on the disease compared to the genetic influence. It also would typically require evaluation in a number of environments with multiple replications. Preliminary research on brown patch resistance in tall fescue indicates that resistance may be quantitative (Simmons and Hamblin, 2002; Bonos et al., 2004; Bokmeyer et al., 2006). We have previously shown that dollar spot resistance in creeping bentgrass is most likely quantitatively inherited (Bonos et al., 2003; Bonos, 2006).

We have been investigating several selection techniques to improve brown patch resistance in colonial bentgrass. Selecting plants based on turf plot evaluations has only resulted in moderate improvements in brown patch resistance. However, we have found that selecting plants based on mowed spaced-plant evaluations has resulted in greater improvements in disease resistance compared to turf plot selection.

Individual colonial bentgrass progeny plants from seven controlled crosses between tolerant and susceptible parents were planted into a stand of perennial ryegrass in the fall of 2001. The mowed-spaced plant trial was maintained at 1.9 centimeters (¾ inch). Tolerant and susceptible parent plants were planted with three replicates. All plants were inoculated with a mixture of two different brown patch isolates isolated from colonial bentgrass. The isolates were grown on sterilized Kentucky bluegrass seed and applied with a drop spreader at approximately 0.25 grams per square meter (g/m^2). Brown patch disease was evaluated weekly after symptoms began to develop using a scale from 1 to 9, 9 representing least brown patch disease and 1 representing completely susceptible. The symptoms occurred approximately two weeks after inoculation. After two full seasons of brown patch disease pressure, significant differences in brown patch disease among colonial bentgrass clones were evident (Figure 4).

From this trial, we found that susceptible parents were not significantly more susceptible than the tolerant parents. Plants crossed between two tolerant parents were not more tolerant than crosses between tolerant and susceptible parents. These results indicated that brown patch resistance is significantly affected by the environment and suggests that inheritance is quantitative.

PHOTO 3

Brown patch disease on colonial bentgrass.

PHOTO 4

Mowed-spaced plant evaluation trial for brown patch resistance in colonial bentgrass.

The colonial bentgrass clones with high levels of disease resistance in the mowed plant trial were selected and moved to isolated crossing blocks and allowed to inter-pollinate. Seed was harvested individually from each plant to establish single-progeny turf plots. And equivalent amounts of seed from each plant were bulked to make a composite in order to establish replicated turf plots in the fall of 2002.

Entries in the turf plot evaluation trial included standard cultivars and experimental selections from numerous turfgrass breeding programs. Entries in each test were seeded using a maximum of 0.22 g/m^2 [1.3 pounds per 1,000 square feet (ft^2)] of seed. Between 8.9 grams of nitrogen per square meter ($g\ N/m^2$)

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PHOTO 5

Colonial bentgrass cultivars selected for brown patch resistance compared to susceptible cultivars.

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and 6.5 g N/m^2 (2.2 pounds and 1.6 pounds of N per 1,000 ft^2) were applied annually (2003 and 2004 respectively). No single N application exceeded 2 g N/m^2 (0.5 pounds N per 1,000 ft^2). The annual fertilization program included two granular N applications in the spring and fall at approximately 2 g N/m^2 and biweekly liquid N applications during the summer months at about 0.8 g N/m^2 (0.2 lb N per 1,000 ft^2). The trial was maintained at approximately 0.48 centimeters (3/16 inch) cutting height. The trials were rated throughout the growing seasons for turf quality (color, brightness, leaf texture, density, uniformity, amount of disease and amount of insect damage) and brown patch disease. The turf trial was not inoculated with the brown patch pathogen. All disease outbreaks were a result of natural infection.

The mowed-spaced plant selection technique has resulted in dramatic improvements in brown patch resistance in colonial bentgrass. The experimental selections developed using this technique (BCD, 9110–8-10, 9111-6-12) had higher brown patch ratings than standard cultivars that were not selected for brown patch resistance (SR 7100, SR 7150) (Photo 5). This data indicates that this technique is effective in improving brown patch resistance.

This technique was also used to evaluate new collection sources of colonial bentgrass, for brown patch disease. We have identified more than 150 colonial bentgrass plants from 20 European collection sources with improved brown patch resistance. The addition of new sources of resistance helps to maintain the genetic diversity of the species and may increase the durability of resistance. These new European sources of brown patch resistance have been crossed with colonial bentgrasses used in the Rutgers breeding program that are adapted to our climate in the United States. These new experimental selections of colonial bentgrass are able to maintain very good quality even in the presence of heavy brown patch disease pressure.

The results reported here indicate that new colonial bentgrass cultivars selected for improved brown patch resistance should be useful on fairways where reduced inputs are anticipated. Newly developed cultivars can maintain acceptable quality with limited fungicides; they can recover from drought stress quickly; and they do not accumulate thatch aggressively and therefore do not require excessive cultural practices to reduce thatch accumulation. These attributes make colonial bentgrass an attractive alternative to creeping bentgrass for superintendents interested in reducing inputs and conserving energy on golf course fairways.

Dr. Stacy Bonos is an assistant professor of turfgrass breeding in the department of plant biology and pathology at Rutgers. Her research focuses on integrating classical and molecular genetics to improve and more efficiently breed grasses. She has received grants from several funding agencies, including the USGA, OJ Noer Research Foundation, and USDA NRI-CSREES Plant Genome Program and the USDA/DOE Rural Development Program. She can be reached at bonos@AESOP.Rutgers.edu.

REFERENCE

Bokmeyer, J., W.A. Meyer, and S.A. Bonos. 2007. Genetic inheritance of brown patch resistance in tall fescue. In Agronomy Abstracts. A.S.A., Madison, WI
Bonos, S.A. 2006. Heritability of dollar spot resistance in creeping bentgrass. Phytopathology 96:808-812.

Bonos, S.A., M.D. Casler, and W.A. Meyer. 2003. Inheritance of dollar spot resistance in creeping bentgrass. Crop Science. 43:2189-2196.

Bonos, S.A., E. Watkins, and W.A. Meyer. 2004. Heritability of brown patch resistance in tall fescue. In Agronomy Abstracts. ASA, Madison, WI.

DaCosta, M. and B. Huang. 2007. Drought survival and recuperative ability of bentgrass associated with abscisic acid and cytokinin production. J. Am. Hort Sci. 132(1):60-66.

DaCosta, M., and B. Huang. 2006. Changes in carbon partitioning and accumulation patterns during drought and recovery for colonial bentgrass, creeping bentgrass, and velvet bentgrass. J. Am. Soc. Hort. Sci. 131:484-490.

Simmons, K.L. and A.M. Hamblin. 2002. Inheritance of brown patch resistance in tall fescue. Agronomy Abstracts. ASA, Madison, WI.

Cultural Management Can Limit Damage From Disease

By Paul Vincelli

Turfgrass diseases can create many headaches for golf course superintendents, and it is tempting to rely on magic bullets to cure them. However, cultural practices are really the foundation of a turfgrass disease control program.

It might surprise you to learn that natural biological control of turfgrass diseases is actually the norm in turfgrass ecosystems. Natural field soils commonly show some degree of disease suppressiveness; this is easy to demonstrate experimentally. However, the problem is that this natural biological control is usually insufficient for complete disease control, so turfgrass managers still must contend with disease outbreaks. Maybe as we learn more about the complex world of natural biological control, we'll be able to recommend ways to consistently treat turfgrass disease.

The use of commercial biological products for controlling diseases is increasing in turfgrass management. This is a wonderful development, but unbiased research shows that the efficacy of the current generation of biological control products is typically not as consistent as inert fungicides. Compost teas — room-temperature water extracts of composts — are being increasingly used for turfgrass management, but to my knowledge there is not yet been any published research on the effectiveness of these against turfgrass diseases.

With commercial biological control agents, expect variability in performance from site to site and from year to year. Furthermore, don't expect good results under high disease pressure. And exercise some healthy skepticism of exciting claims of disease control. Rely on cultural practices and resistant varieties as the foundation of your disease control program, and don't expect the application of biological control products and compost teas to substitute for good agronomics.

Variety selection

If you are seeding or re-seeding, selecting a variety resistant to important turfgrass diseases is

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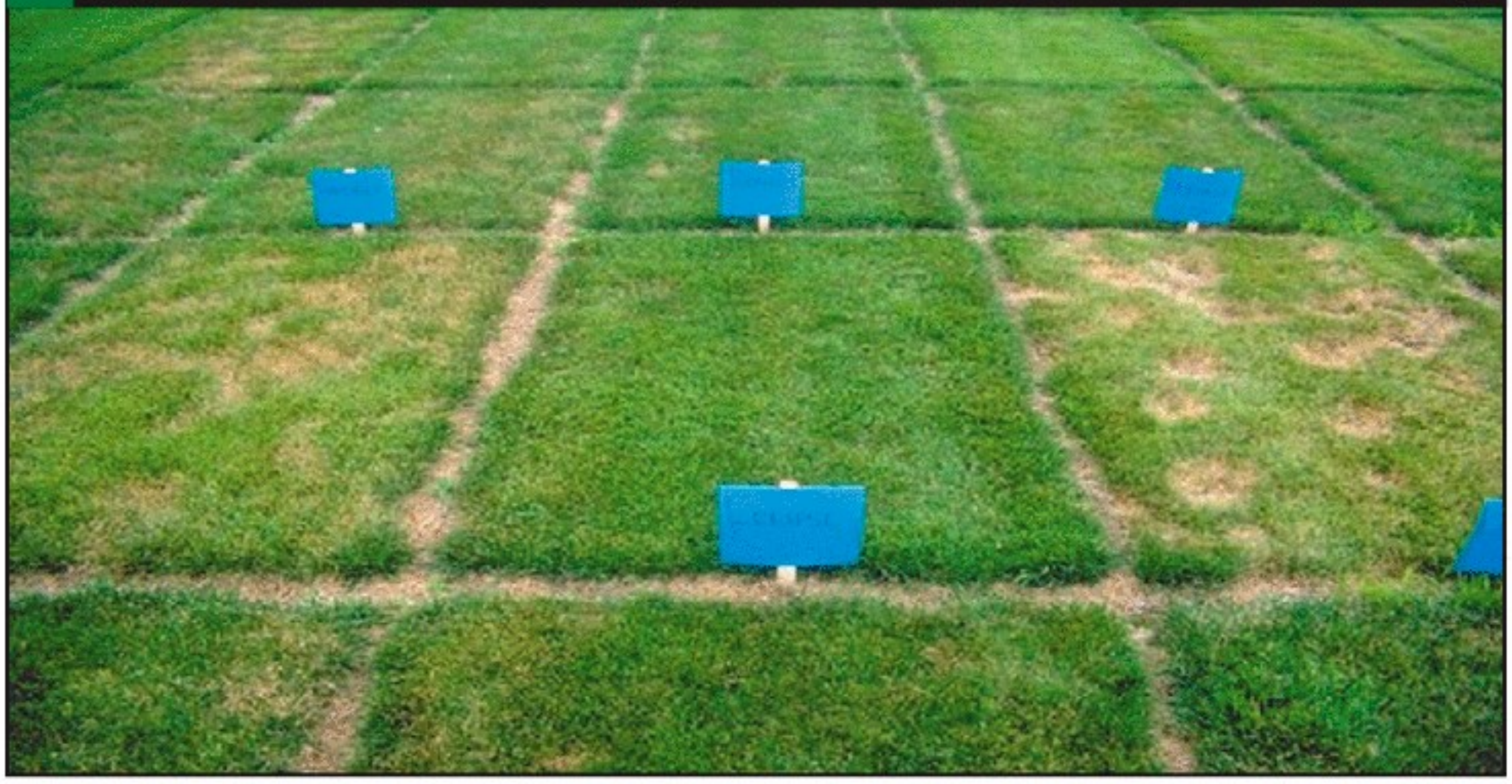
PHOTO 1



Differences in susceptibility to summer patch and necrotic ring spot among Kentucky bluegrass cultivars.

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PHOTO 2

Daily irrigation in evening | Daily irrigation in early morning

Identical amounts of daily irrigation were applied to these plots of fairway-height creeping bentgrass.

Continued from page 64

among your most potent tools for reducing disease pressure (Photo 1, p. 64). If you managed a variety highly susceptible to the patch diseases pictured there, you could likely never use enough fungicide to completely control these soil-borne diseases. However, by choosing a variety with a high level of resistance, you can see you would be able to avoid the use of fungicides for patch diseases.

It is sometimes tempting to ignore disease resistance when selecting varieties. For example, some practitioners are unconcerned about the high susceptibility to dollar spot in some creeping bentgrass varieties, pointing out that fungicides can be used to control this disease. But not only does this lock you into a fungicide dependency, it increases the risk of fungicide resistance by increasing overall pathogen activity, possibly creating a situation where fungicides become less and less useful for the very disease you are trying to control.

Incidentally, excellent information on disease reactions of varieties is available through the National Turfgrass Evaluation Program (http://www.ntep.org/).

Leaf wetness management

With few exceptions, fungi need moisture in order to penetrate and infect plant tissues. Thus, any practice that reduces the duration of leaf wetness periods also reduces pressure from foliar diseases. Mowing at sunrise is a highly effective practice for breaking up leaf wetness as well as for disrupting fungal mycelium. Other useful techniques include dragging the turf using coupled hoses, syringing at sunrise or poling. The foliar application of surfactants can be useful, but our research reveals that these need to be applied too often to achieve disease control.

Timing of irrigation can have a substantial impact on disease development. In a University of Kentucky study, irrigation at sunrise substantially reduced disease pressure compared to applying the same amount of irrigation during the evening (Photo 2). Morning irrigation results in shorter leaf wetness periods than evening irrigation. This is because irrigation at sunrise knocks off most of the moisture on leaf surfaces, permitting faster drying.

In contrast, evening irrigation creates leaf surface wetness that doesn't have time to dry by nightfall, resulting in long leaf wetness periods.

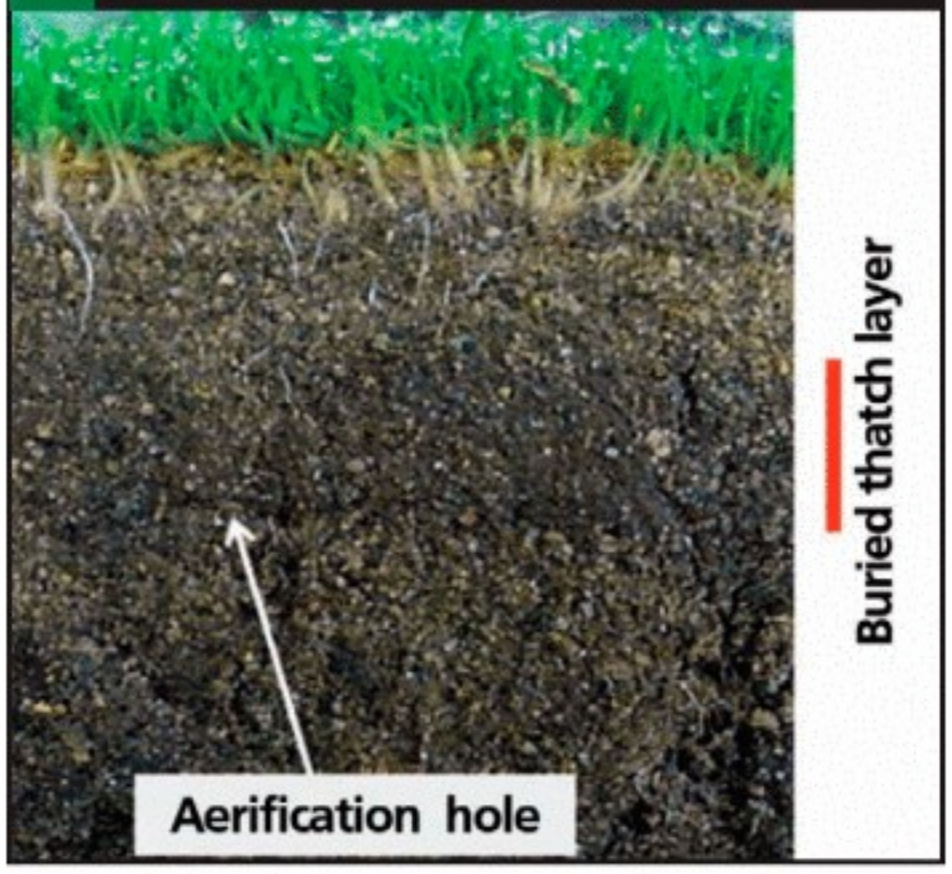
Fertility

Nitrogen fertility can have a substantial impact on disease development. Overfertilization with nitrogen is known to favor *Pythium* blight, brown patch and gray leaf spot, whereas underfertilization favors dollar spot, leaf rusts, anthracnose and red thread.

The form of nitrogen applied can also affect disease development. The best example of this is seen with summer patch and take-all patch. These diseases are less severe in turf regularly fertilized with ammonium forms of N, whereas they are made worse where turf is regularly fertilized with nitrate. Over time, the ammonium causes an increase in acidity around the root (called the rhizosphere), whereas nitrate reduces acidity in the rhizosphere. The benefit from ammonium is not due to the acidity being poisonous to the fungi; they grow quite well under reasonably acid conditions. But the increase in acidity seems to increase turfgrass resistance to infection.

Turfgrass managers should be cautious when applying heavy rates of DMI fungicides with paclobutrazole and flurprimidol.

PHOTO 3



Buried thatch layer in a sand-based putting green.

Mowing practices

Shorter mowing heights commonly increase disease pressure, especially from root-infecting fungi. Turfgrass responds to shorter mowing heights by producing shorter root systems, resulting in greater vulnerability to root infections. Given an equal amount of root infection in two swards, the sward with the higher mowing height is less likely to show foliar symptoms because the plants are more tolerant to the root infection and resulting root rot. Even differences of a few thousandths of an inch can help a putting green limp through a root rot situation or a period of stressful weather.

Organic matter management

A thick thatch layer holds moisture, favoring fungal activity. It also may limit rooting depth, leaving the turf more vulnerable to root infections. A buried thatch layer (Photo 3) develops when thatch is covered by repeated topdressing without thorough incorporation into the thatch layer. A buried thatch layer creates a ponding effect in the root zone with every irrigation or rainfall because water will not percolate uniformly through these soil layers of differing textural class. A problem like this must be corrected in order to reduce activity of fungal pathogens in the root zone.

Turf growth regulators

Trimmet (paclobutrazole) and Cutless (flurprimidol) are both are well-known growth regulators, but they are also weak fungicides. Apply these products to turf and you can often see some weak but measurable reduction in dollar spot pressure. Because these growth regulators have identical modes of action to demethylation inhibitor (DMI) fungicides, one has to be cautious about applying heavy rates of DMI fungicides in conjunction with these growth regulators on putting green turfgrass during stressful periods in summer.

Paul Vincelli is extension professor and provost's distinguished service professor in the department of plant pathology at the University of Kentucky. He can be reached at pvincelli@uky.edu.

REFERENCES

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Editorial Index

Thanksgiving

PHOTO BY: ISTOCK INTERNATIONAL INC.

CAN YOU LIST ALL THE LITTLE THINGS THAT CONTRIBUTE TO OUR GOOD FORTUNE?

BY MARK LUCE

The little kids will tell you about maize and pilgrims. High schoolers will rejoice about the four-day weekend, and many college students will craft any number of excuses to not be able to make it home. But amid all the hand turkey art, cranberry sauce, homemade stuffing and naps in front of the football game, we wanted to remind you that the spirit of this autumnal season remains simple gratitude.

So I've mined the memory banks for a special column, one that speaks my gratefulness of such a wonderfully rich (figuratively, obviously) life. My family, of course — lovely wife Jennifer, and mischievous sons Miles and Quinn — is at the top of the list. The others follow, in no particular order:

Paul Newman in "Cat on a Hot Tin Roof." The flavor-infused heaven of Chicken in a Biskit. Snowmen with scarves, hats and carrot noses. "Schoolhouse Rock." The uproarious Flashman novels of George MacDonald Fraser. The raspy voice, striking lyrics and general weirdness of Tom Waits. The slight arc of a double to the gap from your own bat. Maker's Mark, rocks, splash of water.

Slapstick comedy. That I've seen Tiger Woods swing … in person. That I've seen Roger Federer swing, even though not in person. The austerity of the Midwest landscape in novels by Willa Cather. The intensity of Glenn Gould's piano playing on Bach's Goldberg Variations, and the sheer beauty of Rostroprovich's recording of Bach's Cello Suites. Plain white T-shirts, khaki shorts, Converse All-Stars and a baseball hat from the Negro Leagues Baseball Museum in Kansas City.

The short stories of Alice Munro, Raymond Carver and Denis Johnson. The extraordinary use of light by the painter Caravaggio. The extraordinary use of funk by James Brown. The searing vision of Frank Miller's Sin City series of graphic novels. LEGOs. Netflix. Catfish. Tom Brady.

Popeye, Bugs Bunny and Woody Woodpecker. That I got to become friends with William S. Burroughs. The beat-up, old vinyl recording of Louis Armstrong and his Hot Sevens that sits in my record bin. The Constitution. That I used to get to eat my grandmother's chicken fried steak and my grandfather's chili. Cozy Inn hamburgers and Scheme Pizza in Salina, Kan. Nintendo Wii tennis.

EnerGel Deluxe RTX black pens. The angels of Giotto. Ella Fitzgerald singing "Paper Moon," Willie Nelson singing "Stardust," The Clash singing "Hateful." Milan Kundera's "The Unbearable Lightness of Being." The Tour de France. A 50-inch plasma TV in my living room. Buster Keaton, SpongeBob SquarePants and the Three Stooges. Kansas City barbeque (Gate's or Bryant's) and University of Kansas basketball.

All the teachers I have ever had, many of whom I will never forget. Spending my time teaching others about literature, writing and art history. My colleagues, too numerous to mention. My friends, too numerous to mention. My extended family and all their quirks. My parents. And, of course, writing this column for the last 10 years.

Enjoy your Thanksgiving. I will.

Mark Luce lives in Kansas City, Mo., where he loves really dry stuffing. He can be reached at msluce@everestkc.net.

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