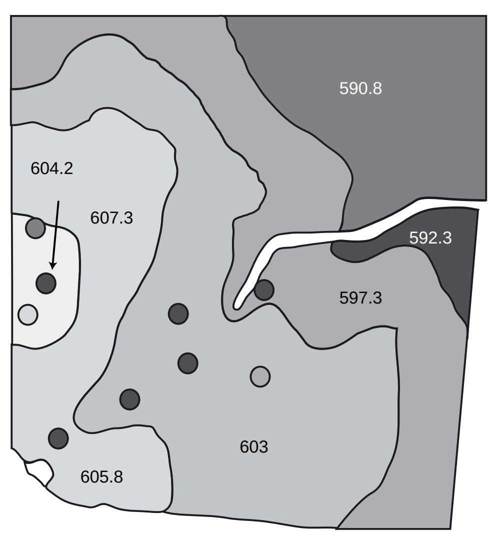
Terrain Analysis and Stepwise Regression. The terrain analysis was conducted by using the DEM and ARCINFO to calculate terrain attributes. Primary terrain attributes were extracted from the farm-scale grids using the sample function in ARCINFO. For calculation of secondary terrain attributes, data were collected from the previous calculation and analyzed using Microsoft Excel®. Statistical analysis was conducted using a split-sample method to generate and validate using multivariate linear models to describe the variability of the perennial plant locations, by species, as a function of the terrain attributes.

Results

The occurrence of hemp dogbane in this field was not correlated with any terrain attribute. There was a correlation between the location of trumpetcreeper colonies and the catchment area and the slope index. Hedge bindweed locations correlated with the catchment area and the slope index. The catchment area and slope index values are indicators of water runoff in the field and the topography of the field.

Catchment area is defined by area per unit width orthogonal to the flow direction. When calculated from DEM data, it is the drainage area divided by the grid-cell size. Definition of the slope index, also known as the slope gradient, is described in terms of percent slope. Both of these hydrological characteristics are good indications of the potential amount of water that may be flowing through a plant colony. The presence of trumpetcreeper and field bindweed in these areas suggests that these species may have a need for this environmental condition or that they simply outlast the other species, thus creating a niche for their development. There is also the potential that waterborne nutrients or reproductive structures were carried to these portions of the field. The map at Figure 1 indicates how the occurrence of trumpetcreeper varies with elevation and that most of the colonies occur in lower portions of the field (catchment area).

Figure 1. Trumpetcreeper locations overlaid on an elevation contour map (elevation is in feet). Filled circles represent trumpetcreeper colonies.



Summary

This experiment revealed that trumpetcreeper and hedge bindweed occurred in areas where water flowed or collected in the field. If these results are confirmed in other fields, then the difficult task of locating weed colonies in growing corn and soybean can be simplified. Growers can utilize digital elevation maps of their fields to identify specific areas of the field to scout for perennial weeds. This process speeds up scouting of fields for weeds since the entire field does not need to be scouted and herbicides can be targeted to specific areas of the field to reduce the cost of controlling these perennial weeds.

Impact of Spring-Applied Wheat Herbicides on No-Till Double-Cropped Soybeans

J.R. Martin, W.W. Witt, and D.L.Call

Studies were conducted between 1999 and 2001 as a part of an ongoing investigation to evaluate the potential for certain wheat herbicides to persist long enough in soil to cause injury to double-cropped soybeans. Herbicides in these experiments included Ally (metsulfuron), Everest (flucarbazone), Maverick (sulfosulfuron), and Peak (prosulfuron). Soybeans, with or without the STS trait, were planted after wheat harvest to determine if this herbicide-resistant technology would help limit injury from wheat herbicides that persist in soil.

Ally and Peak, applied in the spring of 2000, appeared to stunt soybeans without the STS trait; however, the effects of these herbicides on the yield of double-cropped soybeans were inconclusive.

Maverick or Peak applied to wheat in the spring of 2001 caused 35 percent injury to non-STS double-cropped soybeans. This injury was expressed as stunted soybeans. However, very little injury (i.e., $\leq$ 3 percent) occurred with the STS variety. Soybean plants stunted by Peak eventually recovered; however, stunting of the non-STS soybeans from Maverick was still evident when soybeans were harvested. The injury that was observed with these herbicides did not limit the yield of either soybean variety; however, there was a slight but nonsignificant reduction in yield of the non-STS variety where Maverick or Peak was applied to wheat in 2001.

This research demonstrated the importance of following label restrictions regarding the planting of rotational crops. Certain sulfonylurea wheat herbicides were capable of persisting in the soil long enough to cause injury to double-cropped soybeans in Kentucky; however, this injury was less of a risk where STS soybeans were planted.

Factors Influencing Yield Reduction in Glyphosate-Tolerant Field Corn from Sulfonylurea Herbicides

C.L. Brommer, C.H. Slack, and W.W. Witt

Accent and Beacon have been labeled for use in corn since 1989. These herbicides have provided excellent control of johnsongrass and foxtail species. Corn injury from these herbicides has been noted in certain corn varieties, and this injury was the result of late application, antagonism from interactions with in-furrow insecticides, and environmental influences. Injury symptoms include pinched ears, leaf chlorosis, plant stunting, and rolled leaves. Previous research focused on visual injury and plot yields. The yield of corn from a plot does not necessarily show if there is a physiological impact to corn from herbicide treatment. Often, yield components can indicate crop injury where plot yield alone does not. Many hybrids are released each year including transgenic hybrids for glyphosate tolerance. Producers may use herbicides other than glyphosate in glyphosate-tolerant corn. Data are needed to determine the impact of Accent, Beacon, and other sulfonylurea herbicides on yield and yield components in glyphosate-tolerant corn. Currently, there are no published studies with glyphosate-tolerant corn and sulfonylurea herbicides.

Objectives

- Determine if sulfonylurea herbicides cause a yield reduction in glyphosate-tolerant corn.
- Determine if any yield components are affected by these herbicides.

Methods and Materials

A study was conducted on the Spindletop Research Farm in 2001. The glyphosate-tolerant field corn DeKalb 626RR was planted May 23 and emerged on May 30. A conventional tillage regime was used with 30-inch row spacing with a seeding density of 25,000 seeds/ac. The following treatments were made: Roundup Ultra at 1.0 qt/ac, Accent SP at 0.67 oz/ac, Beacon 75DF at 0.76 oz/ac, Exceed 57 DF at 1 oz/ac, and a mixture of Accent SP at 0.33 oz/ac plus Beacon at 0.38 oz/ac. Each treatment was applied to either the V3, V6, or V9 growth stage of corn. All herbicide treatments contained the recommended adjuvant and were applied at 25 gallons per acre. Data on visual injury of corn and solar penetration through the canopy were collected two and four weeks after treatment. Harvest data included plot plant population, plot yield, seed weight, seed number per plot, and seed number per ear. The environmental conditions at Lexington were above average for the season. Timely rainfalls and average temperatures occurred from the V3 stage through harvest.

Plot Yield

Treatments of Accent, Beacon, Exceed, or Roundup Ultra made at the V3, V6, or V9 growth stage did not reduce corn yield. The mixture of Accent plus Beacon reduced corn yield when applied at the V3 stage compared to treatment at the V6 or V9 stage and was lower than the nontreated control.

Seeds per Square Yard

Seed number can be considered the best indicator of yield in a plot as well as for stress situations that directly correspond to the corn life cycle when seed numbers were determined. The expectation is that, as seed number was reduced, seed weight will increase to offset the reduced number of seed. Yield will not fall unless the number of seeds drops below a point where the seed weight can no longer offset the loss. No difference in seeds per square yard was found within the Roundup Ultra, Accent, Beacon, or Exceed treatments made to any growth stage of corn. The V3 treatment of Exceed was significantly lower than either the V6 or the V9 Exceed treatment, and this was similar to the yield data discussed above.

Seed Weight

Again, no seed weight differences within herbicide and treatment stage were found except for Exceed treatment at V6 and the Accent plus Beacon mixture at V9. These treatments had seed weights significantly lower than Beacon applied at V9 and Exceed applied at V9.

Seeds per Ear

The number of seeds per ear was not different for any herbicide or growth stage except for the Exceed treatment at V3.

Persistence and Efficacy of Simazine and Atrazine Applied in the Fall for No-Tillage Corn Weed Control

A.T. Lee and W.W. Witt

Introduction

Simazine (Princep) applied to soybean stubble in the fall before no-till corn production is a relatively new weed management practice in Kentucky. Fall-applied herbicides benefit applicators because they shift some of the workload from the spring to the fall. The producer's primary expectation from fall-applied simazine is to control cool-season weeds such as henbit, deadnettle, chickweed, and marestail. Controlling cool-season weed species may provide warmer spring soil temperatures and rapid surface dry-down by enabling more direct solar radiation (sunlight) and airflow (wind) to reach the soil surface. In addition, controlling cool-season weeds may reduce early season water stress by conserving soil moisture in the germination zone.

Information available concerning fall-applied simazine, or other triazine herbicides, in Kentucky is limited, and many of the previous studies on early preplant treatments have conflicting results. Areas with consistently cold, dry winters generally see better performance because of slower herbicide degradation. Growers in Kentucky need to be aware of fall-applied herbicide persistence and performance relevant to their location.

Simazine (Princep) and atrazine (AAtrex and other product names) were evaluated in this research. Both herbicides are similar in chemical structure and use and have been on the market for more than 30 years. The primary difference between the two is that Princep is generally more soil persistent but has less foliar activity than AAtrex. Princep provides greater control of annual grasses, but AAtrex provides more overall control of broadleaves. Growers and herbicide applicators are familiar and comfortable using both products.

There were three main objectives of this research. The first was to determine the length of fall-applied Princep and fall-applied AAtrex persistence in Kentucky soils. The second objective was to examine control of cool-season weeds from Princep and AAtrex applied in the fall. Finally, the third objective was to identify the performance level and potential advantages a Kentucky corn producer should expect from Princep or AAtrex applied in the fall.

Methods and Materials

Field studies were conducted from November 2000 through October 2001 to determine herbicide persistence and efficacy of fall-applied AAtrex and Princep. A nine-treatment study, comprised of three fall-applied herbicide options followed by three spring-applied herbicide options, was replicated at three climatically and topographically diverse regions in Kentucky (Lexington, Princeton, and Bowling Green). AAtrex 4L at 1.5 qt/ac, Princep 4L at 1.5 qt/ac, and no herbicide were the three fall-applied herbicide treatments. Spring-applied herbicide treatments were Bicep II Magnum at 2 qt/ac, Bicep II Magnum at 2 qt/ac plus Touchdown IQ at 1 qt/ac, and no herbicide applied. Herbicide concentration in the soil, visual efficacy ratings, surface soil temperature, and corn seed yield were used to compare differences among treatments. Soil samples were collected at 30-day intervals (January through May) and analyzed for AAtrex, Princep, and total triazine concentration. February, March, April, and May visual ratings were collected on a percent control basis for cool-season weeds. Surface soil temperatures at a depth of 2 inches were taken at three-hour intervals during March and April. Plots were harvested at the Princeton and Lexington locations in October with a two-row plot combine.

Results and Discussion

Persistence (Table 1). The half-life of Princep in the soil ranged from 33 to 43 days and from 34 to 40 days for AAtrex. Previous research at the University of Kentucky has shown the half-life of spring-applied Princep and AAtrex in the soil to be approximately 15 days. The longer persistence of these herbicides applied in the fall was attributed to the cooler soil temperatures that existed in December, January, and February that slowed herbicide degradation processes.

Weed Control (Table 2). Henbit control at the Princeton location in February with fall-applied AAtrex was 95 percent and statistically greater than Princep at 83 percent. Both herbicides gave up to 95 percent control of henbit in March and April, but neither herbicide controlled nor suppressed summer annual weed populations (data not presented). Wild garlic control with AAtrex was statistically greater than with Princep in February (95 days after treatment [DAT]) and December 2001 (1 year after treatment [YAT]). Wild garlic control ranged from 51 percent to 82 percent in March and April but was not different among treatments within each month.

Soil Temperature at a Depth of 2 Inches (Figure 1). Soil temperatures ranged from 32° to 84°F. The Princep treatment provided excellent control of the cool-season weeds that resulted in more daily soil temperature fluctuation (compared to the untreated check). Daily high soil temperatures were a result of more solar radiation reaching the soil surface in the Princep treated plots; however, the daily low soil temperatures were cooler as a result of this treatment. Although fluctuations in soil temperature were greater in the Princep treatment, the soil temperature was sufficiently warmer to allow for slightly earlier planting of corn.

Seed Yield. Fall-applied Princep or AAtrex did not statistically increase corn seed yield when spring-applied Bicep II Magnum was used (data not presented).

Table 1. Princep (simazine) and AAtrex (atrazine) dissipation at Princeton, Lexington, and Bowling Green, Kentucky. [a]

Location	Herbicide	Half-Life (days)	Dissipation Rate (k)	Coefficient of Determination (r^2)
Princeton	AAtrex	34	-0.020	0.96
	Princep	36	-0.019	0.98
Lexington	AAtrex	40	-0.017	0.95
	Princep	43	-0.016	1.00
Bowling Green	AAtrex	40	-0.017	0.62
	Princep	33	-0.021	0.78

[a] Based on January through March, 2001 concentrations of atrazine and simazine that was applied November and December, 2000.

Conclusion and Management Recommendations

In conclusion, fall-applied Princep and AAtrex half-life in the soil ranged from 33 to 43 days. Fall-applied Princep and AAtrex were both effective options for henbit control, but AAtrex offered greater control of wild garlic 95 DAT and 1 YAT than did Princep. Henbit control resulted in warmer daily soil temperatures but more variability during the diurnal cycle. When fall-applied Princep and AAtrex were integrated with a traditional spring-applied herbicide program, no statistical yield difference was observed. However, fall-applied Princep and AAtrex offered soil temperature and cosmetic advantages that may be beneficial to Kentucky corn producers.

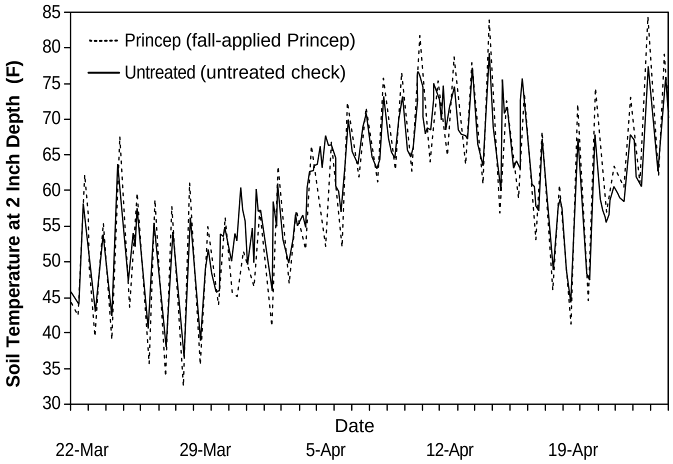
Princep is currently registered for fall treatments in Kentucky, but AAtrex is not registered. Corn producers should practice good land stewardship when using Princep in the fall. Elimination of cool-season vegetation can increase soil erosion and therefore is not recommended for highly erodible areas. Applicators should follow label instructions while being cautious of ground and surface water restrictions. To ensure fall-applied Princep performance, growers should maintain soil pH levels. Growers should remain conscious of cool-season and early warm-season weed populations by routinely scouting fields to

Table 2. Cool-season weed control provided by Princep and AAtrex applied 11/17/00 (Princeton), 11/20/00 (Lexington), and 12/18/00 (Bowling Green).

		Control of Weed Species [a]						
		Henbit Control			Wild Garlic Control			
Location	Treatment	February	March	April	February	March	April	December
		%						
Princeton	Princep	83 b	95 a	95a	21 b	51 a	68 a	10 b
	AAtrex	95 a	95 a	95a	57 a	70 a	82 a	65 a
Lexington	Princep		96 a	96 a				
	AAtrex		96 a	96 a				
Bowling Green	Princep	51 a	91 a	93 a				
	AAtrex	51 a	93 a	93 a				

[a] Means within a column and location followed by the same letter are not significantly different according to Fisher's protected LSD test ($\alpha = 0.05$).

Figure 1. Soil temperature at a depth of 2 inches as affected by fall-applied Princep (March 22 to April 24, 2001) at Princeton, Kentucky.



determine if a burndown herbicide is needed before corn planting. It should also be noted that Princep applied in the fall limits spring planting options. Therefore, corn planting should be prioritized so fields treated with Princep are the first ones to be planted.

Acknowledgments

This project was partially funded by the Kentucky Corn Growers Association and supported by the University of Kentucky Regulatory Services. Sincere appreciation is expressed to both contributors.

* All herbicides mentioned are trademarks of their manufacturers.

Fall Herbicide Applications for Tall Ironweed Control in Kentucky Pastures

M.W. Marshall, J.D. Green, D. Ditsch, and W. Turner

Introduction

The grazing quality of a grass pasture can be substantially lowered by the presence of perennial broadleaves, such as tall ironweed (*Vernonia altissima* Nutt.). Selective grazing due to differential palatability of troublesome broadleaf weeds tends to increase the populations of these weeds over time. In addition, lack of good and timely management practices such as proper soil fertility, using good grazing practices, mowing at the prescribed weed growth stage, and allowing weed seedlings to become established, can also increase the prominence of these weeds over time. Periodic pasture renovation is an important step in maintaining a proper forage stand. In addition, removal of perennial broadleaves, such as tall ironweed, can greatly improve the quality of a grazed pasture.

Objectives

The objectives of this study were to evaluate tall ironweed control in a grass pasture with herbicide treatments applied in the fall and to evaluate the quantity of the forage produced under various treatments.

Methods

Field experiments were conducted at the University of Kentucky Robinson Research Station near Quicksand, Kentucky, in 2000 and 2001 to evaluate and compare tall ironweed control using broadleaf herbicides labeled for grass pastures. The experimental design was a split-plot with the main plot being legume-seeded in the early spring and no-legume seeded. Subplots consisted of the herbicide treatments with individual plot sizes 10 by 30 feet. Herbicide treatments were applied September 5, 2000, when regrowth of tall ironweed reached approximately 24 inches in height after mowing the entire experimental site on July 27, 2000. Herbicide products evaluated are shown in Table 1. Approximately six months after herbicide treatment, red clover was seeded on March 1, 2001. Tall ironweed visual control and density counts were taken on the following dates: May 17, July 12, and September 21, 2001. In addition, total forage biomass was collected on the following dates: May 17, July 25, and September 21, 2001. The four subsamples were separated into grass, tall ironweed, and other plant species.

Results and Discussion

Crossbow at 2 qt/ac and Redeem R&P at 1.5 pt/ac plus 2,4-D at 2 pt/ac provided greater than 90 percent visual control the following year after treatment (Table 2). Redeem R&P at 1.5 pt/ac and Redeem R&P at 2 pt/ac also provided acceptable visual control (> 80 percent) the year following treatment. Initially, Banvel provided good control in the spring (May 17); however, visual control decreased to 70 percent in midsummer and dropped to 50 percent one year after treatment.

Table 1. Herbicide treatments applied 5 September, 2000.

Treatment[1]	Rate/Ac	Active Ingredient(s)
Crossbow	2 qt	triclopyr + 2,4-D
Redeem R&P[2]	1.5 pt	triclopyr + clopyralid
Redeem R&P[2]	2 pt	triclopyr + clopyralid
Redeem R&P[2] + 2,4-D	1.5 pt + 2 pt	triclopyr + clopyralid + 2,4-D
Banvel	2 pt	dicamba

1 Carrier volume of 20 GPA and pressure of 38 PSI.
2 Redeem R&P treatments applied with X-77 nonionic surfactant at 0.25% v/v.

The untreated check indicated that tall ironweed population nearly doubled the following year (Table 2). Treatments with Crossbow at 2 qt/ac, Redeem R&P at 1.5 pt/ac, Redeem R&P at 2 pt/ac, and Redeem R&P at 1.5 pt/ac plus 2,4-D at 2 pt/ac showed a few tall ironweed plants present in the areas treated by midsummer (July 12), but overall the level of control achieved was good to excellent. The Banvel treatment initially suppressed tall ironweed populations (May 17); however, populations increased rapidly throughout the summer (July 12).

The highest forage yield at each harvest date was obtained in the untreated check plots, which consisted of the total forage yield of desirable forage grasses plus tall ironweed (Table 3). Differences among herbicide treatments were not significant with respect to forage yield, except on May 17, 2001 (Table 3). Compared to the untreated check, biomass yield of tall ironweed was lower for all herbicide treatments. Among the herbicide treatments, tall ironweed biomass was the highest with the Banvel treatment, which supports the control and population data.

Table 2. Tall ironweed control and plant populations as affected by fall herbicide treatments.

Treatment	Rate/Ac	Tall Ironweed[1]				
		May 17	July 12	Sept 25	May 17	July 12
		(% control)			(stems 100 ft^2)	
Untreated Check	-	0	0	0	80	84
Crossbow	2.0 qt	93	96	94	4	3
Redeem R&P	1.5 pt	98	95	84	0	5
Redeem R&P	2.0 pt	99	97	88	0	4
Redeem R&P + 2,4-D	1.5 pt + 2.0 pt	99	98	98	0	1
Banvel	2.0 pt	87	71	53	4	33
LSD (0.05)		7	7	11	30	17

1 The initial population was 52 tall ironweed stems per 100 ft^2 at the time of fall herbicide treatment on September 5, 2000.

Table 3. Forage and tall ironweed yield taken on three harvest dates in 2001 as affected by previous fall-applied herbicide treatments.

Treatment	Rate/Ac	Biomass Yield					
		Forage			Tall Ironweed		
		May 17	July 25	Sept 21	May 17	July 25	Sept 21
		(lb/ac)					
Untreated Check	-	6524	7105	8440	447	945	439
Crossbow	2 qt	6427	5881	7401	31	147	0
Redeem R&P	1.5 pt	5693	6317	7830	0	92	15
Redeem R&P	2 pt	5387	5291	7480	0	0	0
Redeem R&P + 2,4-D	1.5 pt + 2 pt	5339	5181	7449	0	62	44
Banvel	2 pt	4302	5667	7430	31	440	112
LSD (0.05)		1814	1624	1265	322	503	176

Conclusions

Tall ironweed populations were reduced with the use of a fall-applied herbicide; however, the use of triclopyr-containing treatments (Redeem R&P and Crossbow) showed the greatest suppression the following year. Herbicide treatments resulted in a slight decrease in total forage yield since fewer tall ironweed plants were found in treatment plots. The use of herbicide is only part of an integrated program, which includes mowing, proper fertility levels, and a good grazing program. Reseeding is an important step in conjunction with herbicide applications because new weeds will emerge in bare areas left by controlled weeds.

Postemergence Control of Honeyvine Milkweed in Corn

J R. Martin

Introduction

Honeyvine milkweed (*Ampelamus albidus*) causes lodging of corn as a result of the vines climbing and becoming entangled with the crop. The stems and leaves of this weed often remain green after the crop has matured, thus adding more burden during the harvesting process.

Honeyvine milkweed plants grow as a warm-season perennial that reproduces from seed and long creeping roots. Plants that develop a well-established root system are difficult to control with traditional synthetic auxin-type herbicides such as 2,4-D and Banvel (dicamba).

Objective

Compare effectiveness of relatively new auxin type herbicide products as well certain Acetolactate-Synthase (ALS)-inhibiting herbicides on managing honeyvine milkweed in corn.

Methods

Studies were conducted in Meade and Simpson counties during 2000. Both sites were treated with atrazine plus a chloroacetamide herbicide for preemergence control of annual weeds. An Imidazolinone Tolerant (IT) corn hybrid was planted in mid-April.

Postemergence herbicide treatments are listed in Table 1. These were applied as a broadcast spray when corn plants had five to six collars and honeyvine milkweed plants were 4 to 18 inches in length.

Results

Honeyvine milkweed infestations were fairly uniform and heavy at both sites. By late season the percent of infested corn plants in the nontreated check plots was 18 percent at Meade County and 30 percent at Simpson County (Table 1). Although none of the postemergence herbicides provided complete kill of honeyvine milkweed, they did limit its growth. All treated plots had a smaller percentage of infested corn compared with the nontreated check plots. The level of suppression of vine growth was the same regardless of herbicide treatment.

This research shows there are several postemergence herbicides that suppress the top growth of honeyvine milkweed plants. Additional research is needed to determine if any of these options offer long-term benefits by reducing populations of this problem weed the following growing season.

Acknowledgments

The author expresses appreciation to the growers and county Extension agents who assisted with this research.

Table 1. The effect of postemergence herbicides on percent of corn plants wrapped with honeyvine milkweed.

	Percent Infested Corn[b]	
Herbicide[a]	**Meade County**	**Simpson County**
Accent Gold 2.9 oz/ac	7	3
Clarity 8 oz/ac	8	6
Distinct 4 oz/ac	5	5
Exceed 1 oz/ac	7	8
Lightning 1.28 oz/ac	2	1
Permit 1.33 oz/ac	3	6
Nontreated Check	18	30
LSD (0.05)	8	14

[a] Adjuvants were included with herbicides according to label directions.

[b] The percent infested corn plants is based on the number of plants wrapped with honeyvine milkweed (approximately 12 inches or more above the soil surface) relative to the total number of corn plants in the plot. Evaluations were made in early August.

Herbicide Comparisons on Cornflower (*Centaurea cyanus*) Control in Wheat

J.R. Martin

Four studies were initiated in Simpson and Warren counties to evaluate and compare herbicides for postemergence control of cornflower in wheat. The dry soil conditions in the fall of 1999 delayed emergence of cornflower; therefore, results of some of the research was inconclusive and not reported.

One study compared Buctril (bromoxynil) at 1.5 or 2 pt/ac; Clarity (dicamba) at 2 or 4 oz/ac; and Sencor (metribuzin) at 4 or 8 oz/ac applied to three-leaf cornflower on 9 February 2000 or six-leaf cornflower on 15 March 2000. Buctril at 2 pt/ac was the most effective in controlling cornflower plants up to six-leaf stage. The trend in reduction of cornflower control when applications of Buctril at 1.5 pt/ac was delayed helps support the fact that Buctril is most effective in controlling plants that are relatively small. Sencor was effective in controlling cornflower plants, provided the high rate of 8 oz/ac was applied to small plants. It should be noted that the favorable weather conditions observed during the spring treatments may have played a role in the success with Buctril and Sencor. Clarity was not effective when applied at 2 or 4 oz/ac.

Another study compared Buctril at 2pt/ac alone or Buctril at 1.5 pt/ac applied alone or in tankmix combination with Clarity at 4 oz/ac or with Harmony Extra (thifensulfuron + tribenuron) at 0.5 oz/ac plus nonionic surfactant at 0.25 percent v/v. Treatments were applied on 3 December 2000, 2 March 2001, and 13 March 2001. Buctril at the rate of 2 pt/ac was consistent in controlling cornflower at all application timings; however, the 1.5 pt/ac rate tended to be less effective when applications were delayed until spring. Including Clarity or Harmony Extra with Buctril at 1.5 pt/ac helped improve cornflower control with the spring applications. These tank mixtures caused wheat injury, yet injury was less evident near the end of the season.

Acknowledgments

The author expresses appreciation to the growers, county Extension agents, and farm-supply business consultants who assisted with this research.

Postemergence Control of Italian Ryegrass in Wheat

J.R. Martin, W.W. Witt, D. Call, and J. James

Introduction

Current herbicide options are somewhat costly and inflexible in regard to application timing. Also, repeated use of some options such as Hoelon (diclofop-methyl) or Achieve (tralkoxydim) may increase the risk of developing populations that are resistant to Accase-inhibiting herbicides. Although herbicide-resistant Italian ryegrass has not been confirmed in Kentucky, there are a number of states in the Southeast that have documented its presence.

Studies were conducted during 2000 and 2001 to compare and evaluate certain products recently registered for ryegrass control as well as experimental herbicides being developed for controlling weedy grasses in wheat.

Methods

Achieve (tralkoxydim), Axiom (flufenacet + metribuzin), Discover (clodinafop-propargyl), Everest (flucarbazone), Hoelon (diclofop-methyl), and Maverick (sulfosulfuron) were evaluated for controlling Italian ryegrass during 2000 and 2001 in Pioneer 2552 wheat. Beyond (imazamox) was evaluated in 2001 in an experimental Clearfield wheat variety that is tolerant to imidazolinone herbicides. Hoelon, Achieve, and Everest are currently registered and available for controlling Italian ryegrass, whereas Axiom, Discover, Maverick, and Beyond (for Clearfield wheat only) are not registered for use in Kentucky.

Results

Achieve, Axiom, and Everest were more consistent in controlling Italian ryegrass when applied in the fall compared with applications made in the spring (Table 1). Hoelon and Discover provided at least 87 percent control of Italian ryegrass for applications made in the fall or early spring and were superior to the other herbicides when applications were delayed until mid-March. Beyond at 5 or 6 oz/ac provided at least 90 percent control of Italian ryegrass up to mid-February (Table 2). However, control declined substantially when Beyond applications were delayed until mid-March. Italian ryegrass control with Maverick did not exceed 60 percent in either year.

Table 1. Italian ryegrass control with fall or spring herbicide applications in Pioneer 2553 wheat (UK Research and Education Center, 2000 and 2001).

Herbicide Treatments[1]	% Ryegrass Control for Different Application Timings[2, 3]				
	2000		2001		
	Fall	Spr 1	Fall	Spr 1	Spr 2
Achieve 7 oz/ac	67	70	90	63	----
9.5 oz/ac	67	67	90	77	60
Axiom 10 oz/ac	63	----	100	80	60
Discover 4 oz/ac	----	----	100	100	93
Everest 0.62 oz/ac	77	----	80	77	43
Hoelon 1.33 pt/ac	87	83	100	87	----
2 pt/ac	----	----	100	96	----
2.67 pt/ac	95	90	100	100	80
Maverick 0.5 oz/ac	60	7	----	----	----
0.67 oz/ac	----	----	----	33	----
LSD (0.05)	13			26	

1 Adjuvants were included with Achieve, Discover, Everest, and Maverick according to label directions.
2 Fall = approximately 2-leaf ryegrass in mid-November; Spr 1 = 2 to 3 tillered ryegrass in mid-February; and Spr 2 = fully tillered ryegrass in mid-March.
3 Control ratings were made in the spring and were based on a scale of 0 to 100 with 0 = no control and 100 = complete control.

Table 2. Italian ryegrass control with fall or spring herbicide applications in an experimental Clearfield wheat variety (UK Research and Education Center, 2001).

Herbicide Treatments[1]	% Ryegrass Control for Different Application Timings[2, 3]		
	Fall	Spr 1	Spr 2
Beyond 4 oz/ac	80	80	53
Beyond 5 oz/ac	90	93	43
Beyond 6 oz/ac	93	100	60
Hoelon 1.67 pt/ac	100	----	----
LSD (0.05)		17	

1 Crop oil concentrate at 1% v/v was included with Beyond.
2 Fall = mid-November approximate 2-leaf ryegrass. Spr 1 = mid-February and 2 to 3 tillered ryegrass. Spr 2 = mid-March and fully tillered ryegrass.
3 Control ratings were made in the spring and were based on a scale of 0 to 100 with 0 = no control and 100 = complete control.

Summary

All herbicides generally provided better control when applied in the fall compared with spring applications. Hoelon and Discover were usually more effective than the other herbicides in managing Italian ryegrass plants that had overwintered and were beginning to tiller. Achieve, Axiom, and Everest were capable of providing early-season control, but regrowth did occur in some instances. The level of Italian ryegrass control with Beyond applications in Clearfield wheat was similar to that of Hoelon when applied to small plants in the fall, but regrowth may be a problem when Beyond applications are applied in the spring to weeds that are fully tillered. Maverick did not offer effective postemergence control of Italian ryegrass and persisted long enough in soil to injure double-cropped soybeans in other research (data not presented).

Tobacco Sucker Control

J. Calvert and G. Palmer

Removal of the inflorescence (topping) of tobacco plants is a standard practice in the production of burley and dark tobacco. Prior to the introduction of effective sucker control chemicals in the mid-1950s, suckers were removed manually. Hand suckering was a difficult and time-consuming process, requiring up to 50 hours of labor per acre. In the late 1950s tobacco growers began using maleic hydrazide (MH) to control suckers. MH had outstanding ability to control suckers, and its use was quickly adopted by growers. However, tobacco leaf processors and manufacturers opposed its use, claiming it lowered leaf quality by leaving residues and altering physical characteristics. As the industry gained experience with MH-treated leaf, its effects on physical characteristics were overcome by manufacturing processes, and a residue tolerance of 80 parts per million (ppm) was accepted.

In the early 1960s, the U.S. Department of Agriculture and scientists at agricultural experiment stations in tobacco-producing states initiated research to study MH effects on all U.S. tobacco types and to evaluate new chemicals being proposed for the control of suckers. Their research has been reported through the Regional Tobacco Growth Regulator Committee. The Committee's research (and that of others) has shown that MH leaf residues are highly correlated with (1) the amount of MH applied, (2) the application technique, (3) the time of topping and MH application, and (4) the amount of rainfall between MH application and harvest. In burley tobacco, it has been demonstrated repeatedly that acceptable residue levels are attained when recommended rates of MH are applied immediately after topping.

Since its beginning, the Regional Committee has tested scores of potential sucker control chemicals, and it continues to evaluate new chemicals and application technologies. Their research has shown that dinitroanaline compounds (e.g., Prime$^+$ and Butralin) when used with reduced rates of MH have provided excellent sucker control while producing leaf with low MH residues. They found that sucker growth was suppressed for longer periods of time where both MH and a dinitroanaline compound were used. Dinitroanaline compounds have both contact and systemic activity and are most effective when the spray solutions contact or thoroughly wet the sucker buds. Spray equipment should be adjusted to deliver coarse droplets, under low pressure, at solution rates of 40 to 45 gallons per acre.

Sucker control in dark tobacco types is more difficult and exacting than in burley. Dark tobacco requires a longer maturity interval between topping and harvest than burley, requiring dark-tobacco growers to exercise greater care in their choice of chemicals and their times of application. The use of fatty alcohol compounds (e.g., Off-Shoot-T and Royaltac) at topping, followed by MH and/or combinations of MH and a dinitroanaline have proven to be effective strategies for controlling suckers in dark tobacco. Dark tobacco sucker control programs utilizing all three types of chemicals have been shown to provide excellent sucker control while minimizing bronzing and browning effects observed when MH was applied immediately after topping at rates sufficient to control suckers until harvest.

No-Till 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 Huntington silt loam soil that is moderately well drained. Wheat was planted no-till and with tillage, and the tillage plots were chisel plowed and disced twice. The plots were 10 feet by 30 feet. The experiment was soil sampled each year, and lime and fertilizer were applied according to University of Kentucky recommendations before planting. N was sidedressed on corn at 150 lb/ac. 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 indicate that both no-till corn and no-till soybeans tend to yield more (3.5 percent for soybeans and 5.5 percent for corn) where the wheat is planted no-till (Table 1). However, the differences are not always statistically significant, but the trend has been fairly consistent.

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 wheat plantings in it. The reason for the difference is not completely known at this time, but research that is taking place indicates the differences may be due to residue cover, soil moisture, soil physical changes, and more specifically a change in pore size distribution.

Soil Changes. There is 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. Soil measurements indicate that the soil structure has changed and has larger aggregates and more medium-sized pores 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 and in 2000 on the no-till soybeans found more moisture available for plant growth in the treatments where tillage was not used for wheat. This resulted in 18 percent and 6.2 percent higher grain yields, respectively, for these treatments during these years. There was little difference in measured soil moisture in the 2000 and 2001 no-till corn, and there were also little differences in the yield. These measurements indicate that the soil changes that have taken place in the no-till treatment sometimes allow the soil to hold more plant available water. The soil moisture advantage for no-till will depend on timing of rainfall and water demands of the plant.

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 5.5 percent and 3.5 percent greater yields, respectively, than when these crops were grown after tilled wheat. The soil changes include larger aggregates and more medium pores that result in more plant-available moisture for these crops.

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

	Wheat Tillage Systems	
Year	**No-Till**	**Conventional**
Soybeans	**(bu/ac)**	**(bu/ac)**
2001	30.5	29.6 N.S.*
2000	45.6	42.9 N.S.
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	35.1	33.9
Corn	**(bu/ac)**	**(bu/ac)**
2001	208.3	215.1 N.S.
2000	169.5	170.7 N.S.
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	197.3	187.1

* N.S. means no significantly statistical differences.

** Statistically different at the 0.1% level.

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 of the UK Biosystems and Agricultural Engineering Department 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. A penetrometer shows that all compacted plots exceeded 300 psi in the top 12 inches.

Corn was planted in 1997, 1999, and 2000, and soybeans in 1998 and 2001. The tilled plots were disced to a depth of 6 inches prior to planting, and the no-till plots were planted directly into the compacted or uncompacted 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 slightly higher than the tilled treatment most years. However, the five-year average yields for the tilled and no-tilled uncompacted treatments are almost identical.

The tilled/compacted treatment yielded about 25 percent less than the uncompacted treatments the first two years and then slowly improved to almost 90 percent of the uncompacted treatment. The no-till/compacted treatment yielded very low the first year (2 percent), and then improved dramatically the next year to 85 percent and then improved to about 90 percent of the uncompacted treatment. The rapid improvement in the no-till/compacted yields is thought to be due to the increased biological activity in no-till that helps ameliorate compaction. The extremely low yield in the no-till treatment the first year was due to compaction of soil at the soil surface. Roots had extreme difficulty becoming established, so plants and yields were very small. The tilled compacted treatment was disced 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 yield recovery of the compacted treatments has moved to about 90 percent of the uncompacted treatments in both the tilled and no-tilled treatments. Recovery beyond this will probably be quite slow. This is reflected in the penetrometer readings in Table 3. The penetrometer readings are remaining high. This indicates that much of the compacted zone remains compacted; however, there are probably cracks, fissures, and root and worm channels that allow root growth through the zone into the soil below it. Before the full recovery can take place, most of the compaction in the compacted zone will need to be broken down.

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

Treatment			Relative Yields* (%)				
Tillage	Compaction	Subsoiled	1997	1998	1999	2000	2001
			Corn	Soybeans	Corn	Corn	Soybeans
Tilled	Yes	No	73	74	82	85	86
Tilled	Yes	Fall '99	79	74	77	91**	83**
Tilled	No	No	95	95	97	100	94
No-Till	Yes	No	2	85	88	81	92
No-Till	Yes	Fall '99	2	80	91	97**	91**
No-Till	No	No	100	100	100	87	100

* Percent of highest yielding treatment for that year.
** Treatment subsoiled only in fall of 1999.

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

Treatment			Yield (bu/ac)				
Tillage	Compaction	Subsoiled	1997	1998	1999	2000	2001
			Corn	Soybeans	Corn	Corn	Soybeans
Tilled	Yes	No	76	31	148	114	76
Tilled	Yes	Fall '99	82	31	139	123*	74*
Tilled	No	No	98	40	174	135	84
No-Till	Yes	No	2	36	158	109	82
No-Till	Yes	Fall '99	2	33	163	130*	81*
No-Till	No	No	104	42	180	117	89

* Treatment subsoiled only in fall of 1999.

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	2001	2002
No-Till Compacted	100	100	88	75	88	88
Tilled Compacted	94	94	94	100	100	100

Subsoiling some of the compacted treatments in the fall of 1999 increased the 2000 yields to close to the uncompacted yields. The no-till subsoiled treatments seemed to respond better than the subsoiled tilled treatments. The 2001 yields of these subsoiled treatments were no better than the compacted treatments. This indicates that the subsoiling effect only lasted one year and would need to be repeated to remain effective.

Conclusions

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. Yield of compacted no-till treatments rebounded rapidly without tillage, due probably to a high rate of biological activity in the root zone.
4. The compacted treatments of both tilled and no-tilled recovered most of the yield loss during the five years and now yield about 90 percent of the uncompacted treatments.
5. Subsoiling the tilled and no-tilled compacted treatments in the fall improved yields to about the same as the uncompacted treatments. However, the yield improvement only lasted one year.

Applying Variable Rate Nitrogen Using Yield Maps

L. Murdock and P. Howe

At the present, most farmers in Kentucky apply nitrogen (N) to corn at constant rates on all their fields. Most farmers use the same N rate within each field as well as on all fields. Most farmers indicate that they use this method to ensure high corn yields on all parts of the field, even though they do not expect all parts of the field to be able to use the highest rates of N. The amount of N needed by a corn crop during the season will depend, to a large extent, on the yield obtained for that year. Recent research has shown that the yield potential of corn fields in the karst areas of Kentucky can vary greatly within a field and is mostly dependent on soil type, drainage, and past erosion.

Farmers who have a history of yield mapping using GPS and GIS procedures can identify the areas of the fields that have high, medium, or low yield potential. By using yield maps to establish past corn yield history in a field, it was hoped that N could be varied within the field to match the yield productivity of the crop in different parts of the field.

Method

Trials were established on fields in Trigg County on the Wayne McAtee Farm in 2000 and 2001 to determine if yield maps could be used to vary the N rate within a field. The soil types (Crider, Pembroke, Nolin, and Huntington) are typical of those found in the karst areas of Kentucky. Replicated N rate strips were established in the field that had historical areas of low, medium, and high corn yields. A trial with different N rates that were constant through the entire strip was established in part of the field, and in another part the N rates were varied along the strip using the previously mapped yield potential zones as the basis on which to vary the N rates. Yield maps (three-year average) using GPS-GIS technology were used to establish yield zones of less than 100, 100 to 120, 120 to 140, 140 to 160, and greater than 160 bu/ac. N application was varied according to yield using three different treatments. They were 0.9 lb N/bu, 1.2 lb N/bu, and a reverse rate. The reverse rate used 100 lb/ac N on the three highest yielding zones and 175 lb/ac on the two lowest yielding zones.

Results

The results in Table 1 indicate that there is no basis for making N recommendations based only on past yield history. This was true, even though the yields ranged from 80 to 190 bu/ac. The nitrogen rates needed for optimal yields were almost the same in the high yielding areas as in the low yielding areas. These data strongly indicate that the corn yield response to N is independent of the yield potential within the field.

Table 2 shows the average yield for each N treatment in the constant rate trials that were applied across the different yield zones in each strip. The amount of nitrogen needed to achieve maximum yields was relatively low compared to the standard University of Kentucky recommendations (125 to 150 lb/ac N). This indicates that the cropping system in this field (with no manure history) is supplying a high amount of natural N to the corn crop. The lack of yield increase with N rates above about 100 lb/ac supports the above conclusion that the response to N is independent of the yield potential within the field.

Table 3 shows the yields of corn that was fertilized with variable N rates. There was no significant difference in yield among any of the methods. Treatment V1 used 0.9 lb N/bu of proven yield, and treatment V2 used 1.2 lb N/bu of proven yield applied to the different yield zones in each strip. There was no difference in the yields between the two treatments indicating that 0.9 lb/N/bu was enough N. The V3 treatment reversed the other two methods. In this case, a high N rate (175 lb/ac) was applied to the low areas of proven yield, and a low rate of N (100 lb/ac) was applied to the high proven yield areas. The yields were just as good as the other two methods. This lends more support to the fact that variable N rates of these well-drained soils is not agronomically sound. It appears that N recommendations, proven with research and based on tillage type, soil drainage class, and previous crop, are still the most accurate.

Table 1. Yield response to N rates within different yield zones.

	N Rate (lb/ac)	Yield (bu/ac) Historic Yield Zone Low	Medium	High
(Year 2000)	100	84	108	182
	120	90	106	180
	170	95	109	188
(Year 2001)	36	98	145	168
	106	106	159	175
	136	103	160	178
	166	105	161	177

Table 2. Corn yield as affected by different N rates applied at constant rates in strips with different yield zones.

	N Rate (lb/ac)	Yield (bu/ac)
(Year 2000)	100	134.5
	120	136.0
	170	140.5
(Year 2001)	36	139.6
	106	150.9
	136	151.7
	166	150.0

Table 3. Effect of different variable N rate methods on corn yield.

Treatment	Added N[2] (lb/ac)	Yield (bu/ac)
V1[1]	86	157.1
V2[1]	121	156.2
V3[1]	94	160.2

1 V1 = 0.9 lb N/bu of proven yield applied to different yield zones in each strip.
V2 = 1.2 lb N/bu of proven yield applied to different yield zones in each strip.
V3 = Reverse (low N on high yield areas and high N on low yield areas).

2 Average N/ac rate used over each treatment.

Conclusions

1. In the karst soils the amount of N needed for maximum yields is the same in all parts of the field regardless of yield potential.
2. Using yield maps to vary the N rate within a field with highly variable yield areas is not agronomically sound. A single rate would be more economically and agronomically sound.
3. N is mineralized at high rates in these soils and needs to be taken into account when making N recommendations.
4. N recommendations, proven with research and based on tillage type, soil drainage class, and previous crop, are still the most accurate.

Tillage, Previous Tillage, and the Nitrogen Requirement of Wheat in the Corn/Soybean/Wheat-Double-Crop Soybean Rotation

J.H. Grove

The objective of this research is to determine whether the optimal N fertilizer rate for wheat following full-season soybean (which followed corn) will be different with past and present soil management system (no-tillage vs. chisel plowing). The tillage rotation treatments imposed prior to wheat planting include: 1) chisel plowing after two years of no-tillage, 2) first year no-tillage after chisel plowing, and 3) second year no-tillage after chisel plowing.

The experiment was located at the Spindletop experimental farm, located outside Lexington, Kentucky. The soil was a Maury silt loam, which is a well-drained soil moderately high in organic matter and general fertility (Alfisol). The wheat (cv. Pioneer 25R26) was seeded in the fall of both 1999 and 2000 at a rate of 33 to 34 seeds per square foot using a Lilliston 9680 no-till drill. Weed control was managed with fall and/or spring applications of herbicides. The fertilizer N source was ammonium nitrate, applied at rates ranging from 0 to 120 pounds of N per acre. The N was all applied in the spring and was split into two applications (25 percent at green-up and 75 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 2000 and 2001.

In 2000, the third year of this experiment, the tillage management had only a small effect on the average yield of wheat following soybean in this rotation (Table 1). There was a tendency for wheat to yield more with greater duration of no-tillage. There was a good average response (+13.7 bu/ac) to fertilizer nitrogen (N), with yields increasing up to a total fertilizer N rate of 40 lb N/ac. On average, there was no response to additional N above 40 lb N/ac. However, there was an interaction between tillage and fertilizer N rate. The greater the duration of no-tillage prior to wheat planting, the greater the response to fertilizer N. Two years of no-tillage caused the fertilizer N requirement to optimize yield to total 80 lb N/ac, while that for the chisel plow wheat was only 40 lb N/ac. The more modest N response of tilled wheat was likely due to greater mineralization of N from organic matter. Lodging was observed in the chisel plow wheat at the two highest fertilizer N rates.

Table 1. Effect of tillage sequence and fertilizer nitrogen on wheat yields.

Fertilizer N Rate (lb/ac)		Annual Tillage Sequence			N Rate Average
	1999	CH*	NT	NT	
	2000	NT	CH	NT	
	2001	NT	NT	CH	
		Grain Yield (bu/ac)			
0		50.0**	49.6e	57.1d	52.2z**
40		68.1c	68.4c	80.8a	72.4y
80		74.3b	80.8a	85.1A	80.1x
120		82.6a	86.5a	82.7a	84.0x
Tillage Average		68.7B***	71.4AB	76.4A	

* CH = chisel plow plus secondary discing; NT = no-tillage.
** Yield values followed by the same lower case letter are not significantly different at the 90% level of confidence.
*** Yield values followed by the same upper case letter are not significantly different at the 90% level of confidence.

In 2001, the fourth year of this experiment, present and past tillage management had a significant effect on the average yield of wheat. The more recent the chisel tillage, the greater the wheat yield. Wheat yields were reduced with greater duration of no-tillage. There was a large average response (+31.8 bu/ac) to fertilizer nitrogen (N), with yields increasing up to a total fertilizer N rate of 80 lb N/ac. There was again a trend for no-till wheat to require more N (between 80 and 120 lb N/ac) to optimize yield than chisel plow wheat (between 40 and 80 lb N/ac). Lodging was again observed, only in the chisel plow wheat at the very highest fertilizer N rate.

The results suggest that wheat producers need not worry greatly about differential performance due to past and present tillage where winter wheat follows soybean. They should give some consideration to the optimal fertilizer N rate, following University of Kentucky recommendations that no-till wheat receive more N (30 to 40 lb N/ac).

Effects of Fusarium Head Blight Infection during Wheat Seed Development on Seed Quality and Deoxynivalenol (DON)

J. Argyris and D. TeKrony

Fusarium head blight (FHB) commonly called "head scab," caused by *Fusarium graminaerum* (Schwabe), results in yield reduction through floret sterility and poor seed filling. Infection by *F. graminaerum* results in reductions in storage protein, cellulose, and amylase in the seeds. Infected grain is often contaminated with deoxynivalenol (DON), a mycotoxin produced by *F. graminaerum.* In contrast to seeds used for other purposes, seeds planted to regenerate the crop must be alive and possess those physiological traits that allow germination and seedling establishment. Infection by *F. graminaerum* may affect both the physical and physiological aspects of seed quality including seed size and weight, composition, germination, and vigor. Consequently, an FHB epidemic can be a serious problem for seed producers.

Varietal differences in resistance to FHB in wheat were first reported in 1891 and include resistance to initial infection (Type I resistance) and resistance to spread of infection within the plant (Type II). A number of studies have reported differences between susceptible and resistant varieties both in severity of infection and modes of resistance but have failed to assess the effects on seed quality throughout seed development in a field environment. Likewise, little information is available regarding when peak infection occurs during seed development and maturation and how these infection levels relate to seed germination and vigor and the production of DON.

The objective of this study was to determine the effects of infection of *Fusarium graminaerum* during wheat seed development on the production of DON and seed quality across varieties with variable tolerance and susceptibility to FHB.

Materials and Methods

Four soft red winter wheat varieties differing in Type II resistance to *F. graminaerum* [one susceptible (Pioneer 2552), one resistant (Pioneer 25R18), and two moderately resistant (Roane, Coker 9474)] were established following corn in a chisel plowed and disced seedbed on Spindletop Farm in October of 2000. Corn seed infected with *F. graminaerum* was distributed in the plots to initiate FHB disease infection, and the plots were mist irrigated from heading through seed development. Heads of each variety were tagged at anthesis (flowering). Starting at 10 days after anthesis (DAA), 80 previously marked heads were harvested from each variety and harvests continued at four-day intervals until harvest maturity (HM) for a total of 10 harvests in all varieties.

At each harvest date, 25 heads were separated and threshed, and 100 fresh seeds were selected at random from the composite sample and evaluated visually for Fusarium damaged seeds and seed infection. One hundred fresh seeds from all harvests were plated for determination of *Fusarium graminaerum* infection on modified PDA agar. Seeds were analyzed for DON using direct competitive ELISA with an EZ-Quant® Vomitoxin (DON) plate kit (Beacon Analytical Systems Inc., Portland, Maine).

Standard germination (SG) was determined by testing four 50-seed samples (from 30-head composite sample) in rolled towels at 20°C for seven days following a pre-chilling treatment. Additionally, Raxil (tebuconazole) was applied to subsamples of seed at a rate of 1 ml/1000 g seed for an evaluation of SG of fungicide-treated seed. Accelerated aging germination, a stress vigor test, was conducted by placing 20 g of seed over 50 ml deionized water and aging at 43°C for 72 hours prior to testing for germination as described previously.

Results

Flowering occurred in all varieties from May 10 to14, and the seed reached physiological maturity (PM, maximum dry seed weight) approximately 30 days later. Seed moisture declined steadily during development and at PM ranged from 42 (Roane) to 47 percent (P-25R18).

Favorable temperatures and wet conditions provided by irrigation led to an abundance of primary inoculum. *F. graminaerum* seed infection (freshly harvested seed) increased in all varieties from ≤ 20 percent at 10 DAA, to maximum levels (>95 percent), which were maintained until the final harvest (~50 DAA) (Figure 1). The largest increase in seed infection occurred between 18 and 36 DAA and exceeded 65 percent in all varieties at PM. High levels of DON were present in seeds of all varieties very early in seed development (5 to 18 ppm) at 10 DAA (Figure 1). The most susceptible variety, Pioneer 2552, had the highest levels of DON (>25 ppm) throughout seed development; however, the levels of DON in all varieties (including the most resistant, P-25R18) exceeded acceptable levels for finished grain products. There was little relationship between DON and *Fusarium graminaerum* seed infection (r = 0.24).

Figure 1. Fusarium seed infection (closed symbols) and DON (open symbols) in four wheat varieties during seed development in 2001.

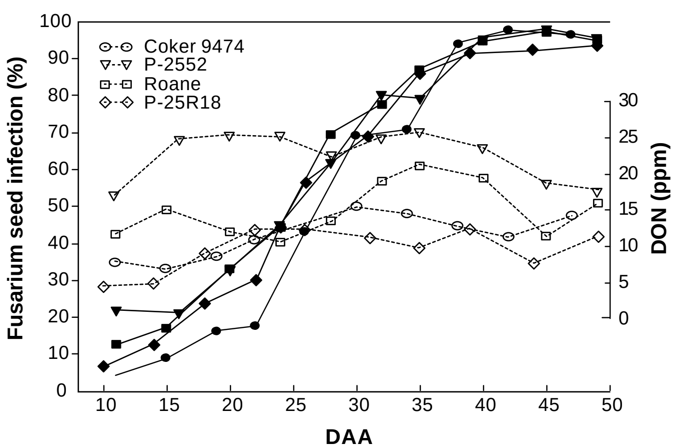
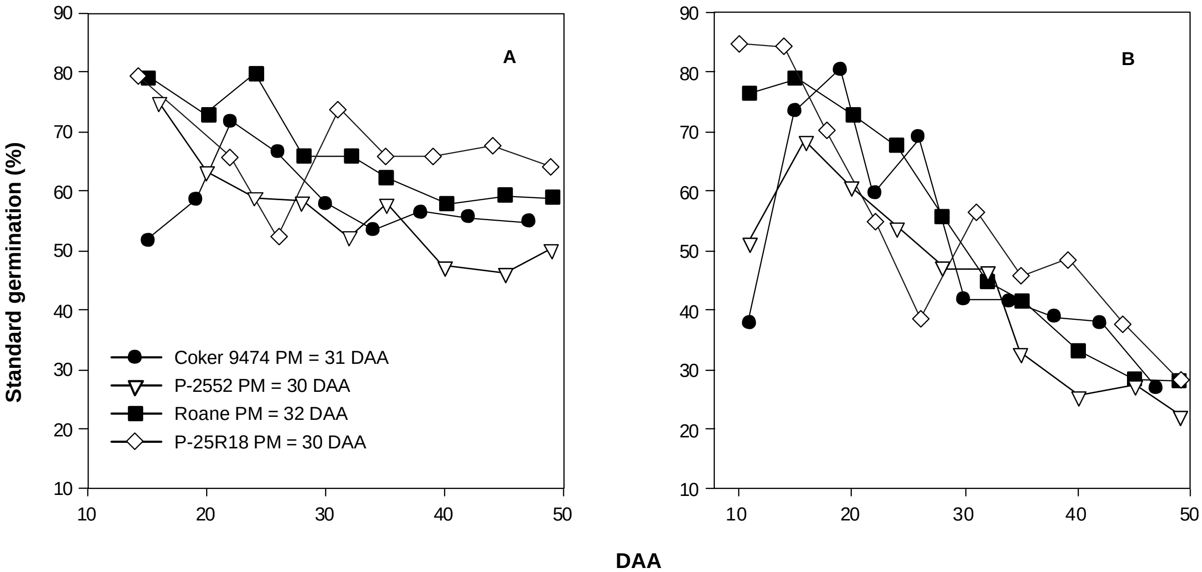


Figure 2. Standard germination of treated (A) and untreated (B) seeds of four wheat varieties harvested at various stages of maturity in 2001.



Standard germination (SG) of untreated seed for the four varieties was highly variable in early harvests (Figure 2B) ranging from <40 percent (Coker 9474) to above 80 percent for Roane and P-25R18. Germination declined to unacceptable commercial quality (<80 percent) in all varieties by 25 DAA and continued to decline to approximately 30 percent at the last harvest. Standard germination of untreated seed showed a significant negative relationship to *F. graminaerum* seed infection (r^2 = 0.64, Figure 3).

Fungicide seed treatment reduced the variability in SG prior to PM and improved germination of seed of all varieties as seed infection increased (Figure 2A). Although germination of treated seeds was consistently higher than untreated seeds from PM to maturity, the quality was still below acceptable quality for all varieties. Trends for AA germination were similar to SG of treated seed (Figure 2A). AA germination ranged from 66 percent (Coker 9474, P-25R18) to 33 percent (P-2552) after PM and had little relationship to *F. graminaerum* seed infection or DON (data not shown).

Summary

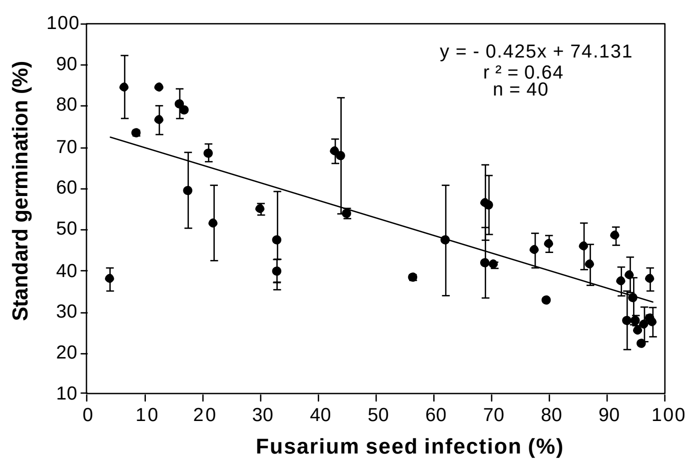
High levels of *Fusarium graminaerum* were present during seed development and maturation, which resulted in unacceptable seed quality. Standard germination declined to below acceptable commercial quality (80 percent) early in development (approximately 22 DAA) when seed infection remained $\leq$ 20 percent (Figure 2).

Type II resistance in Coker 9474, Roane, and P-25R18 related poorly to severity of seed infection and resulted in little improvement in germination and seed vigor (AA germination) compared to the highly susceptible variety P-2552. Standard germination of untreated seed declined at a linear rate (Figure 3) in both Type II resistant and susceptible varieties, indicating there was no preferential time during seed development or maturation in which *F. graminaerum* seed infection functioned to reduce standard germination. Thus, the substantial increase in seed infection during seed development and maturation observed in resistant and susceptible varieties would seem to limit the value of Type II resistance in preventing seed infection in the field and improving seed quality.

Type II resistance was more closely associated with measurements of DON contamination, with the most susceptible variety, P-2552, having the highest levels of DON at all harvests, compared to the lowest levels observed in the resistant P-25R18 (Figure 2B). However, it must be emphasized that the DON levels in all varieties during seed development and maturation were still well above acceptable limits for finished grain products (1 to 2 ppm).

Severe disease pressure and subsequent seed infection by *Fusarium graminaerum* resulted in unacceptable seed quality.

Figure 3. Relationship between standard germination and mean *F. graminaerum* seed infection in four wheat varieties in 2001.



Type II resistance was effective in reducing DON and visual seed damage in resistant P-25R18 compared to susceptible P-2552, but the advantages were not apparent in reducing seed infection. Therefore, Type II resistance may function to increase grain quality and mitigate yield loss but have no effect on reducing seed infection and little effect on improving subsequent seed quality during a severe FHB epidemic.

Effect of Imperfect Wheat Stands on Yield

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

Introduction

A perfect wheat stand is the goal in producing wheat. It is felt that an optimum, uniform stand is needed to achieve a high yield potential. However, stands are usually not perfect. This is especially true for no-till wheat. In fact, this is one of the reasons that some producers have not adopted no-till wheat. Often the stand looks bad, and it is believed that yield potential is probably reduced.

But is this true? Many farmers use tramlines in their wheat, and studies indicate that yields are not reduced. The rows on each side of the tramline seem to compensate for the loss of stand in the skipped rows. If this is true, then a certain amount of stand loss in a wheat field can be tolerated. The question is how much?

Methods

In order to better understand the effects of imperfect stands (within row skips having no plants) on wheat yield, three studies were initiated in the last two years. All studies were planted using tillage. Soon after wheat emergence, plants were removed (skips were established) to simulate imperfect stands. In 1999-2000, the skips were 6, 12, or 18 inches in length and in 2000-2001 all skips were 12 inches in length. Varying the number of skips resulted in 5, 10, 15, or 20 percent of the area within plots having no plants. The trials were planted at 35 seeds/ft^2 with some treatments planted at 25 seeds/ft^2 in 2000-2001. The trials were located at the Research and Education Center in Princeton (1999-00; 2000-01) or in Fulton County (1999-00). Two varieties (Pioneer 25R26 and Pioneer 2552) were used. Pioneer 25R26 is a more prolific tillering variety.

Results

The yields were very high, resulting in a good test for this type of study.

Length of Skip. Table 1 shows wheat yields at different skip lengths in 1999-00. The length of the skip (18 inches or less in this study) did not seem to have an effect on the yield. When the percent of the area skipped (i.e., containing no plants) remained the same but the length of the skip increased (up to 18 inches), there was no significant change in the yield. Skip lengths greater than 18 inches were not included in this study, so it is not known if longer skips would have reduced yield, regardless of the percent of area skipped.

Table 1. Effect of stand loss (percentage of area in skips and length of skip) on wheat yield (1999-2000).

Location	Area Skipped (%)	Length of Skip (inches)	Wheat Yield* (bu/ac) Pioneer 25R26	Wheat Yield* (bu/ac) Pioneer 2552
Fulton County	0	0	110.3 a	107.0 ab
	5	12	109.0 a	102.3 bc
	10	12	104.5 a	108.0 a
	10	18	108.0a	107.5 ab
	15	12	109.1 a	100.6 c
	15	18	105.8 a	100.6 c
Princeton	0	0	-	107.5 b
	5	6	-	111.5 ab
	5	12	-	113.0 a
	5	18	-	108.3 ab
	10	6	-	108.5 ab
	10	12	-	110.9 ab

* Means in individual columns followed by the same letter are not statistically different at the p = 0.1 probability level.

Percent of Area Skipped. The percent of area skipped refers to the percent of the area that had no plants due to skips. The percentage of the area skipped definitely had an effect on the yield (Tables 1 and 2). The effect depended on the variety. Pioneer 2552, which tillers less prolifically, showed lower yields in the studies when 15 percent or more of the area was skipped. Pioneer 25R26, a more prolific tillering variety, did not show a yield reduction even when as much as 20 percent of the area was skipped. Considering both varieties, it appears that 10 percent of the area could have skips (of at least 12 inches in length) without having an effect on yield.

Table 2. Effect of stand loss (percentage of area in skips and length of skip) on wheat yield (2000-2001).

Area Skipped (%)	Length of Skip (inches)	Seeding Rate (seeds/ft^2)	Wheat Yield* (bu/ac) Pioneer 25R26	Wheat Yield* (bu/ac) Pioneer 2552
0	12	35	97.2a	92.0a
5	12	35	92.7a	89.2ab
10	12	35	94.6a	91.0ab
15	12	35	97.9a	85.9bc
20	12	35	92.4a	87.1abc
20	12	25	95.6a	82.5c

* Means in individual columns followed by the same letter are not statistically different at the p = 0.1 probability level.

Seeding Rate. The seeding rate may have an effect on the yield when skips are present. In Table 2, seeding rates of 35 and 25 seeds/ft^2 were compared in the treatment that had 20 percent of the area skipped. When 20 percent of the area was in skips, yields were unaffected by seeding rate in the more prolific tillering Pioneer 25R26 variety. With the less prolific tillering Pioneer 2552 variety, there was a tendency for the yields to be less at the lower seeding rate (25 seeds/ft^2) when 20 percent of the area was in skips.

Yield Compensation. In order for yield to remain the same when stand loss (due to skips containing no plants) occurs, the yield of plants around the skip must increase. The compensation of the wheat plants surrounding the skips can come from more heads, more grains per head, or more weight per grain. Head counts made near harvest in 1999-2000 (data not shown) indicated that the compensation was not due to more heads (increased tillering). However, head counts made in 2000-2001 (Table 3) showed more heads for the plants surrounding the skipped areas. The increases were in the order of 35 to 45 percent more heads/ft^2.

Table 3. Effect of skips on wheat head counts (2000-2001).

	Area Skipped (%)	Seeding Rate (seeds/ft^2)	Head Counts (heads/ft^2)*	
			No Skips	Beside Skips
Pioneer 25R26	15	35	55.2 b	82.3 a
	20	35	53.2 b	75.0 a
	20	25	51.8 b	71.6 a
Pioneer 2552	20	35	45.9 b	72.2 a
	20	25	47.8 b	70.7 a

* Means within each row followed by different letters are statistically different at the p = 0.1 probability level.

Summary

This trial will continue in order to try to verify what has been found to this point. At present, it appears that the length of a skip (up to 18 inches in these studies) did not affect yield. However, the percent area of skipped did have an effect on yield. When the amount of area skipped is 10 percent or less, there is no effect on yield regardless of variety. There is also no effect on yield with varieties that tiller prolifically if the area skipped is as high as 20 percent.

Seeding Rate Effects on Stand Establishment and Yield in Wheat

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

Introduction

Establishing an optimum stand of wheat is the foundation upon which a high yield potential is built for your wheat crop. Several factors that will influence the wheat stand you obtain are wheat seeding rate, planting conditions, and seed quality. Factors that will influence the yield potential of the established stand are variety, cultural management, and weather. What is considered an optimum stand for high wheat yield potential? What seeding rates are needed to obtain optimum stands? Can suboptimum stands compensate via growth and development, and what is their yield potential? A wheat seeding rate study was conducted to evaluate the effect of different seeding rates and established stand on the yield potential of soft red winter wheat.

Methods

The experiment was conducted in 1998-99 and 1999-00 at the University of Kentucky Research and Education Center in Princeton, Kentucky. Wheat varieties utilized were Pioneer 2540 (excellent tillering capacity) for 1999 and Pioneer 2552 (good tillering capacity) for 2000. Wheat was planted at an optimum time each year (10-12-98 and 10-20-99) with a Lilliston 9670 no-till drill (7-inch row spacing) in a conventionally tilled (chisel plow, 2 discings, roterra) seedbed in 1998-99 and 1999-00 and also a no-till seedbed (previous corn crop) in 1998-99. Good wheat management practices were followed each year.

Four wheat seeding rate treatment/goals (15, 25, 35, and 45 seeds/ft^2) were compared in 1998-99, and seven wheat seeding rate treatment/goals (10, 15, 20, 25, 30, 35, and 40 seeds/ft^2) were compared in 1999-00. The drill was calibrated for each seeding rate treatment to ensure seeding rate accuracy and to establish drill settings that would deliver the amount of seed needed in close proximity to the seeding rate treatment goals. Seeding rates were adjusted for germination so that wheat stand establishment would be numerically close to the seeding rate treatment goals. Wheat data were collected on fall stand counts, spring head counts, lodging, and yield.

Results

Wheat Stands. Excellent stand establishment was achieved at all seeding rates in both 1998-99 (Table 1) and 1999-00 (Table 2). The percent stand achieved (Column 3), based on the actual number of seeds drilled (Column 1) and fall plant stands achieved (Column 2), was more than 80 percent for all seeding rate treatments each year, which is considered good. Generally, the lower seeding rate treatments achieved a higher percent stand than the higher seeding rate treatments. The actual plant stands achieved (Column 2) were numerically very close to the seeding rate treatment goals and is attributed to the adjustment of seeding rates for germination (Column 1) and also excellent planting conditions in the fall of 1998 and also the fall of 1999. In 1998-99 (Table 1), the final plant stands achieved were very similar for

Table 1. Effect of seeding rate on wheat stand, head number, lodging, and grain yield in a conventional till and no-till planting system (1998-99).

Seeding Rate Goal (seeds/ft^2)	(1) Actual Seeds Drilled (#/ft^2)*	(2) Fall Plant Stand (#/ft^2)	(3) % Stand Achieved	(4) Head Counts (#/ft^2)	(5) Heads Per Plant	(6) Lodging (%)	(7) Grain Yield (bu/ac)
Conventional Tillage							
15	16.0	15.9 d	99	68.2 c	4.3	11	105.8 a
25	29.6	25.1 c	85	75.6 b	3.0	24	105.2 ab
35	38.8	33.5 b	86	79.8 a	2.4	25	104.0 ab
45	48.8	40.1 a	82	76.5 b	1.9	38	100.6 b
No-Tillage							
15	16.0	14.9 d	93	68.6 d	4.6	11	104.3 a
25	29.6	25.1 c	85	75.6 c	3.0	29	107.7 a
35	38.8	34.7 b	89	81.4 b	2.3	30	103.9 a
45	48.8	40.6 a	83	84.6 a	2.1	40	103.6 a

* Adjusted for 90% germination.
Means in a column (within each tillage system) followed by the same letter are not significantly different (p = 0.1 probability level).

Table 2. Effect of seeding rate on wheat stand, head number, lodging, and grain yield (1999-2000).

Seeding Rate Goal (seeds/ft^2)	(1) Actual Seeds Drilled (#/ft^2)*	(2) Fall Plant Stand (#/ft^2)	(3) % Stand Achieved	(4) Head Counts (#/ft^2)	(5) Heads Per Plant	(6) Lodging (%)	(7) Grain Yield (bu/ac)
10	10.9	10.0 g	92	48.8 d	4.9	0	110.2 a
15	18.2	16.0 f	88	50.7 d	3.2	0	110.5 a
20	22.6	19.9 e	88	55.4 c	2.8	0	110.9 a
25	27.8	24.7 d	89	56.3 bc	2.3	0	111.2 a
30	34.0	29.4 c	87	57.7 ab	2.0	0	112.2 a
35	41.7	34.4 b	83	58.4 ab	1.7	0	111.3 a
40	45.7	38.1 a	83	58.7 a	1.5	0	112.0 a

* Adjusted for 85% germination.
Means in a column followed by the same letter are not significantly different (p = 0.1 probability level).

both tillage systems within each seeding rate. This provided an excellent opportunity to compare the influence of tillage system on wheat yield potential when plant stands are equivalent.

Head Counts. Total wheat head numbers (Column 4) were greater at the higher seeding rates. In 1998-99 (Table 1), even at the lowest seeding rate, total heads/ft^2 were sufficient for optimum wheat yield potential (considered to be >60 heads/ft^2). The wheat variety, Pioneer 2540, is known to have excellent tillering capacity. Overall, head counts were lower in 1999-00 (Table 2). No seeding rate treatment achieved greater than 60 heads/ft^2, and the two lowest seeding rates had a total of only ~50 heads/ft^2. However, for the variety used, Pioneer 2552 (good tillering capacity), a total of 50 heads/ft^2 was apparently sufficient to achieve a high yield in the 1999-2000 growing season. Both the 1998-99 and 1999-2000 growing seasons had favorable weather (mild fall/winter and early/warm spring), resulting in excellent wheat growth, development, and tillering. Winter survivability was excellent both years with no stand loss occurring. At the lower seeding rates, the wheat plant compensated for thinner stands by developing more tillers and heads per plant (Column 5).

Lodging. Considerable lodging occurred in 1999 (Table 1) from severe wind and rain storms in late May. Lodging increased as seeding rate increased; however, some lodging occurred even at the lowest seeding rate. The variety, Pioneer 2540, has a tendency to lodge. There was no correlation between the amount of lodging and yield level, which indicated that lodging occurred late enough so that it did not affect yield potential. The wheat was also carefully harvested so that harvest loss was not a factor. No lodging occurred with any of the seeding rates in 2000 (Table 2). The variety, Pioneer 2552, used has good standability.

Wheat Yield. Excellent wheat yields were achieved at all seeding rates (Column 7) in both years. Little, if any, significant yield difference occurred among the seeding rates either year. The results were somewhat surprising since it was expected that the lowest seeding rates would have a lower yield potential. These results demonstrate the great ability of wheat to compensate. It was apparent that more head-bearing tillers were produced per plant to compensate for the thinner stands. Favorable growing seasons (mild fall/winter and early/warm spring) occurred both years, which allowed excellent fall growth, tiller development, and spring growth. In 2000 (Table 2), it is also plausible that the lower seeding rates, despite having what is considered to be suboptimal heads/ft^2, may have compensated with greater seed size and/or greater seed numbers per head. There was no difference in yield among the seeding rates between the two tillage systems in 1999 (Table 1) when plant stands were equivalent.

Conclusions

The low seeding rate/final stands (< 25/ft^2) produced yields equal to higher seeding rate/final stands (25 or more per ft^2). This demonstrates the remarkable compensatory ability of the wheat plant. This does not imply that these low seeding rates should be utilized for soft red winter wheat and that similar results would be obtained. Each year's results were with only one variety at one location. Other factors need to be considered. The varieties used in this study have good tillering capacity, particularly Pioneer 2540. Other varieties with less tillering capacity may not perform as well at low seeding rates. Also the 1998-99 and 1999-2000 growing seasons were excellent for fall growth and tiller development, winter survival, and spring growth, whereas adverse growing seasons would hinder plant growth and development, and thinner stands would not perform as well.

The Green Stem Problem in Soybean

D.B. Egli and W.P. Bruening

Maturation in a soybean field is usually very dramatic—all leaves turn bright yellow and fall from the plant and the pods and stems turn brown. Occasionally something goes wrong with this process and the stems stay green after the pods turn brown. This problem with green stems occurs sporadically throughout the soybean belt. When many green stems are present in a field at harvest maturity, it takes longer to harvest the crop, and the seeds may be exposed to more mechanical damage. The green succulent stems are hard to run through the combine and require slower ground speeds. Waiting for the green stems to turn brown may result in over-drying the seeds, which can increase mechanical damage during harvesting and processing and reduce seed quality.

No one knows for sure what causes green stems. Some think it is caused by disease (for example, in some fields, bean pod mottle virus has been found in plants with green stems) or by insects feeding on pods. Others think it is more common when yields are high and speculate that it may be associated with the development of high-yielding varieties (perhaps as a result of selection for delayed senescence or the stay-green trait). Its sporadic occurrence suggests that environmental conditions may play a significant role.

While searching for a common characteristic in this list of possible causes, we developed the hypothesis that green stems could be a result of not having enough pods on the soybean plant. We know that carbohydrates and nitrogen move from leaves and stems to seeds during seed filling. This transfer process is part of the normal senescence of vegetative plant parts, and when senescence is complete, much of the nitrogen and carbohydrates are gone and the leaves are yellow and the stems are brown. However, if the pod load is too small, there would be no place for the carbohydrates and nitrogen to go and the stems would stay green.

We investigated this hypothesis in a field experiment in 2001 with nine high-yielding soybean varieties (three each from maturity groups III, IV, and V). Two replications of each variety were planted in 30-inch rows at the recommended population, and 50 percent of the pods (all pods from alternate nodes) were removed from all plants in 3 feet of row early in the seed-filling period (beginning of growth stage R6). We made visual ratings of pod and stem color on control and depodded plans every other day as the plants matured.

Pod maturation (pods turning brown) on the depodded plants was delayed, relative to the controls (not depodded), but the delay was not large, and all pods on the depodded plants were brown roughly five days after the control plants. The stems on the control plants were brown when all of the pods turned brown. But the stems of the depodded plants on all cultivars were still green when all of the pods were brown, and it took up to 25 days for these stems to turn brown (Table 1). The stems on the depodded plants of some varieties turned brown faster, but we need more data to determine if these differences are variety characteristics.

The stem nitrogen and carbohydrate (soluble sugars and starch) levels of depodded plants of two varieties (LG Seeds C9474 and Asgrow AG5001) were much higher (three to 10 times higher for both nitrogen and carbohydrates) than control plants

Table 1. The effect of 50% depodding on the development of brown stems, Spindletop Farm, 2001.

	Time of 100% Brown Stems	
Cultivar	**Control**	**Depodded**
Maturity Group III	**Date**	**Days after Control**
Golden Harvest H-3983RR	October 3	22
Pioneer Variety 93B85	October 3	13
Stine 3870-0	October 3	25*
Maturity Group IV		
Stressland	October 7	18*
LG Seeds C9474	October 7	18
Southern States	October 7	21*
Maturity Group V		
Hutcheson	October 17	11*
Delta King 5465RR	October 17	11
Asgrow AG 5001	October 17	11

* Some stems were not brown when the last ratings were taken near the end of October.

when the pods turned brown. These high levels confirmed our hypothesis that reductions in pod number would limit the movement of these materials out of the stem during seed filling.

Our results demonstrate that reductions in pod number, or in crop physiology terminology a source-sink imbalance favoring the source, can cause green stems in soybean. A source-sink imbalance of this type occurs when there are not enough pods to utilize all of the photoassimilate produced by the leaves. A season-long stress that reduced pod number would probably not cause green stems because the supply of assimilate would also be reduced and the source and sink would still be in balance, but yield would be reduced. We think green stems occur only when the balance is disturbed by reducing sink size (pod number) and maintaining source activity (photosynthesis). Pod number could be reduced by disease, insect feeding, or changes in weather conditions during the growing season. Attributing green stems to a source-sink imbalance provides a mechanism that may explain many of the suggested causes of this problem.

We will continue our research this summer to evaluate our hypothesis for a second year, which will help determine if some varieties are more susceptible to green stems than others. We will also determine if lower levels of depodding can create this problem.

Management Practices to Enhance Composition of Specialty Soybean

C. Steele, T. Pfeiffer, and L. Grabau

Soybean growers have had varying experiences with the production of novel soybean varieties. Because novel soybeans are often lower yielding than commodity soybean, a primary factor in the production of specialty soybean is seed quality. The quality component of interest, such as protein concentration in high-protein soybean, is the determining factor in the premium level. For most contracted soybean, failure to meet expected quality standards will result in reduced premiums or in rejection of the grain. A number of management factors may be modified to enhance or maintain the desired quality components. This research was supported by a USDA special grant for New Crop Opportunities.

As more and more types of novel soybean varieties become available, Kentucky growers will need information on which, if any, management practices they may need to modify to successfully produce a given novel type. Food grade tofu soybean may need to be planted at lower rates; planting rates that are too high may decrease soybean size and quality <http://web.aces.uiuc.edu/value/factsheets/soy.htm>. Although seed protein concentration does not usually increase in soybean <www.ag.iastate.edu/farms/2000reports/ne/InSeasNitroFertof Bean.pdf> with nitrogen fertilization, the replacement of nitrogen from nitrogen fixation with mineral nitrogen has increased seed protein concentration (Crop Science 37:498-503, 1997). This may prove beneficial in maintaining or increasing seed protein concentration in high-protein soybean varieties.

Table 1. Variety characteristics in the tofu management test.

Variety	Type	Yield (bu/ac)	Seed Size (mg/seed)	Protein (%)
FG1	Tofu	68	221	36.7
IA 3011	Tofu	62	208	39.2
Pioneer 9305	Tofu	65	166	36.1
Pioneer 93B01	Commodity	65	121	35.1

Materials and Methods

Tofu Test: Four maturity group III soybean varieties, three tofu varieties, and one commodity variety (Table 1), were planted at Lexington and Princeton, Kentucky, in 2000 and 2001. Planting dates ranged from 1 May to 10 May. All experiments were planted as a randomized complete block with four replications of a factorial design. Management treatments compared the application of 40 lb/ac N at growth stage R2 (mid-flowering) with no N application and a standard seeding rate of 175,000 seeds/ac (600 seeds/plot) with a two-thirds seeding rate of 117,000 seeds/ac (400 seeds/plot). Plot sizes were six 15-inch-wide rows 20 feet in length. Data presented in this report are yield, seed size, and protein concentration (Table 2).

High-Protein Test: Six soybean varieties—a maturity group II, III, and IV high-protein variety and a maturity group II, III, and IV commodity variety (Table 3)—were planted at Lexington and Princeton, Kentucky, in 2000 and 2001. Planting dates and plot sizes were the same as for the tofu test, and the planting rate was the standard planting rate as in the tofu test. Management treatments compared the application of 40 lb/ac N at growth stage R5 (beginning seed fill) with no N application. The maturity group II applications occurred around 19 July, the maturity group III applications around 24 July and the maturity group IV applications around 2 August. Data presented in this report are yield and protein concentration (Table 4).

Results and Discussion

The objective in producing tofu quality soybean is to produce a large seed with moderately high protein. The varieties differed significantly in yield, but the commodity soybean variety was only in the middle of the range. The tofu varieties yielded well in this test. In the 2001 Kentucky Soybean Performance Tests, however, these three tofu varieties all yielded below the maturity group III one- and two-year average yields. Varieties were significantly different for seed size and protein

Table 2. Yield, seed size, and protein concentration as affected by seeding rate and N application on three tofu-type soybean and one commodity soybean.

Yield (bu/ac)				Seed Size (mg/seed)				Protein (%)				Seeding Rate
FG1	**IA3011**	**9305**	**93B01**	**FG1**	**IA3011**	**9305**	**93B01**	**FG1**	**IA3011**	**9305**	**93B01**	
67	61	63	65	218	207	164	119	36.5	39.4	35.9	34.9	67%
69	62	68	67	225	210	169	123	36.8	39.0	36.3	35.4	100%
												N applied
68	60	64	65	221	209	168	120	36.7	39.5	36.1	35.0	0
68	62	66	66	221	208	165	122	36.5	38.9	36.0	35.3	40 lb

concentration, with the commodity soybean variety having a smaller seed size and a lower protein concentration than the tofu varieties.

The 67-percent seeding rate produced a significantly lower yield and a significantly smaller seed size. It did not affect protein concentration. The reduction in seed size was unexpected and undesired in these tofu varieties. The R2 nitrogen application did not alter yield, seed size, or protein concentration (Table 2).

The objective in producing high-protein soybean is to increase protein per bushel and protein per acre if possible. The six varieties differed significantly in yield (Table 3), but the high-protein variety was lower yielding in the maturity group IV set. K1431 has by far the highest protein concentration of any novel soybean that we have tested in the Kentucky Soybean Performance Tests the past two years. All three of these high-protein varieties were near the bottom of the yield list in their respective maturity groups in the 2001 Kentucky Soybean Performance Tests. The varieties differed significantly for protein concentration, with the high-protein varieties having higher protein concentrations than the commodity varieties (Table 3).

The R5 nitrogen application did not affect seed yield, and the variety x N application interaction was also nonsignificant. Similarly, the R5 nitrogen application did not affect seed protein concentration, and the variety x N application interaction was also nonsignificant. The commodity soybean varieties and the high-protein varieties did not respond differently to the addition of late-season fertilizer nitrogen.

Table 3. Variety characteristics in the high-protein management test.

Variety	Maturity Group	Type	Yield (bu/ac)	Seed Size (mg/seed)	Protein (%)
U97-207427	II	high protein	62	150	38.5
Jack	II	commodity	59	130	37.2
NE3396	III	high protein	64	101	38.6
Pioneer 93B11	III	commodity	64	155	35.5
K1431	IV	high protein	56	151	44.3
CF461	IV	commodity	64	131	36.2

Table 4. Yield and protein concentration as affected by N application in the high-protein management test.

U97-207427	Jack	NE3396	93B11	K1431	CF461	N applied
Yield (bu/ac)						
62	60	65	65	54	64	0
62	58	64	63	58	63	40 lb
Protein %						
38.9	37.3	38.7	35.5	44.3	36.4	0
38.2	37.2	38.6	35.6	44.2	36.0	40 lb

Conclusion

Additional mid- to late-season nitrogen is not needed to produce tofu or high-protein specialty soybean with acceptable protein concentrations. Standard planting rates should be maintained when growing these specialty soybean types.

Barnhisel, Richard
Professor of Agronomy and Geology
Telephone: (859) 257-8627
E-mail: RBARNHIS@UKY.EDU
Surface mine reclamation, waste utilization, and clay mineralogy

Barrett, Michael
Professor and Chairman
Telephone: (859) 257-7310
E-mail: MBARRETT@UKY.EDU
Selectivity and toxicity mechanisms for herbicides in plants, emphasizing cytochrome P450 monooxygenases

Bitzer, Morris J.
Professor
Telephone: (859) 257-3975
E-mail: MBITZER@UKY.EDU
Applied research on corn, soybeans, wheat and sweet sorghum including silage studies

Burton, Harold R.
Associate Professor
Telephone: (859) 257-1901
E-mail: HBURTON@UKY.EDU
Organo-analytical chemistry

Bush, Lowell P.
Professor
Telephone: (859) 257-3309
E-mail: LPBUSH@UKY.EDU
Alkaloid metabolism and plant-fungal interactions

Calvert, Jimmy
Research Specialist
Telephone: (859) 257-2632
E-mail: JCALVERT@UKY.EDU
Production and management of burley tobacco; facilities coordinator for agronomy research

Chappell, Joseph
Professor
Telephone: (859) 257-4624
E-mail: CHAPPELL@UKY.EDU
Plant molecular biology

Claywell, Gerald
Research Specialist
Telephone: (859) 365-7541
E-mail: GCLAYWEL@UKY.EDU
Plant breeding—grain & corn

Collins, Glenn B.
Professor
Telephone: (859) 257-5333
E-mail: GCOLLINS@UKY.EDU
Development of genetic engineering systems and introduction of useful foreign genes into plants

Collins, Michael
Professor
Telephone: (859) 257-3358
E-mail: MIKE2@UKY.EDU
Forage physiology and management

Cornelius, Paul
Professor
Telephone: (859) 257-2928
E-mail: corneliu@MS.UKY.EDU
Statistical methods for agronomic research

Coyne, Mark S.
Associate Professor
Telephone: (859) 257-4202
E-mail: MSCOYN00@UKY.EDU
Microbial ecology, nitrogen transformations, and fecal contamination of groundwater

Elisa M. D'Angelo
Assistant Professor
Telephone: (859) 257-8651
E-mail: EDANGELO@UKY.EDU
Soil and water biogeochemistry

Dinkins, Randy
Research Specialist
Telephone: (859) 257-7331
E-mail: RDDINK1@UKY.EDU
Cellular genetics

Ditsch, David C.
Associate Extension Professor
Telephone: (606) 666-2438 x231
E-mail: DDITSCH@UKY.EDU
Forage production, surface mine reclamation, and nitrogen management of high-value cash crops

Dougherty, C.T.
Professor
Telephone: (859) 257-3454
E-mail: CDOUGHER@UKY.EDU
Utilization of grasslands by grazing livestock

Egli, Dennis B.
Professor
Telephone: (859) 257-7317
E-mail: DEGLI@UKY.EDU
Crop physiology and management (soybean)

Falcone, Deane L.
Assistant Professor
Telephone: (859) 257-3677
E-mail: DFALCON@UKY.EDU
Plant metabolic engineering, molecular physiology

Gan, Susheng
Assistant Professor
Telephone: (859) 257-4806
E-mail: SGAN@UKY.EDU
Plant molecular genetics, senescence

Green, J.D.
Extension Professor
Telephone: (859) 257-4898
E-mail: JGREEN@UKY.EDU
Weed management in field crops, forages, and turf

Grove, John
Associate Professor
Telephone: (859) 257-5852
E-mail: JGROVE@UKY.EDU
Soil fertility and cropping systems

Henning, Jimmy C.
Extension Professor
Telephone: (859) 257-3144
E-mail: JHENNING@UKY.EDU
Forage establishment, quality, management, and utilization

Herbek, James
Extension Professor
Telephone: (270) 365-7541 x205
E-mail: JHERBEK@UKY.EDU
Applied research practices and management for profitable grain crop production

Hildebrand, David F.
Professor
Telephone: (859) 257-7319
E-mail: DHILD@UKY.EDU
Genetic engineering of plants for improved quality and stress resistance

Hill, Robert
Research Specialist
Telephone: (270) 365-7541 x240
E-mail: BHILL@UKY.EDU
Tobacco breeding and genetics

Hunt, Arthur G.
Professor
Telephone: (859) 257-3637
E-mail: AGHUNT00@UKY.EDU
Messenger RNA formation and metabolism in plants

Karathanasis, Tasos
Professor
Telephone: (859) 257-5925
E-mail: AKARATHA@UKY.EDU
Soil genesis, classification, and mineralogy

Kennedy, Brenda
Research Specialist
Telephone: (859) 257-5023
E-mail: BKENNEDY@UKY.EDU
Tobacco Breeding-Pathology

Lacefield, Eugene
Research Specialist
Telephone: (859) 257-1825
E-mail: ELACE0@UKY.EDU
Variety testing of soybeans

Lacefield, Garry D.
Extension Professor
Telephone: (270) 365-7541 x202
E-mail: GLACEFIE@UKY.EDU
Applied research to improve forage establishment, production, management, and utilization

Legg, Paul
Professor
Telephone: (270) 365-7541 x212
E-mail: PLEGG@UKY.EDU
Dark tobacco breeding and genetics

Marshall, Michael
Research Specialist
Telephone: (859) 257-7326
E-mail: MMARSHAL@UKY.EDU
Weed science

Martin, James R.
Extension Professor
Telephone: (270) 365-7541 x203
E-mail: JAMARTIN@UKY.EDU
Managing problem weeds in agronomic crops

Matocha, Chris J.
Assistant Professor
Telephone: (859) 257-9312
E-mail: CJMATO2@UKY.EDU
Soil chemistry

Miller, Robert D.
Professor
Telephone: (859) 323-4727
E-mail: RDMILLER@UKY.EDU
Tobacco breeding and genetics

Mueller, Thomas G.
Assistant Professor
Telephone: (859) 257-8887
E-mail: MUELLER@UKY.EDU
Precision agriculture/soil management

Murdock, Lloyd
Extension Professor
Telephone: (270) 365-7541 x207
E-mail: LMURDOCK@UKY.EDU
Applied research on conservation tillage, soil compaction, and soil fertility

Palmer, Gary
Associate Extension Professor
Telephone: (859) 257-8667
E-mail: GPALMER@UKY.EDU
Tobacco production

Pearce, Bill
Research Specialist
Telephone: (859) 257-1874
E-mail: WPEARCE@UKY.EDU
Variety testing of corn

Pearce, Robert C.
Associate Extension Professor
Telephone: (859) 257-5110
E-mail: RPEARCE@UKY.EDU
Burley tobacco production-management systems

Perry, Sharyn
Assistant Professor
Telephone: (859) 257-3810
E-mail: SPERR2@UKY.EDU
Plant biochemistry, molecular biology of embryogenesis

Pfeiffer, Todd
Professor
Telephone: (859) 257-4678
E-mail: TPFEIFFE@UKY.EDU
Soybean genetics and breeding

Phillips, Timothy D.
Associate Professor
Telephone: (859) 257-2937
E-mail: TPHILLIP@UKY.EDU
Tall fescue genetics and breeding

Powell, Jr., A.J.
Extension Professor
Telephone: (859) 257-5606
E-mail: AJPOWELL@UKY.EDU
Turfgrass management, weed control, and cultivar evaluation

Rasnake, Monroe
Associate Extension Professor
Telephone: (270) 365-7541 x206
E-mail: MRASNAKE@UKY.EDU
Soil erosion and water quality, soil fertility, poultry manure, crops, forages, and biomass

Ritchey, Edwin
Research Specialist
Telephone: (859) 257-7309
E-mail: ELRITC2@UKY.EDU
Tobacco genetics and breeding

Sikora, Frank J.
Associate Extension Professor, Adjunct
Telephone: (859) 257-2785
E-mail: FSIKORA@UKY.EDU
Soil testing and fertility

Siminszky, Balazs
Assistant Professor
Telephone: (859) 257-4934
E-mail: BALAZS@UKY.EDU
Herbicide-plant interactions

Slack, Charles
Research Specialist
Telephone: (859) 257-3168
E-mail: CSLACK@UKY.EDU
Herbicide evaluation and weed management

Spitaleri, Robert
Research Specialist
Telephone: (859) 257-4150
E-mail: RSPITALE@UKY.EDU
Variety testing of forages

Taylor, Norman
Professor
Telephone: (859) 257-5785
E-mail: NLTAYLOR@UKY.EDU
Red clover breeding and genetics

TeKrony, Dennis M.
Professor
Telephone: (859) 257-3878
E-mail: DTEKRONY@UKY.EDU
Evaluation and utilization of seed vigor as a component of seed quality

Thom, William
Extension Professor
Telephone: (859) 257-4633
E-mail: WTHOM@UKY.EDU
Applied research on soil management, animal waste management

Tomes, Letha
Research Specialist
Telephone: (859) 281-1109
E-mail: LTOMES@UKY.EDU
Foundation Seed Project

Van Sanford, David A.
Professor
Telephone: (859) 257-5811
E-mail: DVS@UKY.EDU
Wheat breeding and genetics

Wagner, George J.
Professor
Telephone: (859) 257-5974
E-mail: GWAGNER@UKY.EDU
Plant biochemistry, metal accumulation in crops

Williams, David W.
Assistant Professor
Telephone: (859) 257-2715
E-mail: DWILLIAM@UKY.EDU
Turfgrass science

Witt, William W.
Professor
Telephone: (859) 257-1823
E-mail: WWITT@UKY.EDU
Weed management and herbicide persistence in tilled and no-tilled crops

7-2002, 1,000 copies