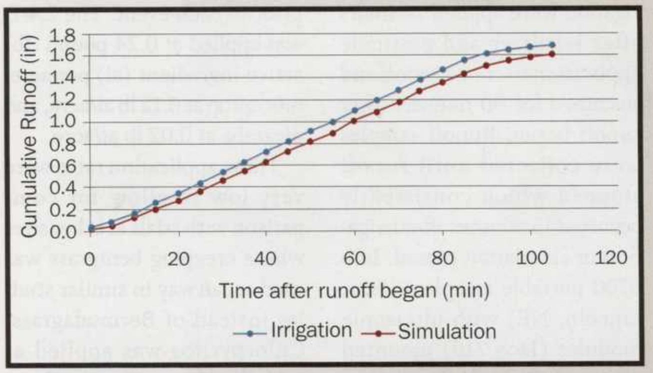
Figure 2.



can be significant if the soil is saturated and rainfall duration and intensity is high. Smith and Bridges (25) for instance, found that 9 percent, 14 percent and 13 percent of the applied 2,4-D, dicamba, and mecoprop, respectively, from hybrid Bermudagrass during four simulated rainfall events over an eight-day period, was lost to runoff. Researchers have concluded that the greatest mass and concentration of pesticides in runoff from a turf area occurs during the first significant runoff event after pesticide application (7, 18, 25), and the amount of pesticide loss is primarily related to its solubility (24).

TURF AS A DETERRENT TO RUNOFF. Krenitsky et al. (16) compared natural and man-made erosion control materials and turfgrass. They found tall fescue sod was an effective material for delaying the start of runoff and decreasing total runoff volume. Gross et al. (12, 13) studied nutrient and sediment losses from turf and found turfgrass alone – without buffers – effectively reduced nutrient and sediment losses compared with bare or sparsely vegetated soil. Linde and Watschke (17) found sediments in runoff were low even after vertical mowing of creeping bentgrass and perennial ryegrass. Wauchope et al. (28) investigated pesticide runoff from bare soil plots compared with grassed plots and determined that the bare plots required one-third less precipitation to produce the same amount of runoff and yielded twice as much sediment as the grassed plots.

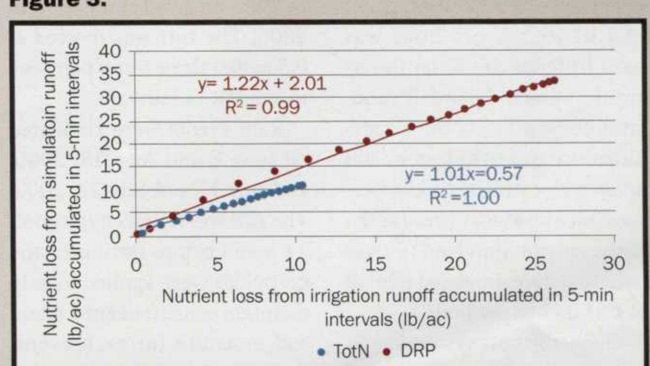
Harrison et al. (14) determined nutrient and pesticide concentrations in runoff from sodded Kentucky bluegrass. Plots were fertilized with N, P and K in a maintenance program typical of golf course turf in the northeast U.S. Irrigation at rates of 3 inches per hour and 6 inches per hour for one hour was applied one week prior to and two days following fertilizer applications. The researchers reported nutrient concentrations in runoff remained low throughout the experiment and generally were no higher than the concentrations found in the irrigation water. However, the N concentrations in runoff were as high as 5 ppm, and dissolved P concentrations were as high as 6 ppm. Both N and P concentrations were above those that can cause eutrophication of surface waters. The researchers concluded that under the conditions studied, nutrient runoff from established turfgrass areas was low due to low runoff water volume and was not affected by establishment method.

Gross et al. (12) studied nutrient and sediment loss from sodded tall fescue and Kentucky bluegrass plots. The plots were sodded on land that was previously cropped to tobacco. Slope at the site was 5 percent to 7 percent. Plots were fertilized with either urea dissolved in water as a liquid application or urea as a granular application at a rate of 4.5 pounds N per 1000 square feet per year. Control plots were not fertilized. Nutrient and sediment losses were low for all replications. The researchers concluded nutrient and sediment runoff from turfgrass areas is low, especially when compared with a previously cropped tobacco study (12).

Gross et al. (13) studied runoff and sediment losses from tall fescue stands of various densities under simulated rainfall conditions. Plots were established at seeding rates of 0, 2, 5, 8 and 10 pounds per 1000 square feet in September 1986. Simulated rainfall was applied at intensities of 3, 4 and 5 inches per hour in June 1987. The highest runoff volume was observed from the non-seeded plots at each of the rainfall intensities applied. Runoff volume was not statistically different among the seeding rates. The researchers also recorded visual quality, density and tiller counts. They concluded even low-density turfgrass stands can significantly reduce surface water runoff from well-maintained turfgrass areas. Kauffman III and Watschke (15) studied phosphorus and sediment runoff from creeping bentgrass and perennial ryegrass following core aeration. They concluded the DRP concentrations found in the runoff and the minimal soil erosion should not be considered a serious threat to surface waters. When turfgrass is healthy and dense it is an effective deterrent to off-site transport of nutrients and pesticides in runoff. Easton et al. (10) reported the establishment of turfgrass on bare soil increased soil infiltration by more than 65 percent over a two-year period. As shoot density increased, infiltration rate increased and runoff decreased.

Nonetheless, turfgrass sites can contribute to nutrient and pesticide losses to surface water in concentrations greater than recommended. It is the turfgrass manager's responsibility as environmental steward to practice management techniques that limit runoff transport of potentially-dangerous nutrients and pesticides. We used a rainfall simulator and

Figure 3.



typical sprinkler-type irrigation system for turf to create runoff and measured runoff losses of nutrients and pesticides to determine how much product was lost to runoff during a severe precipitation event. We also wanted to determine if the two precipitation systems differed in the amount of nutrients and pesticides lost to runoff, and whether or not the application rate of the products caused a significant difference in the amount product lost.

METHODS. The research was conducted on the Oklahoma State University Turfgrass Runoff Research Site, Stillwater, Okla., on a Norge silt loam (fine-silty, mixed, active, thermic Udic Paleustolls) with an infiltration rate of less than 0.5 inch per hour. The runoff site was divided into whole plots of event containing subplots of simulated rainfall and sprinkler irrigation replicated twice. The subplots (simulation and irrigation blocks) consisted of two experimental units each that measured 20 ft wide with a uniform 5 percent slope that measured 80 ft long.

The site was graded and sodded with 'U-3'Bermudagrass in the summer of 1998 and has been used for runoff research since 2000. An in-ground sprinkler-type irrigation system that delivered a precipitation event of 1.61 inches per hour was used to force runoff on the irrigation plots. A rainfall simulator designed after the Coody-Lawrence patented system and adjusted for peak sprinkler performance by Mark Carroll at the University of Maryland (5) was used to supply simulated rainfall at 1.51 inches per hour.

Our irrigation system could not supply sufficient water to operate the irrigation system on two plots and the simulator system on two plots simultaneously, so the simulator was supplied with water through a fire hydrant fed from a reservoir by gravity flow. The Christiansen's coefficient of uniformity (1) for the simulator averaged 78 percent compared with 80 percent for the irrigation system. To maintain experimental precision, the two plots that generated precipitation using the simulator system in 2005 were exchanged to receive irrigation in 2006, and the two plots that received irrigation in 2005 received simulation in 2006. The turf was mowed at 0.5 inches three times per week to simulate a fairway.

Rain events were simulated on June 8 and Aug. 18, 2006, and July 17 and July 22, 2007. The site was irrigated to runoff 24 hours before fertilizers and pesticides were applied to help maintain consistent antecedent soil moisture for each event. Samples were collected at this time to test for residual pesticides, but none were detected.

Simulated rainfall and irrigation were applied 24 hours after fertilizer and pesticide application to create runoff and sustained for 90 minutes after runoff began. Runoff samples were collected until runoff stopped which consistently occurred 15 minutes after irrigation or simulation ceased. Isco 6700 portable samplers (Isco, Lincoln, NE) with ultrasonic modules (Isco 710) mounted over each Parshall flume were programmed to collect samples in 5-minute intervals and to measure runoff flow rate in 1-minute intervals.

Runoff concentrations detected varied primarily by solubility, but pesticide and nutrient losses from simulated rainfall did not differ from runoff losses caused by sprinkler irrigation.

NUTRIENT AND PESTICIDE APPLICATIONS. In addition to N from urea and P from triple superphosphate, a fungicide, flutolanil (Prostar, Bayer Environmental Science, Research Triangle Park, N.C.), a broadleaf herbicide, 2,4-D plus mecoprop plus dicamba (Trimec Classic, PBI/Gordon, Kansas City) and an insecticide, chlorpyrifos (Dursban, Dow Agrosciences, Indianapolis) were applied prior to each event. The 2,4-D was applied at 0.24 pound (lb) active ingredient (ai) per acre, mecoprop at 0.12 lb ai/acre, and dicamba at 0.02 lb ai/acre.

These application rates were very low to allow for comparison with trials at other sites where creeping bentgrass was used as fairway in similar studies instead of Bermudagrass. Chlorpyrifos was applied at 1.00 lb ai/acre. Flutolanil applications were made at high rates and varied by event to investigate the relationship between flutolanil applied and flutolanil lost in runoff. N and P applications varied by event for the same reason and were determined by random selection of spreader settings.

ANALYTICAL PROCEDURES. Water samples were analyzed for NO3-N and NH4-N using colorimetric methods by automated flow injection analysis and DRP using the phosphomolybdate colorimetric procedure em-

Acknowledgements Funding was provided by the United States Golf Association through its Turfgrass and Environmental Research Program, as well as the Oklahoma Turfgrass Research Foundation and the Oklahoma Agricultural Experiment Station.

ployed by Murphy and Riley (20). The detection limit was 0.01 ppm for each nutrient in the runoff water samples. The average background levels of nutrients in the irrigation water samples were 2.7 ppm for total N (NO3-N + NH4-N) and 5.8 ppm for DRP and 2.5 ppm total N and 7.0 ppm DRP in simulated rainfall samples. The concentration of NO3-N, NH4-N and DRP in the precipitation was measured during each event and subtracted from the measured concentrations in collected runoff before statistical analyses were performed.

COMPARISON OF RUNOFF LOSSES DURING RAINFALL SIMULATION AND IRRIGATION. The irrigation system produced precipitation at 1.61 inches per hour and the simulator produced precipitation at 1.51 inches per hour. This difference in precipitation rate caused a slight difference in runoff rate (Figure 1). Runoff from the irrigated plots averaged 0.93 inches per hour and runoff from the rainfall simulator plots averaged 0.88 inches per hour. However, the differences in runoff flow rate between irrigation and simulation were not statistically significant. The amount of runoff that occurred during individual precipitation events differed in spite of considerations such as uniform plot size and slope, individual flume calibrations and steps to maintain uniform antecedent soil moisture designed to improve consistency. Differences in water pressure from the gravity-fed rainfall simulator resulted in variation among runoff flow rates by event (Figure 1), but these differences were not significant nor was there significant interaction between precipitation sources and events. However, the difference in precipitation rate between the irrigation system at 1.61 inches of precipitation per hour and the simulator system at 1.51 inches per hour caused a significant difference in cumulative runoff between the systems (Figure 2).As a result, the runoff rates for irrigation were adjusted downward by a factor of 1.51/1.61 prior to analysis of cumulative nutrient and pesticide losses.

RESULTS. A total accumulation of 1.67 inches of irrigation runoff was lost from a single plot during each event. A total accumulation of 1.59 inches of runoff was lost from each rainfall simulator plot. After adjusting by multiplying irrigation runoff by a factor of 1.51/1.61 total irrigation runoff was reduced to 1.57 inches making total runoff losses from irrigation and rainfall simulator nearly equal.

Nearly 2.5 percent of the N applied was lost in irrigation runoff and the same amount (2.4 percent) was lost to simulation runoff. The total P lost was nearly 20.1 percent of that applied to the irrigated plots and 16.6 percent of that applied to simulated-rainfall plots. Neither P loss nor N loss from irrigation and simulation were significantly different, nor did losses differ for any pesticide.

The concentrations of 2,4-D collected in irrigation runoff accounted for 1.1 percent of that applied and accounted for 0.8 percent in simulation runoff. Nearly 3.5 percent and 3.1 percent of the mecoprop applied and 12.3 percent and 15.7 percent of the dicamba applied (analyzed for only one event) were lost to irrigation and simulation runoff, respectively. Chlorpyrifos was lost to irrigation runoff at 0.28 percent of that applied and lost to simulation at 0.14 percent of that applied. Nearly 15.1 percent and 15.7 percent of the flutolanil applied was lost to irrigation and simulation, respectively. None of these results differed significantly by precipitation type demonstrating irrigation or simulated rainfall applied to Bermudagrass turf did not differ in their influence on runoff or nutrient and pesticide losses.

COMPARISONS OF PRODUCT APPLIED VERSUS PRODUCT LOST IN RUNOFF. The amount of P applied did not significantly affect the amount of P lost to runoff. The amount of N applied also did not significantly affect the amount of N lost, nor did the amount of flutolanil applied significantly affect the amount of flutolanil lost.

However, the work does suggest the amount of nutrient or pesticide applied has some effect on the amount lost. Averaged over all plots and events (n=16) regardless of precipitation type, 0.2 percent of the chlorpyrifos, 15.4 percent of the flutolanil, 3.3 percent of the mecoprop, and 1 percent of the 2,4-D was lost in runoff. Dicamba losses were only assessed for one event (June 18, 2006) and amounted to 14 percent of that applied. Dicamba was the most soluble pesticide applied, and although it was only applied in a small amount, 14 percent of it was lost in runoff demonstrating how easy it is to lose a highly soluble product to runoff.

Of the remaining pesticides, chlorpyrifos has poor solubility, flutolanil has medium solubility, and mecoprop and 2,4-D have high solubilities. With the exception of flutolanil, pesticide losses in runoff followed what would be expected according to pesticide solubility with chlorpyrifos having very low loss rates and mecoprop and 2,4-D demonstrating higher losses. However, it must be remembered that flutolanil was applied at very high rates (4.4 pounds per acre on average), and mecoprop (0.09 pounds per acre) and 2,4-D (0.17 pounds per acre) were applied at very low rates. In fact, 49 times more flutolanil was applied than mecoprop and 26 times more flutolanil than 2,4-D. It is likely that the large difference in application rates affected the high loss rates of flutolanil and the low loss rates of mecoprop and 2,4-D.

Consequently, the fact that application rates did not significantly affect the cumulative losses of nutrients and pesticide applied does not necessarily indicate that application rate did not influence the amount of product lost. More likely, there are other factors that collectively interfered with a direct relationship between product applied and product lost.

Perhaps future research will determine more about additional factors that need to be considered when attempting to determine the amount of product likely to be lost during a measured runoff event.

In the meantime, high application rates should be considered more likely to generate high runoff losses than low application rates. Although the research has demonstrated high losses of nutrients and pesticides from turfgrass systems are unlikely, the relatively huge losses of P and flutolanil in this study demonstrate what can happen when nutrients and pesticides are applied 24 hours after soil saturation and a severe rainfall event occurs 24 hours after application. **GCI**

Citations
See February's Online Extras for a complete list of this research's noted citations.

Terry Buchen, CGCS, MG, is president of Golf Agronomy International. He's a 41-year, life member of the GCSAA. He can be reached at 757-561-7777 or terrybuchen@earthlink.net.

Globetrotting consulting agronomist Terry Buchen visits many golf courses annually with his digital camera in hand. He shares helpful ideas relating to maintenance equipment from the golf course superintendents he visits – as well as a few ideas of his own – with timely photos and captions that explore the changing world of golf course management.

PORTABLE BEDKNIFE GRINDER

Florida Gateway College, formerly Lake City Community College, of Lake City, Fla., has a world-class turf equipment management program for aspiring equipment managers. Program instructors Mark Yarick and Jonathan Morriss fabricated a frame under their Foley bedknife grinder to hold the coolant tank and facilitate easy relocation of the unit.

They wanted to easily move the grinder to facilitate cleaning and reorganization of the shop. A simple frame was constructed so a pallet jack could move the unit. The frame attaches to the leveling feet of the machine. As an bonus, the coolant tank, which previously sat on the floor, was mounted onto the frame. The grinder frame is 2-inch x 56-inch square tubing with angle iron welded on the ends and extends about 5 inches to give the lift needed for the pallet jack. Slots were ground in the angle iron to receive the leveling bolts on the machine. These bolts were also used to attach it to the bottom of the grinder. The tank holder is 2-inch x 24-inch angle iron pieces bolted the correct distance to receive the coolant tank. The materials were already in stock and it took about two hours to complete. **GCI**

FOR SALE

Discount
Small Engines & Parts

Small engines & parts from Briggs & Stratton, Kohler, Tecumseh, Robin and more.
www.smallenginesuppliers.com

Also, look up your own parts and buy online at
www.smallenginepartssuppliers.com

TECH SALES
Golf Course Division

REPLACEMENT:
Bearings, Oil Seals, V-Belts

> Nation's Leading Supplier
> Most Competitive Pricing In The Industry
> Same Day Shipping On Most Parts

1-800-373-6002
www.techsales-golfcoursedivision.com

WWW.GOLFCOURSEINDUSTRY.COM

GOLF CLUB MANAGEMENT

LEARN ALL ABOUT GOLF CLUB MANAGEMENT

THREE DAY TRAINING SEMINAR

UNITED STATES GOLF MANAGERS ASSOCIATION

Usgolfmanagersassociation.com
1-888-346-3290

SEEDS

NATIVE SEEDS

Largest distributor of native seed east of the Mississippi, from Canada to Florida! We specialize in upland to wetland sites, including bioengineering for riparian sites. See what a difference natives can make!
www.ernstseed.com – 800/873-3321

Let us help you get the WORD OUT.

Golf Course Industry provides a cost-effective, high impact way to promote your company's products and services.

Our professionally designed article reprints can be used as direct mail pieces, sales literature, training aids or trade show handouts.

For even more targeted marketing, add your customized advertising message, logo, mission statement or other valuable company information.

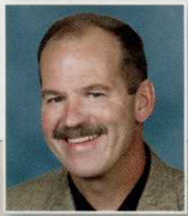
ARTICLE REPRINT SERVICE
800-456-0707 to learn more.

GOLF COURSE INDUSTRY.

AD INDEX

COMPANY	WEBSITE	PAGE
Agrium Advanced Technologies	www.agriumat.com	5
Arysta LifeScience	www.arystalifescience.com	23
Becker Underwood	www.beckerunderwood.com	9
Bernhard and Co.	www.bernhard.co.uk	15
Bioverse	www.bioverse.com	59
Champion Turf	www.championturffarms.com	10-11*
DuPont Professional Products	www.proproducts.dupont.com	30-31
Hustler Turf Equipment	www.hustlerturf.com	20
Interstate Batteries	www.interstatebatteries.com	3
Jacobsen	www.jacobsengolf.com	45
John Deere Golf	www.deere.com	68
JRM	www.jrmonline.com	64
Kalo	www.kalo.com	10-11*
PBI/Gordon	www.pbigordon.com	39
Pennington Seed	www.penningtonseed.com	36
Primera Turf	www.primeraturf.com	41
Rain Bird	www.rainbird.com	33
Sipcam/Advan	www.sipcamadvan.com	67
STEC	www.stecequipment.com	37
Stens	www.stens.com	25
Tee-2-Green	www.tee-2-green.com	2
Trojan Battery Co.	www.trojanbattery.com	19
Turfco	www.turfco.com	8, 21
Underhill International	www.underhill.us	54, 55
Valent	www.valentpro.com	7

*denotes regional advertising



Pat Jones is editorial director and publisher of Golf Course Industry.
He can be reached at pjones@gie.net or 216-236-5854.

US VS. THEM

I'm actually in Orlando at the GIS while I write this. Yes, I'm waaaaay behind schedule because of all the time and effort we put into preparing for the show. So, the bad news is I'm late and I've delayed the magazine by a day because I couldn't make time to get this done. The good news is that, because of my tardiness, I can offer you a little perspective from the many smart folks I've already spoken with the past day or so while I've scampered about for meetings, events, video shoots, speeches, booth set up and all the usual craziness that comes with the industry's biggest schmoozefest.

Any time you want to have an interesting conversation with any veteran grass god, just ask one simple question: "What's up with jobs in your area?" They will glance around to see if anyone else is within earshot and say, "Well I'm sure you heard about so-and-so leaving the Blazer Club..." And then you will learn what's really going on in that person's local market.

Good jobs are, in a word, scarce in our happy little business these days and great jobs are rarer than talented Kardashians.

Our business – to put it crudely – has a bad case of employment constipation. And there's no bottle of Ex-lax on the horizon to get things, er, flowing properly any time soon.

So, the tales being told by those veteran guys I've run into here in Orlando are ones you've probably heard before: 400 applicants for every good job that opens, long-term assistants being passed over for jobs they thought they'd been "guaranteed" and unemployed high-level supers accepting any position they can get to keep working, pay the bills and follow the professional path they're passionate about.

But there is a new twist on those tales I'm hearing more and more often. In the past, when a good job became available, you'd hear about applicants getting to the top five, learning whatever they can about the facility's current status and boning up on their presentation skills prior to the final interview. If they were smart, they'd reach out to a few colleagues or perhaps a club member they'd befriended for a reference or a good word with the selection committee. All that was accepted and cool.

Now there's something different: the full-court press. The intense interest in those all-too-rare good jobs has created a new kind of team approach for top candidates. They are literally putting together a group of high-powered supporters who will back them through the process, do all the right things to "endorse" a candidate and even coordinate a mini PR effort on the candidate's behalf.

It feels, for all intents and purposes, like a political campaign with managers, advisers and promotional people. There's deal-making, arm-twisting, favor-granting and smoke-filled back-room deals. All to position an already highly qualified person for those $200,000+ opportunities.

Frankly, there's absolutely nothing wrong with the approach. It's just taking old-school recruitment advice and practices to a more sophisticated level. I do find it mildly disturbing to hear rumors that some savvy folks actually charge a candidate a fee for their services – successful or not. If true, it seems odd in a profession that's always placed such a high value on mutual support and helping friends without expecting compensation in return. Yet, if the candidate chooses to go that route, so be it.

But I was a little uncomfortable when a major position search was described to me by two people – both guys I respect – as an "our team beat theirs" kind of thing. It felt like a competition…and I'm not sure that's the best way to approach the employment process.

There are times in your life that you quite simply have to stand alone. Sure, advice and encouragement are great. But an organized effort where each side makes their case, whispers in the ears of decision-makers and pits their "marquee" endorsements against the other's feels…weird. What happened to self-determination?

I wonder how long it will be before this mini-trend evolves – like politics has – to include smearing the opposition. I do not believe that any of the people who described this to me would stoop to something like that. They're honorable men who understand the culture and traditions of this profession. But, when it becomes a game, there is always a temptation to bend the rules. Sooner or later, honor will lose out to winning.

Honestly, this isn't something that the vast majority of you will experience directly. But, at the highest level of the business it is a distinct possibility every time a world-class job opens. It's a once in a blue moon occurrence, perhaps…but it's a sign of the times that the culture of the business is changing and becoming a bit more dog-eat-dog every day.

The late great Gordon Witteveen told me once that he feared the erosion of the "band of brothers" philosophy that has always bonded greenkeepers and superintendents for generations. I fear Gordon was more right than he knew. **GCI**


THE NATURAL CHOICE
300
200
100
Echo® ETQ™
Turf Fungicide
A summer stress breakthrough.
Echo® ETQ™ Turf Fungicide combines the trusted and proven performance of Echo brand chlorothalonil with an exceptional pigment additive. While the ETQ additive minimizes the factors contributing to turfgrass stress, Echo prevents dollar spot, brown patch, leaf spot, gray leaf spot, anthracnose and other diseases. What results is remarkable disease control accompanied by improved turf color, strength, density and consistency. All at a fairway-friendly price and without resistance issues. Make Echo ETQ Turf Fungicide your go-to product for disease control and enhanced turf quality. It's a stress relief breakthrough for your turf . . . and for you.
SipcamAdvan
The Natural Choice™
www.sipcamadvan.com
800-295-0733
©2011 Sipcam Agro USA, Inc. Echo is a registered trademark of Sipcam Agro USA, Inc. The Natural Choice and ETQ are trademarks of Advan LLC. Always read and follow label instructions.
EEGCI0111