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Center for Grassland Studies

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Chemical Characteristics of Aging Golf Greens

by Roch Gaussoin, Department of Agronomy and Horticulture, UNL

Since 1997, a UNL research project funded by the United States Golf Association (USGA) has been focused on developing a better understanding of the agronomic characteristics of sand-based rootzones as they mature. While many research endeavors may be conducted for two or sometimes three years, it is rare when a research site is evaluated for more than five years. Thanks to the long-term funding commitment of the USGA – and in the initial five years, also the Environmental Institute for Golf – we have been able to evaluate the long-term microbial, chemical and physical characteristics of structured research greens ranging in age from one to eight years. The research on golf green microbial ecology is available online at usgatero.msu.edu. This article will summarize the chemical characteristics. A similar summary on the physical characteristics will appear in the next issue of this newsletter. A more comprehensive article on this research is also available at the above web site.

Profiles taken from USGA 80:20 (sand:peat) greens collected 15 June 2004 at the JSA Turfgrass Research Facility near Mead, NE. Once established, formation of amt is increasing approximately 6.5 mm (0.25") annually and ranges from 5cm (2") to 7cm (2.75") for 5-year and 8-year greens, respectively.

Experimental Set-up and Design

Research was conducted at the University of Nebraska John Seaton Anderson Turfgrass Research Facility near Mead, NE. Four experimental greens were constructed following USGA specifications in sequential years from 1997 to 2000. Treatments included two rootzones – 80:20 (v:v) sand and sphagnum peat and an 80:15:5 (v:v:v) sand, sphagnum peat, and soil (silty clay loam), and two establishment grow-in programs – accelerated and controlled. Establishment treatments were based on recommendations gathered by surveying golf course superintendents and a USGA agronomist with experience in establishing putting greens. The accelerated establishment treatment included high nutrient inputs and was intended to speed, or decrease time for, turfgrass cover development and readiness for play. The controlled establishment treatment was based on agronomically sound turfgrass nutrition requirements. Plots were seeded with "Providence" creeping bentgrass (*Agrostis stolonifera* Huds.) at 1.5 lbs per 1000 ft^2. During the establishment year, the total amount of N, P, and K of the accelerated establishment treatment was two times and four times the amount of the controlled establishment treatment for pre-plant and post-plant, respectively.

All construction materials were tested by Hummel & Co, Inc. (Trumansburg, NY) and met USGA specifications for putting green construction. The first putting green was constructed in late summer of 1996. The rootzones were allowed to settle over the winter and seeded 30 May 1997. The same procedures were used for construction and seeding of greens in 1998, 1999, and 2000.

Following the establishment year, management practices applied to the putting greens did not differ and were maintained according to regional recommendations for golf course putting greens.

Chemical Characterization Data Collection: Soil samples were obtained annually from 1997 to 2003 for USGA-specification putting greens. Soil samples were collected to a 3-inch depth in the fall of each year with a 1-inch diameter soil probe. Thatch was removed from all samples.

Chemical Characterization Results: USGA rootzone mixes comprised of 80:20 (sand:peat) generally were not significantly different from 80:15:5 (sand:peat:soil) during the establishment year or beyond for chemical properties investigated. For the purpose of clarity, establishment year and grow-in year will be used synonymously throughout this discussion.

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The Center for Grassland Studies is a unit within the University of Nebraska-Lincoln Institute of Agriculture and Natural Resources. It receives guidance from a Policy Advisory Committee and a 50-member Citizens Advisory Council. This newsletter is published quarterly.

Martin A. Massengale .....CGS Director
Pam Murray.....CGS Coordinator
Jan Shamburg..... CGS Secretary
Anne Moore ..... Newsletter Layout

From the Director

In any company, agency or organization, it is the people who make it function effectively. The question frequently arises – is there enough people power to handle the work and are they properly trained?

I was fortunate to be invited recently by the National Academy of Sciences to participate in a summit on undergraduate education in agriculture. The primary objectives of this summit were to help define the future of undergraduate education in agriculture and to improve the learning experience so that undergraduates are better prepared for careers in agriculture and at the intersection of agriculture, human nutrition, life sciences, environment and related disciplines.

Since we offer two multi-disciplinary undergraduate majors – Grazing Livestock Systems and Professional Golf Management – through the Center for Grassland Studies, it seemed important for me to attend and participate. We believe our students at the University of Nebraska receive an excellent education, but we always look for ways to improve their experiences and training.

The food, fiber and renewable energy industries employ approximately 17 percent of the nation's workforce today. It is vitally important that we have a successful agriculture for the benefit of our nation overall. Some of the individuals addressing this summit were Secretary of Agriculture Mike Johanns, Under Secretary for Research, Education and Extension Gale Buchanan, and Gary Radkin, Chief Executive Officer for ConAgra Foods, Inc.

There has been a declining trend in enrollment in colleges of agriculture over the last several years, leading to a concern as to whether we will have enough people trained appropriately to propel the agricultural industry into the future. There are fewer students attending universities today with a farm or ranch background, and many young people with urban backgrounds don't understand that colleges of agriculture now offer programs that are much broader than production agriculture.

Our student body is more heterogeneous today than ever before; thus, we need more flexibility in preparing them. Also, agriculture is deeply embedded in social, political and environmental issues worldwide. Will our graduates be prepared to live and work effectively in this global environment? Industry needs people with good technical backgrounds along with good communication and personnel skills.

Today, for workers to be highly effective, they need to master a number of disciplines and be able to function in a multi-disciplinary environment. Few of industries' problems can be solved by a single discipline. How are we going to integrate these multi-disciplinary needs into the curriculum? First, we must enlist the faculty to help with this transformation. There also needs to be a "shepherd" for such programs, and finally there must be a good way to evaluate and reward those faculty who are actively participating in multi-disciplinary programs. The two multi-disciplinary majors administered by the Center for Grassland Studies are both fortunate to have active faculty participation.

Our Citizens Advisory Council for the Center will be meeting on October 20, 2006. The focus of the meeting will be preparing students to be future grassland managers, researchers, educators and policy makers. Participants in this program will include the deans of agriculture from UNL and Nebraska College of Technical Agriculture at Curtis, an instructor at Southeast Community College in Beatrice, heads of federal and state government agencies and non-profit organizations, ranchers and others with grassland interests.

From these sessions we hope to model a curriculum for the future.

M. A. Massengale

A Tale of Two States

by Jana Beckman, Kansas Center for Sustainable Agriculture and Alternative Crops,
K-State Research and Extension

Farmers and ranchers like learning from other farmers and ranchers. Information collected at the 2004 through 2006 Kansas Winter Grazing Conferences and the Nebraska Grazing Conferences communicates a common desire. Producers want practical information about the application and implementation of grazing livestock systems. Thirty percent of the comments from each conference request more producer panels and more producer instructors and speakers to explain the "hands on" of practical application.

The ranchers and farmers of Nebraska and Kansas have some programming requests in common as well. Nebraskans express a need for more information and outreach on winter grazing alternatives and adding legumes to pasture. Kansans express a need for outreach related to selecting and managing a diverse mix of forages and stockpiling forages for winter grazing. In essence, farmers and ranchers in both states are looking for methods to extend both the length of season and quality of grazing in order to reduce feed costs and increase profitability.

The Story Broadens

A recent survey of Kansas agricultural extension agents follows the same trend as the information gathered from farmers and ranchers. Sixty percent of the survey respondents identified annual forages that extend the grazing season and the necessary management for optimal utilization of those forages as an agent training need. Other areas where training needs were identified include strategies for drought management decisions, rotationally grazing native and introduced forages, controlling brush and invasive weeds, selecting and managing a diverse mix of forages and extending the grazing season.

The majority of Kansas extension agents responding to the survey have more than ten years of extension experience. Eighty-three percent of the extension agents indicated they would be determined or very determined to attend an agent training that included a grazing and forage update. Sixty-four percent of the agents indicated that they would be very likely to expand current programming efforts if they were provided with more training and support related to grazing and forages. Sixty-four percent also indicated they would incorporate grazing and forage related topics into new programming if they had increased access to training and support.

Producer Harold Garner (foreground left), K-State Specialist Dr. Walt Fick (foreground center) and K-State Research and Extension Greenwood County Agricultural Agent Jeff Davidson (foreground right) discuss on-ranch research results and grazing strategies implemented on Garner's ranch to increase utilization while controlling invasive species.

Extension agents were also asked to identify the grazing and forage related areas where additional research is needed. Fifty percent felt more research was needed on the economics and practices of converting crop ground to grazing and specifics on extending the grazing season. In discussion sessions held after the survey was administered, agents expressed a need for more specific information so that more accurate enterprise budgets could be developed. For example, "what are the economic and herd health impacts on gain when grazing turnips or other forages commonly used to extend the grazing season?"

The length of service, the strong response for more information and a willingness to enhance or increase grazing and forage related programming are indicators that extension agents are in tune with local producer needs and desire to respond to the needs expressed by farmers and ranchers in their county or district.

Common Priorities

Groups in Nebraska have collaborated to host and sponsor the Nebraska Grazing Conference. In Kansas also, increased collaboration has enhanced state and local grazing and forage production programming.

Between 2004 and 2006, the Kansas Graziers Association, the Kansas Rural Center and the Kansas Center for Sustainable Agriculture and Alternative Crops, a center within K-State Research and Extension, have cosponsored an annual grazing conference, and the three organizations, with the support of local extension offices, have hosted grazing tours. On average, three tours were held each year, primarily in the fall. The focus of conference and tour outreach included multi-species grazing, extending the grazing season and water system development. Producers were asked what information was gained regarding the three focus areas.

The focus on extending the grazing season provided 65% of the farmer and rancher respondents with answers to their questions. Sixty-seven percent learned of resource material available to them, 61% picked up new ideas to try immediately, and 54% met other producers or resource professionals who could assist with the consideration of and the implementation of forages to extend the grazing season.

Farmers and ranchers are one of the most valuable resources in the Great Plains. They bring years of experience and a willingness to share that experience with others. Organizations such as the Kansas Graziers Association, K-State Research and Extension and the Kansas Rural Center can augment producer experience with corresponding research data, information about other resources, and expertise in organizing, sponsoring and promoting activities. Each individual and organization has a different strength and unique roles.

Collaborative outreach efforts in Kansas that respond to the needs expressed by the stakeholder and include stakeholders such as farmers, ranchers and extension agents in the planning and delivery of programs have been successful. Impacts on the level of knowledge and the change in practices that have occurred because of the newly gained knowledge or attitude can be measured in the extension agent target audience as well as the farmer and rancher audience.

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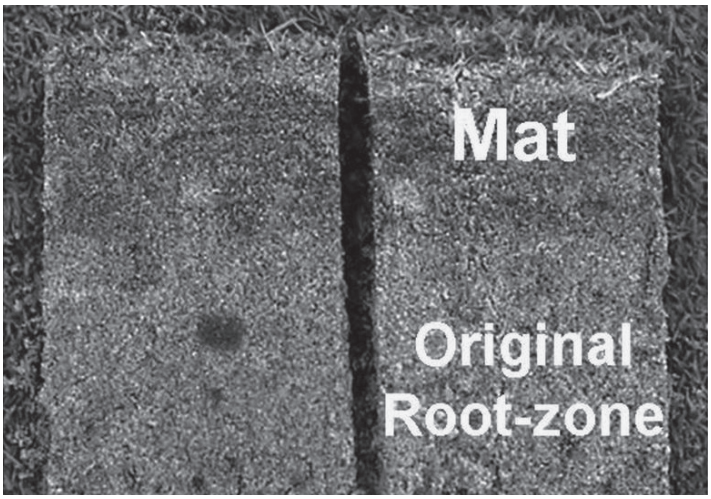
Chemical Characteristics of Aging Golf Greens (continued from page 1)



Mat region and original root-zone in profiles taken from 8-year old USGA 80:15:5 (sand:peat:soil) green collected 15 June 2004 at the JSA Turfgrass Research Facility near Mead, NE. While a transition between mat and original root-zone is evident, individual layering and a distinct grow-in layer it not.

During the grow-in year, all but four of the chemical properties investigated were significantly greater for the accelerated establishment treatment (ET) when compared to the controlled ET. Boron, organic matter, and sodium were also higher in the accelerated ET, but these differences were not significant. Only pH was lower in the accelerated ET during the grow-in year. This was likely caused by an acidification effect from increased fertilizer inputs containing ammonium-nitrogen and sulfur, both known to lower soil pH.

All USGA-specification putting greens receiving increased amounts of phosphorus during the first year of establishment retained significantly more phosphorus beyond establishment. This relationship was not evident for any other nutrients investigated.

Phosphorus retention likely occurred because it is relatively non-mobile even in high-sand soils and thus does not readily leach. Furthermore, sands used in construction of these greens were limestone ($CaCO_3$)-based, calcareous sands with an alkaline pH. Alkaline conditions have been found to further contribute to limited mobility of phosphorus because alkalinity increases the tendency of phosphorus to form complexes with other elements in the soil and is less soluble for plant uptake or leaching. Calcium carbonate in calcareous soils may also limit the mobility of phosphorus because calcium, in the presence of $CaCO_3$, bonds with phosphorus and forms insoluble calcium phosphates. For this reason, slightly alkaline soil conditions and calcareous sands may have contributed to phosphorus retention in the putting green rootzone over time when compared to other nutrients investigated.

Conversely, several studies have observed considerable phosphorus leaching, to varying degrees, through sand-based systems. However, researchers in these studies attributed phosphorus leaching primarily to the turfgrass being young during the establishment year when roots were unable to adequately absorb phosphorus from the soil, excessive rates of phosphorus fertilization, or during increased irrigation, high rainfall events, or both.

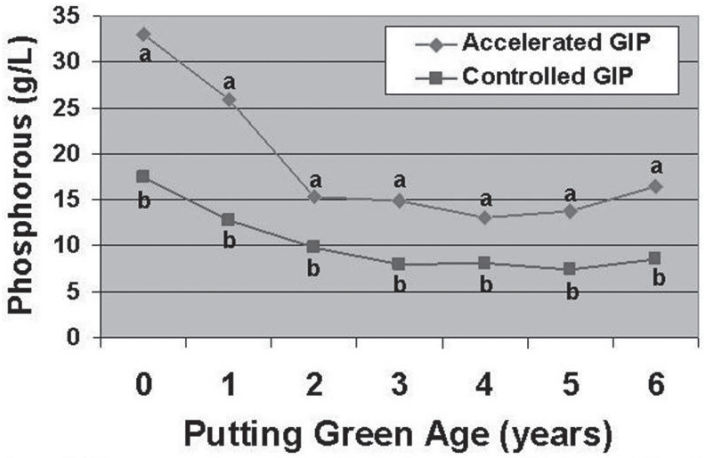
High soil pH can also limit the solubility of other nutrients in addition to phosphorus, including iron, manganese, copper, boron and zinc. Iron, copper and zinc, all of which exhibit varying degrees of solubility and mobility in soils, were also observed to be consistently higher beyond the establishment year for greens receiving the accelerated ET, although these differences were not always significant.

As expected, NO_3-N in our study was not retained beyond the grow-in year for rootzones receiving the accelerated ET when compared to rootzones receiving the controlled ET. It is speculated that greens receiving the accelerated ET in this study may not have retained potassium, sulfur, or other mobile nutrients with time because the amount supplied exceeded turfgrass demand.

Establishment-year comparisons among the four experimental putting greens (i.e., green constructed in 1997 vs. 1998, etc.) were significant for all but three chemical properties investigated. While all four experimental putting greens were constructed in the same way from 1997 to 2000 and all met USGA rootzone specifications, they were not constructed with exactly the same rootzone material each year, and therefore were not identical. Results from this study suggest that USGA-specification putting greens are also not the same in regard to nutritional status, as evidenced by the variability between these four USGA experimental putting greens and the significant differences for nearly all chemical properties investigated.

All nutrients and chemical properties investigated, excluding pH and potassium, generally decreased following the grow-in year, but began to increase several years later. Increased chemical properties and nutrient retention may be explained, at least in part, by the development of a mat layer with time. Mat development was observed, although not measured, in the upper region of putting green rootzones in this study, particularly as putting greens increased in age. Mat is defined as an organic zone, or layer, that is buried below the soil surface and comprised of partially decomposed thatch. Organics in the mat are intermixed with soil from sand topdressing, with sand as the dominant matrix. Organic matter enhances nutrient retention and cation exchange capacity in high-sand rootzones. As such, mat development and organic matter accumulation in our study likely contributed to increased chemical properties, such as CEC, and nutrient retention in older putting greens.

In summary, the 80:20 (sand:peat) rootzone mix was generally not chemically different from the 80:15:5 (sand:peat:soil)



Effect of grow-in procedure (GIP) on phosphorus (P) in the upper 15cm (6") of USGA-specification root-zones. Means are averages of 80:20 and 80:15:5 root-zone mixes because ro0t-zones were not significantly different. Data means within years with different letters are significantly different based on Fishers Protected LSD (P=0.05).

mix during or beyond the establishment year. Since rootzone mix generally had no effect, incorporating soil into the rootzone may be a more economical alternative than peat when used as an amendment in USGA greens.

Chemical Characterization Conclusions: During the grow-in year, all but four of the chemical properties investigated were significantly higher for the accelerated ET when compared to the controlled ET. Only soil pH was lower in the accelerated ET when compared to the controlled ET. Excluding phosphorus, ET generally had no effect beyond the grow-in year. Only phosphorus remained higher for greens receiving increased inputs via the accelerated fertility program. Furthermore, the accelerated ET did not speed turfgrass establishment for putting greens investigated in this study. In fact, rootzones receiving the accelerated ET resulted in reduced creeping bentgrass quality ratings due to increased incidence of Pythium foliar blight (*Pythium* sp.) injury. As such, increased fertilizer inputs during the establishment year may not be feasible or environmentally responsible since 1) it had a negative effect on turfgrass establishment, and 2) these rootzones did not retain these inputs over time when compared to the controlled ET. Additionally, since the rootzone containing soil was essentially equal to the non-soil containing rootzone, incorporating an appropriate, locally available soil into the rootzone may be a more economical alternative than peat when used as an amendment in USGA greens.

2006 Nebraska Grazing Conference Best Yet!

The sixth annual Nebraska Grazing Conference held August 7-8, 2006 was the most successful so far, with 253 participants from 11 states, 25 presenters, and 22 sponsors (19 of whom exhibited). There was also greater involvement of college students – both in the audience and at the podium. Topics included using animal behavior to manage grazing, measuring success in grazing management, grazing yearlings, irrigated pastures, holistic grazing, setting up grazing systems, winter and summer grazing options, breeding grasses for improved beef cattle income per acre, integrating pasture with row crop production, promoting grassland biodiversity, conservation easements, and the interaction of grazing and wildlife.

A packed ballroom listened to Byron Shelton from Colorado discuss holistic grazing planning.

After his opening presentation Monday morning, Dr. Fred Provenza from Utah State University presented a workshop after the evening banquet.

Proceedings from the 2006 and previous conferences are still available for $10 and $5, respectively. They contain the material submitted by most of the presenters prior to the conferences. The conference web site (www.grassland.unl.edu/grazeconf.htm) contains the programs for each conference. To order proceedings, send a check payable to Nebraska Grazing Conference to the CGS office. (For orders outside the U.S., check with the Center on cost prior to ordering.)

If you have not attended previous conferences but would like to be on the mailing list to receive notice of next year's conference, to be held in the same location, and again on August 7-8 (although that will be Tuesday-Wednesday), simply send your name and address to the CGS office. Details of the 2007 program will be posted on the conference web site as they become available early next year.

The Nebraska Grazing Conference has several sponsors including this year's conference underwriters: UNL Center for Grassland Studies, Nebraska Game and Parks Commission, and Nebraska Grazing Lands Coalition.

CGS Associates

Robert (Bob) Shearman was recently named the Sunkist Fiesta Bowl Professor of Agronomy.

At the National Association of County Agricultural Agents annual meeting in July, **Steve Melvin** received the Distinguished Service Award.

A Tale of Two States (continued from page 3)

Questions to the Answers

Planning quality programs includes stakeholder involvement in identifying programming needs, curriculum development and the delivery mechanism. Effective programming also includes preplanned methods for evaluation. Communicating the success and impact often increases the enthusiasm, support and interest for a program.

One of the respondents to the producer survey wrote that they had learned "questions to my answers." Questions to our answers – what a great approach to program planning and evaluation!

Can Ecophysiological Characteristics Explain the Success of Woody Species in the Sandhills of Nebraska?

by Kathleen Eggemeyer, Tala Awada, F. Edwin Harvey, David Wedin, Xinhua Zhou and Sue Ellen Pegg
School of Natural Resources, UNL

At 50,000 km^2, the Nebraska Sandhills are the largest stabilized sand dune formation in the Western Hemisphere and a major recharge zone for the High Plains (Ogallala) Aquifer. Although the Sandhills are almost entirely stabilized by grasses, tree encroachment into Sandhills grasslands is increasing. For example, ponderosa pine (*Pinus ponderosa* P.& C. Lawson) has expanded into grasslands in the Pine Ridge and Niobrara Valley of Nebraska, and eastern redcedar (*Juniperus virginiana* L.) is spreading throughout the Sandhills. These vegetational changes reflect shifts from open grasslands and savannas to more closed-canopy woodlands in semi-arid landscapes worldwide. Although decreased fire frequency is certainly one driver of these changes, over-grazing, climate change, elevated atmospheric CO_2, atmospheric N deposition, and human-enhanced dispersal may also favor woody species over native warm-season C_4 grasses, such as those dominating the Sandhills. Shifts in vegetative cover from grasslands to wooded areas have profound ecological and economical impacts affecting livestock grazing, fire risk, carbon sequestration and water balance.

Ongoing research in Nebraska is evaluating the physiological basis for tree success in the Sandhills. Studies are being conducted at the Nebraska National Forest at Halsey to investigate and contrast ecophysiological responses of woody species and dominant warm-season grasses to the environment. Differences in physiology, phenology, and rooting patterns between trees and grasses affect their responses to environment and may contribute to the success of trees in semi-arid grasslands and savannas. These responses were determined via the measurements of gas exchange (i.e., photosynthesis, stomatal conductance, transpiration and water use efficiency), plant water status, sap flow (tree level transpiration), and carbon isotope discrimination (°C^{13}) in the two native cool-season C_3 trees: ponderosa pine and eastern redcedar, and two dominant native warm-season C_4 grasses: little bluestem (*Schizachyrium scoparium* (Michx.) Nash) and switchgrass (*Panicum virgatum* L.). Isotopic signatures of hydrogen (δ^2H) and oxygen (δ^{18}O) were also used to quantify the spatial (depth) and temporal (seasonal) utilization of soil water by these species, and to better understand how such use in times of stress affect their ability to survive in semi-arid environments. Environmental variables (e.g., temperature, relative humidity, soil moisture, precipitation, wind speed and light) were also continuously monitored on site using weather stations.

The climate diagram (Figure 1) indicates that most of the precipitation occurred in the spring, and drought started mid-July and ended at the beginning of October during the study period. The seasonal soil volumetric water content was highly variable at 0.2 m depth, reflecting recent precipitation events. In contrast, the water content at 1 m depth was found to be less responsive to precipitation events, exhibiting higher water content than shallower layers during the dry summer months as expected.

To investigate the depth of water that trees and grasses are utilizing, isotopic signatures (δ^2H and δ^{18}O) were determined

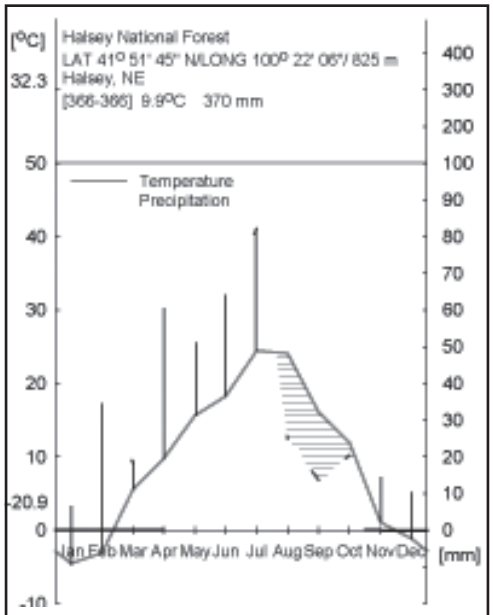


Figure 1. Climate diagram of mean monthly temperature and precipitation data for the Nebraska National Forest, Halsey during the study period. Horizontal and vertical lines indicate relative drought and humid periods, respectively. Bold dates (on x-axis) indicate frost periods (Eggemeyer et al. 2006).

(Water Science Laboratory, UNL) over a 12-month period on water extracted from: 1) non-transpiring tissues; 2) soil (0-3 m at 0.15 or 0.2 m intervals); 3) groundwater; and 4) precipitation. Little bluestem and switchgrass revealed similar isotopic signatures that remained seasonally consistent. These grasses were acquiring water from similar shallow depths, using only recent precipitation events. Isotope analysis demonstrated a shallow active rooting zone in these species. The grass results differed, however, from those of ponderosa pine and eastern redcedar where the isotopic values in trees varied by species and date, suggesting that trees obtained water from different soil depths on a seasonal basis. Our findings suggested that 1) under conditions of adequate soil moisture, trees used both shallow soil water derived from recent precipitation and water from deeper in the soil profile; and 2) during periods of water stress (freezing soils or drought), water was drawn only from depth (< 0.8 m). Thus, when moisture was available in the upper soil profile (i.e., spring), trees and grasses utilized and competed for the same shallow water sources, but when soil moisture was depleted near the surface, as occurs frequently in the Sandhills, trees alone had access to the deeper soil water throughout the year via their extensive rooting system. Our findings also suggest that under drought stress, ponderosa pine was able to tap to deeper water in the soil profile than eastern redcedar.

The differences in rooting pattern and water acquisition between grasses and trees should result in differences between these species in how they respond to environmental stresses. To address this, we followed the ecophysiological responses of the four species over a one-year period for trees and during the growing season for grasses. Winter tree measurements showed that although physiological activity was low in response to climatic conditions and endogenous rhythms, plants remained physiologically active at temperatures > 0 °C (32 °F), showing potential winter carbon gain in trees, while grasses were dormant. Physiological results

were consistent with both sap flow measurements and water uptake from below the frozen soil layers (using isotopic signatures of δ^2H and $\delta^{18}O$). The rate of tree photosynthetic activity and water use increased as temperatures and radiation rose in the spring and peaked in May prior to summer drought. Grasses during the growing season displayed higher photosynthetic rates and water use efficiency than trees in June and July. Our results on water status in plants showed that while grasses were more drought tolerant, they were significantly more drought stressed than the trees in August due to their shallow roots, forcing them into dormancy. Trees, however, were able to avoid and recover from drought stress due in part to their ability to access water from greater depths in the soil profile. Eastern redcedar, in addition to acquiring water from deep in the soil profile, was also shown to be more drought tolerant than ponderosa pine.

In the semi-arid grasslands in Nebraska, trees coexist with grasses. In recent decades, we have seen a vegetation shift in communities from open grasslands to savannas and sometimes closed-canopy forests. Fire appears to be a critical factor controlling vegetation distribution in several major biomes including grasslands and savannas. In fact, climate in these ecosystems does not limit tree establishment, as has been shown by fire suppression or fire introduction experiments (Eggemeyer et al. 2006, and references in). Ponderosa pine and eastern redcedar possess avoidance and/or tolerance strategies that allow them to deal physiologically with soil moisture stress in semi-arid grassland environments. The deeper roots of ponderosa pine, and to a lesser extent eastern redcedar, permit these species to access water from below the frozen soil profile during winter, to avoid drought stress during the summer, and to facilitate their survival on relatively dry sites. This source of water is not available to grasses, forcing them into dormancy earlier in the season during drought years while trees continue to function.

We conclude that ponderosa pine and eastern redcedar trees appear to be well suited for survival in a semi-arid grassland like the Nebraska Sandhills, provided that: 1) sufficient soil moisture exists in early spring for these species; 2) deep (>1.5 m) soil moisture persists during drought periods; and 3) fire suppression continues to be a dominant policy. Both species can continue to invade and displace dominant grasses. This expansion of woody vegetation into the C_4 grass-dominated Nebraska Sandhills has potentially important implications for local and regional biodiversity and geochemistry. The shift from grass to tree species is likely to change plant productivity, standing plant biomass, and the relative allocation and storage of carbon in above- and below-ground components, and may contribute to a decline of groundwater recharge.

Reference: Eggemeyer, K.D., Awada, T., Wedin, D., Harvey, F.E. and Zhou, X. (2006) Physiological characteristics explain the success of Pinus ponderosa and Juniperus virginiana expansion into the semi-arid grasslands of Nebraska. Int. J Plant Sci. 167: 991-999.

Comparison of a Long Yearling System to Calf-fed Performance and Economics

by Will Griffin and Terry Klopfenstein, Department of Animal Science, UNL

There are two major types of cattle production systems. One is an extensive system (yearling production system) where cattle are placed in a backgrounding program after weaning on crop residue or harvested/grazed forage through the winter. After wintering, cattle can be placed in the feedlot or enter summer grazing before finishing. The other is an intensive system (calf-fed production system) where cattle are weaned and fed a high-concentrate diet until slaughter. These two different production systems are important to the industry in terms of utilizing available resources and supplying a year-round supply of cattle. Additionally, body type and body weight are extremely diverse in the cattle population, with weights ranging from a 350 lb heifer to a 750 lb steer at weaning. The heavier calves at weaning are better suited for intensive finishing systems, which results in acceptable carcass weights at a quality grade of Choice. However, if larger-framed animals are placed in an extensive production system, animals may become too heavy and produce overweight discounts. In contrast, lighter, smaller-framed animals can be grown for a period of time in an extensive system and still be slaughtered at acceptable weights. These smaller-framed animals can enter intensive production systems; however, this leads to lighter carcasses and decreased profitability because weight sold is a major driver in economical beef production.

A calf vs. yearling grow/finish system comparison was made utilizing data from calf-finishing and a yearling grow/finish system at UNL from 1996-2004. Calf-finishing trials that were selected began in the fall of each year. Calves were sorted from a large pool of animals that were received during the fall of each year and sorted by weight. After sorting, the heavier, larger-framed animals entered a calf-feeding system. Comparisons were made both between calf-feds and the entire yearling system (winter, summer, and finishing), and between calf-feds and only the finishing phase of the yearling system.

Calf trials were selected based on the composition of the finishing diet. Finishing diets had to contain a minimum of 25% wet corn gluten feed (WCGF) and a maximum of 40% WCGF. This range in WCGF inclusion was used to provide a large supply of calves for this study and because inclusion of WCGF at levels of 25 to 40% have not shown any differences in finishing performance of steers. Calves were weaned in the fall, acclimated to the feedlot for 20 to 40 days, and placed directly on feed until slaughter, which occurred in late April to early May, depending on the year.

For the yearling production system, steers were purchased in the fall and grazed cornstalks in the winter. During the wintering period, steers were supplemented 5 lb dry matter/hd daily of WCGF to achieve a gain of 1.5 lb/d. After the wintering period, steers were placed on brome grass pasture until the middle of May and then moved to Sandhills range for the remainder of the summer grazing period. After completion of the summer grazing period, steers were placed into the feedlot. The finishing diet contained 40% WCGF and 45% of either dry-rolled or high-moisture corn, depending on the year.

At receiving, calf-feds were 116 lb heavier than steers entering the yearling/grow finish system. However, when comparing calf-feds to yearlings at feedlot entry, the yearling cattle were 315 lb heavier than calf-feds. The increase in initial feedlot body weight led to an 83 lb heavier final body weight for yearling cattle compared to calf-feds. Yearlings consumed more dry matter per day than calf-feds; however, calf-feds consumed 838 lb more total dry matter during the finishing period than yearlings. The increase

in total dry matter is because calf-feds were fed 78 days longer than yearlings. Yearlings had 0.72 lb greater daily gain compared to calf-feds; however, calf-feds were 16.7% more efficient than yearlings. When comparing hot carcass weights, yearlings were 52 lbs heavier than calf-feds. Calf-feds were fatter than yearlings; however, quality grade was not different. Calf-feds produced more yield grade 4 carcasses and yearlings produced more overweight carcasses. Yield grade 4 carcasses and overweight carcasses carry similar discounts in the packing plant and are the issues that feeders attempt to manage with calf-feds and yearlings, respectively.

For the duration of the production system, calf-feds gained 640 lb and yearlings gained 839 lb. This increase in the amount of weight gained for the yearlings is approximately a 28% increase in the amount of weight compared to calf-feds, because the calf-feds were 22% heavier than the yearlings at the beginning to the production system, and the yearlings were 6% heavier than the calf-feds at slaughter. Additionally, yearlings consumed 1.64 lb of corn per lb of gain and calf-feds consumed 2.81 lb of corn per lb of gain. When looking at grain intake as a function of final weight for yearlings and calf-feds, yearlings consumed 1.01 lb of corn for each lb of weight sold and calf-feds consumed 1.40 lbs of corn for each lb of weight sold. The increased efficiency in corn grain usage for yearling cattle is critical with the increasing demand for corn grain from ethanol production and other competing livestock markets.

Economics were calculated using a seven-year average for all feedstuffs used and cattle. The cost of interest, feedlot yardage, and death loss were added to the cost of the respective systems. Yearlings were $60.04/steer more profitable than calf-feds. Yearlings had a lower initial animal cost than calf-feds because yearlings were lighter at purchase. Also, during the growing period, yearlings had a considerably lower cost of gain ($0.39/lb of gain) compared to calf-feds that had a cost of gain of $0.43/lb of gain. However, in the feedlot yearlings had a higher cost of gain than calf-feds ($0.50 vs. $0.43/lb of gain). Therefore, the key to realizing the increased profit from this yearling system is to retain ownership through the entire production system, and taking advantage of the lower cost of gain in the growing period and the increase in the amount of weight sold.

For more information, see the *2007 Nebraska Beef Report*, which should be online in late December 2006 at beef.unl.edu/reports.shtml.

Table 1. Animal performance as a main effect of treatment.

Item	*Calf-fed*	*Yearling*
Receiving weight, lbs	642	526
Initial Feedlot, lbs	642	957
Final weight[a], lbs	1282	1365
Feedlot ADG	3.81	4.53
Days Fed	168	90
DMI, lbs/d	21.36	30.56
Feed:Gain	5.63	6.76
Total Feed[b], lbs	3592	2754

[a]Final weight calculated using carcass weight divided by 0.63.
[b]Total Feed = amount of feed consumed during the finishing period.

Table 2. Carcass characteristics as a main effect of treatment.

Item	Calf-fed	Yearling
Fat thickness, in	0.53	0.47
Yield grade	2.71	2.60
Marbling Score[a]	510	525
% Choice	58.4	65.0

[a]Marbling score = 400=slight^0, 500=small^0, etc.

Calendar

Contact CGS for more information on these upcoming events:

2006

Nov. 12-16 ASA-CSSA-SSSA International Meetings, Indianapolis, IN, www.agronomy.org/meetings.html

Dec. 10-13 3rd National Conference on Grazing Lands, St Louis, MO, www.glci.org/3NCGLindex.htm

Dec. 11 Grazing Management Series: Dryland Pastures, Norfolk, NE

Dec. 12 Grazing Management Series: Rangeland, Albion, NE

Dec. 13 Grazing Management Series: Annuals, Hartington, NE

Dec. 14 Grazing Management Series: Irrigated Pastures, O'Neill, NE

2007

Aug. 7-8 Seventh Annual Nebraska Grazing Conference, Kearney, NE, www.grassland.unl.edu/grazeconf.htm

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