CORNELL UNIVERSITY TURFGRASS TIMES

CUTT

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Fertility Programs for Sand-Based Rootzones

Turfgrass managers today have a wide array of fertilizer products to choose from when making nutrient management decisions. The development of an appropriate fertility program for sand-based rootzones is of paramount importance. Recent regulations in Minneapolis barring the use of phosphorus fertilizers on home lawns, and obligatory nutrient management plans for farms in Maryland, foreshadow increasing scrutiny of golf course fertilizer usage and nutrient fate. Turf managers must obtain knowledge of their site, assimilate information on available fertilizer formulations, and apply the selected products in a manner that optimizes turfgrass performance.

This paper will address a few of the issues crucial to an understanding of nutrient management in sand-based rootzones. First, knowledge of chemical properties in sand root zones is essential. Next, turfgrass managers must assess nutrient status in the root zone, and determine fertility requirements. Products and application methods that meet identified fertility needs must be selected. Finally, products can be applied and effects of the treatments can be monitored.

An important example of sand-based rootzones are golf course greens constructed to specifications published by the United States Golf Association. This construction method provides aeration, resistance to compaction, and excellent drainage. However, the specifications are for soil physical properties, and do not take into consideration chemical properties of the soil such as nutrient holding capacity.

Soil amendments are often added during construction to modify the physical and chemical properties of the root zone. Addition of organic amendments can increase water and nutrient holding capacity of sands. Inorganic

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This Times

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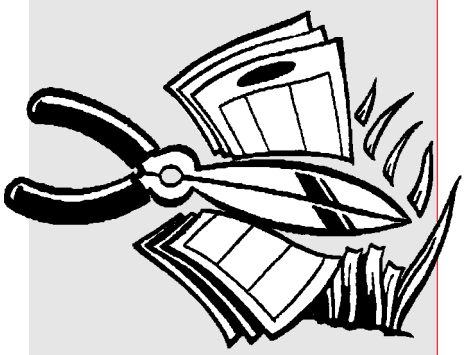
Clippings

In the interim period, Paul Robbins and Nancy Consolie need to be recognized for their outstanding commitment to continuing the work initiated under Mike's leadership.

Paul and Nancy exhibited friendship, commitment and dedication under the most difficult of circumstances. Their expertise and willingness to share information will help our new soil insect ecologist to be successful.



Soil Insect Ecology Position Offered

On May 15, 2002 we marked the one year passing of our friend and colleague Mike Villani. The loss of Mike forces us to pause and reflect not only on his friendship, but also his contributions to the Cornell Turfgrass Team. Clearly, Mike would want us to move forward. We are pleased to announce that the search for a scientist to continue the work in soil insect ecology is completed and an offer has been made to a highly qualified candidate.

We look forward to recapturing this vital capacity for our turf team. However, in the interim period, Paul Robbins and Nancy Consolie need to be recognized for their outstanding commitment to continuing the work initiated under Mike's leadership. Not only have they been able to continue active projects, a few new ones have been initiated. Paul and Nancy exhibited friendship, commitment and dedication under the most difficult of circumstances. Their expertise and willingness to share information will help our new soil insect ecologist to be successful. Also, your contributions to the Mike Villani Graduate Student Fund will help support a student working with our new scientist (see information in enclosed box below).

Villani Fund Established

The passing of Mike Villani has resonated around the world in the scientific community, as well as locally, as we grapple with the loss of our friend. The loss of a man as selfless and giving as Mike is difficult to honor in a way that would be worthy. This is why prior to Mike's death he assisted with setting up a Memorial Fund. *The Mike Villani Graduate Student Research Fund in Entomology* will be awarded to a deserving graduate student in entomology at the Geneva Station.

Donations can be made to *The Mike Villani Graduate Student Research Fund in Entomology.* Checks should be made payable to Cornell University and mailed to the Mike Villani Fund, Cornell University, Development Office, 272 Roberts Hall, Ithaca, NY 14853.

Cornell Turfgrass Field Day 2003

The 2002 season is the off-year of the Cornell Turfgrass Field Day. Next year the Field Day returns on Tuesday June 17, 2003. To make it easier to attend we asked industry leaders when was the best time. Many indicated returning to June would allow more participants to enjoy the internationally recognized research under way in Ithaca.

The research continues to expand in golf turf management and new projects have been initiated in lawn and sports turf. Studies include understanding organic-based products and management, managing high traffic areas, and demonstration projects underway on the Robert Trent Jones Golf Course at Cornell.

Mark your calendar now for an exciting day in Ithaca. For more information contact Joann Gruttadaurio, Director of Turfgrass Education (607) 255-1792 or jg17@cornell.edu.

Cornell Short Course 2003

The Cornell Turfgrass Education Program continues to provide an excellent foundation of turfgrass programming in 2003. For professionals entering the industry, key employees or experienced professionals who want a refresher, the Cornell Turfgrass Management Short Course is scheduled for January 6-11 2003 in Ithaca, NY. The week long course has been structured to meet the requirements for 30 hour pesticide certification. This course is the original hands-on training mixed with lecture and laboratory learning. Graduates of this course always seem to improve their employment status, enjoy learning more about turfgrass science and network with industry leaders.

The short course road season will include returning to Long Island and our first visit to Western NY. The course offered at the remote locations will focus on an Organic Approach to Turfgrass Management. Specifically this week long course will offer organic approaches to soil modification and establishment as well reviewing product performance of the latest in biological control and organic fertilizers.

For more information on these exciting educational opportunities, contact Joann Gruttadaurio, Director of Turfgrass Education (607) 255-1792 or jg17@cornell.edu.

Compost and Dollar Spot Control

Increased pressure on local and state governments is resulting in continued regulation of pesticide application. A recent ordinance was passed in the Canadian Province of Quebec banning the use of 30 pesticides on public and private land. It follows then that some important research on alternative to chemical controls is being conducted in Canada.

Work conducted by Professor Greg Boland at Guelph University in Ontario investigated the effect of compost on dollar spot. A creeping bentgrass area was managed to putting green conditions A variety of compost products were produced and applied at various frequencies. Composts contained horse, chicken and paunch (remains of animal gut) manure, bone meal ash, bark mix, soybean meal and in some cases milorganite.

The results indicated that the high rate of compost (10 lbs/1000 ft^2) applied every 3 weeks obtained equal to the control of the low rate of chlorothalonil (Daconil). There is speculation that control is derived from increases in microbial activity and/or nutritional contribution from the compost. The authors conclude that while compost applications are a viable means of suppressing dollar spot on putting greens, they are not likely to replace commercial fungicides. Clearly there is a good opportunity to reduce pesticide use from compost, yet not all composts are effective at suppressing the disease. Finding the right source of material and making timely applications are still critical for success.

From: Boulter, J.I., G.J. Boland, and J.T. Trevors. 2002. Evaluation of composts for suppression of dollar spot of turfgrass. Plant Disease 86:405-410.

Biological Control of Dandelion

The most difficult area of pest management for the use of biological control has been for weed management. Historically, the use of an organism (insect or microbe) while effective under laboratory conditions fails in the field. Again, Canadian leadership is being supplied in this area in Professor Greg Boland's program.

Boland and co-workers have been working on a Sclerotinia for dandelion control. The study investigated the effect of inoculated barley grit and dandelion (20,40 or 60g / m^2), treated or not with 2,4-D. Twenty eight days after inoculation the high rate of Sclerotinia provided as much control as any of the inoculations plus a sequential 2,4-D application. There was also a synergistic effect of the two applied together that would allow for significant reduction in 2,4-D use.

While these are exciting results and offer great promise, again it is unlikely that it will completely replace commercial herbicides in the short term. However, the possibility of significant pesticide reduction is very real and will be an excellent step towards large scale reductions through a more integrated approach.

From: Schnick, P.J., S.M. Stewart-Wade, G.J. Boland. 2002. 2,4-D and Sclerotinia minor to control common dandelion. Weed Science 50:173-178.

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Scaning the Journals

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amendments, such as zeolite, a silicate mineral, also increase the nutrient and water holding capacity of sands.

Cation exchange capacity (CEC), represented as centimoles of negative charge per kilogram of soil (cmols kg^{-1}), is an indicator of a soil's ability to retain positively charged nutrients such as potassium and calcium. Because sand is inherently low in CEC, organic matter provides the majority of CEC in sand-based rootzones.

The CEC levels in sand-based rootzones are limited by the desired physical properties of the sand root zone. USGA Guidelines call for root zone total porosity of 35-55%, air-filled porosity of 15-30%, and saturated conductivity (water) of 6-12" $hour^{-1}$. The addition of organic matter or other amendments to sand root zones can increase nutrient and water holding capacity, but organic matter also serves to slow water infiltration and percolation while decreasing the air-filled porosity.

When organic matter is added to sand on a weight basis, 1-3% organic matter by weight generally meets the USGA-specified guidelines, while 4% or higher amounts of organic matter mixed with the sand may not meet USGA specifications. Because desired nutrient holding characteristics in the root zone have to be balanced with necessary physical properties, CEC values in sand greens at the time of construction are typically less than 5 cmols kg^{-1}. Experiments measuring the leaching of potassium from sand root zones found an exponential decrease in leaching as CEC increased from less than 1 cmol kg^{-1} to 6 cmol kg^{-1}. As CEC was raised above 6 cmol kg^{-1} in this experiment, little change was observed in potassium leaching. This indicates that for minimal leaching of potassium, the optimum CEC in sand greens may be at least 6 cmols kg^{-1}. However, because CEC levels in sand root zones are often less than 6 cmols kg^{-1}, care must be taken when nutrients are applied. In order to maintain plant health without stimulating a growth flush, and to prevent leaching of nutrients from the root zone, nutrients must be applied either at very low rates, or in a controlled release form.

Before selecting fertilizer products and application strategies, it can be very helpful to obtain more information about the putting green system by conducting soil nutrient analysis (soil test) and plant analysis (tissue test). Careful analysis of test results is essential in understanding the implications of the tests.

A typical soil test will provide analysis of pH, phosphorus, potassium, calcium, and magnesium. Other parameters often reported include CEC, organic matter, sulfur, sodium, and micronutrients such as iron, copper, zinc, and manganese. Soil nutrient analyses do not typically test for nitrogen, because nitrogen in a moist soil is in flux. Tests for soil nitrogen are not an effective predictor of future nitrogen availability. Tissue tests can provide an accurate reading of nitrogen fertility, but most turfgrass managers rely upon experience and turfgrass monitoring to determine nitrogen requirements.

In the laboratory, various chemical extractants are used to remove nutrients from the soil sample. The amount of nutrients removed varies with the extraction procedure used. However, the amount of nutrient extracted, regardless of the method, should correlate with a desired plant quality so that fertilizer recommendations can be developed.

Unfortunately, few calibration studies relating soil nutrient analysis to turfgrass growth response and turfgrass quality have been performed. Additional calibration studies relating various components of turfgrass quality to soil nutrient analysis and tissue analysis results, and particularly studies that evaluate nutrient interactions, are needed. Sufficiency levels for tissue nutrient concentrations have been published, but they do not always correlate with sufficiency levels for nutrients in the soil. An investigation of soil test levels and tissue nutrient concentrations for turfgrass growing in sandy soils has suggested tissue analysis may be more effective than soil nutrient analysis for determining the nutrient status of turfgrass.

Even with its shortcomings, soil nutrient analysis remains a valuable tool for evaluating soil nutrient levels. However, because many of the nutrient extractants and fertilizer recommendations were developed for mineral soils, and considering the limited number of calibration studies completed in turfgrass, soil nutrient analysis may be most useful as an indicator of trends in soil properties.

Other methods exist for monitoring nutrient status of putting greens without sending soil or tissue sample to a laboratory. Measuring clipping yield is an effective way to monitor growth,

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Light, frequent fertilizer applications utilize liquid sources to increase precision.

which can serve as an indicator of nutrient status. Evaluation of turfgrass color is another method that can be used to determine fertilizer needs. Certain diseases that are more prevalent at certain nutrient levels or imbalances can indicate nutrient needs as well.

After evaluating the root zone properties and existing nutrient status, fertilizer products and application methods can be selected. For example there are a few factors that distinguish fertilizer selection from other turfgrass areas. The inherently low nutrient holding capacity of sand root zones steers one in the direction of light, frequent applications. The low cutting height of most greens precludes usage of regular sized granular products, so specially formulated granular products must be used. Also, a slow, steady growth rate is usually desired for playability reasons, so again either controlled release products or light and frequent applications are usually desired.

There are essentially two ways to apply fertilizer to putting greens. Products can be applied that will enter the soil and eventually be available to the plant roots, or products can be applied to the foliage and be taken up into the leaves. The foliar application method fits very well with the desired goal of light and frequent applications. A lot of confusion exists surrounding the subject of foliar absorption of nutrients, and it can often be the subject of a seemingly endless debate. The mechanisms involved with foliar absorption are not fully understood, but numerous studies have been conducted, and some semblance of understanding can be constructed.

Foliar absorption of nutrients has been acknowledged for over 150 years, but the first definitive studies in the field were performed shortly after World War II with the advent of radioactive isotopes, which can be used as "tracers" in scientific experiments. The radioisotopes can be used to differentiate between nutrients taken up by the foliage, or nutrients taken up through the root system.

An important thing to remember is that nearly all the research and literature concerning foliar uptake of nutrients has been conducted on crops other than turfgrass. Certainly many of the mechanisms and experimental results may be transferable from these other species, but one can not be sure of results in turfgrass until more tests are performed. Golf course superintendents who have used foliar nutrition possess a great deal of practical knowledge concerning the efficacy of these products.

Plant leaves are covered with a waxy cuticle that serves as a diffusion barrier for the water and nutrients inside the leaf. The cuticle also prevents excessive leaching of nutrients from leaves during rainfall, heavy dews, or other wetting events. The presence of the cuticle poses problems for plant uptake of min-

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eral nutrients. The process of foliar absorption appears to consist of three steps: nutrient adsorption at the leaf surface, diffusion or penetration through the cuticular membrane, followed by cellular uptake within the leaf. The initial barrier to absorption is the cuticular membrane. Nutrients can enter the leaf through small pores in the cuticle, or via diffusion across the cuticular membrane. Stomatal entry is not considered to be a significant factor in nutrient absorption by leaves. The primary function of stomata is regulation of gas exchange with the atmosphere, and the stomata reach their greatest aperture during active photosynthesis, in full sunlight. A cuticular layer coats the interior of stomatal openings, so nutrients still face a barrier to absorption even if they somehow enter a stomatal pore. Studies have shown both increased uptake of solutes at night, when stomata are closed, and uptake of nutrients in the absence of stomata. We can conclude that nutrient absorption does not occur through stomatal openings in plant leaves.

Absorption rates have been determined for many nutrients applied to agronomic or horticultural crops. With nitrogen, up to 50% uptake of applied product can occur within 1 to 4 hours. For potassium, however, 50% uptake of applied product does not occur for 1 to 4 days. In 24 hours, 8% of applied iron has been taken up in beans.

These uptake rates may seem low. One wonders how the efficiency of foliar uptake relates to nutrient uptake from the soil. At least with nitrogen, there does not appear to be much of a difference. Studies investigating foliar absorption of various nitrogen sources applied to the leaves of ryegrasses and bluegrasses have found about 40% of the applied nitrogen absorbed by the leaves within 48 hours. Numerous studies examining nitrogen fate in soils have shown only 5% to 74% of applied N is actually recovered in the plant. One important consideration is that with equivalent nutrient concentrations in solution, the absorption rates for leaves are much smaller than the absorption rates for roots. The reason for this difference is the small size of the pores in the leaf cuticle, which restrict absorption.

So how does one maximize the efficiency of foliar applied nutrients? Increased humidity at the leaf surface improves nutrient absorption by leaves, most likely because it increases the diameter of the cuticular pores. Research has shown that different product formulations require different humidity levels to remain mobile and able to cross the cuticle. Once an applied product has dried on a leaf, the rate of absorption will decline, but subsequent increases in humidity will improve uptake of the remaining material.

Research has shown that organically chelated potassium is absorbed more readily than molecules.

What does all this mean for the golf course superintendent? Not all nutrients applied to turf, either as granular fertilizers or as foliar products, will be absorbed by the plant. Both types of product have their place in a nutrient management program, and foliar products can be an ideal way to spread nutrients evenly and at a low rate across putting greens. Foliar products can be ideal when limiting conditions prevent uptake of nutrients from the roots, or when a quick response to nutrients is required. Recent developments in granular fertilizer formulations have also significantly reduced mower pickup, and superintendents can utilize these products effectively as well.

The key to developing an effective fertility program for sand-based rootzones is consolidated knowledge of the entire system. The chemical properties of the root zone must be understood. Nutrient analysis of the system should be conducted, either through monitoring plant characteristics or by submitting soil or tissue samples to a laboratory. The different fertilizer products, and the mechanisms of their uptake, need to be considered. Once these three factors of a sand-based system are understood, turfgrass managers can focus on the most important facet of fertilization–the maintenance of an excellent turf surface.

Micah Woods
Graduate Research Assistant

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The Horticulture Elemental/Nutrient Analytical Laboratory is one of a small number of university laboratories nationwide dedicated to assisting growers and homeowners in evaluating the nutritional and environmental status of their plants, water and soil.

The lab has been performing plant nutrient analyses for growers and researchers since the 1950s. Cornell faculty work closely with lab personnel to provide fertilizer recommendations and consultations on growers' specific problems. Soil or plant samples may also be submitted for total carbon/nitrogen ratios.

In the last decade, lab services have expanded to include environmental testing of water, plants, amended soil, and sewage sludge. This provides homeowners, turf managers and municipalities with levels of potentially toxic heavy metals so that they can evaluate the safety of their environment. State-of-the-art plasma emission technology is used to provide simultaneous elemental analysis of 30 elements.

The Horticulture Elemental/Nutrient Analytical Laboratory is committed to quality data, and the operation is tested quarterly through the North American Proficiency Testing Service. Please contact the lab for more information on sample preparation, available services and prices. The Horticulture Elemental/Nutrient Analytical Laboratory, 20 Plant Science, Cornell University, Ithaca, NY 14853-5908; (607) 255-1785; www. hort.cornell.edu/department/facilities/icp/index.html.

Need your irrigation water tested?

Not sure of the nutrient content of your fertilizers?

Need an inexpensive tissue nutrient test?

Check out the Horticulture Analytical Laboratory.

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Editors Note

"When we put flow meters on the intake pipe on golf courses," Mike informs, "it is clear golf course superintendents are using much more water than they think, or maybe even need."

Mike found that during the irrigation season the 30-day average use is 142,000 gallons per day (GPD) and peak use is 275,000 GPD.

The Art & Science of Irrigation

A good portion of the eastern seaboard has endured severe water use restrictions. Florida has been in various stages of water restrictions for the last few years and the USDA Drought Monitor (http://drought.unl.edu/dm/monitor.html) indicates more than half of the United States is experiencing some form of drought.

Turf managers have learned the importance of being involved in regulatory discussions, few are more critical than water advisory boards that set watering restrictions. Advisory boards meet to clarify exact water needs and how golf courses are irrigated.

Professors Bob Carrow and Ronny Duncan at the University have outlined five steps for water conservation in turfgrass management. The strategies are species and cultivar selection, use of non-potable water, irrigation system design, irrigation scheduling and golf course design.

Turfgrass research has focused on biological implications of species and cultivar selection and non-potable water, with less on scheduling and virtually none on system and golf course design. Yet from a manager's perspective the design and more importantly the flexibility of an irrigation system is where the "rubber hits the road" when it comes to water management.

Water Use

Mike Brownell is a Water Resource Scientist with the Susquehanna River Basin Commission (SRBC). The SRBC is a regulatory body responsible for managing the water resources in a 27,000 square mile watershed through three states. Mike is responsible for permitting new projects in the basin and monitoring consumptive use by golf courses.

"When we put flow meters on the intake pipe on golf courses," Mike informs, "it is clear golf course superintendents are using much more water than they think, or maybe even need." Mike found that during the irrigation season the 30-day average use is 142,000 gallons per day (GPD) and peak use is 275,000 GPD. To put this in perspective, to water 2.5 acres of bentgrass greens daily for 7 days to supply 1.6", it will take approximately 15,500 GPD.

The SRBC reports that high use for 30 day period was between 736,000 to 828,000 GPD watering the whole course to a low of 89,000 GPD watering greens and tees only. It is important to consider the potential influence on environmental quality when consuming large volumes of water. This would be consistent with a deep and infrequent watering approach.

If golf courses water deeply and infrequently there can be 475,000 gallons removed at once that will have a greater impact than if the golf course irrigated at 100,000 GPD. On-site storage is an option for mitigating large removals from a source. If, for example, a golf course has 13,000,000 gallons of water in storage they can pump at a low rate from the stream or well. Maintaining storage on site for peak needs will cause less of an impact on the environment.

In an effort to more thoroughly understand how superintendents make irrigation decisions, the SRBC surveyed golf courses in the basin. Superintendents were asked the amount and frequency of irrigation. There were no relationships among courses of similar grass and soil types nor topography and expected quality. The only consistent result was that irrigation amounts appeared to be related to superintendent.

Troubleshooting irrigation systems is critical to water conservation and maximizing turf performance.

One could be surprised by the personal nature of irrigation that gives the appearance of imprecision. Yet on the other hand, with the variety of microenvironments that exist on a golf course it could be due to site-specific irrigation. Of course when considering the amount of water being consumed in a region that will receive about 30 inches of precipitation during the growing season leaves one wondering about irrigation practices.

Is the industry doing all it can to use the minimum amount of water or are we simply making global adjusts on the irrigation software? Are we activating four heads in a zone when we only need one head or instead of dragging a hose?

Site-Specific Irrigation

Carrow and Duncan discuss the importance of efficient irrigation design for water conservation. The efficiency is derived from limiting water loss from leaching or runoff, irrigating within evening time constraints, salt-leaching or water-control authorities and finally by making precise site-specific irrigation.

Top of the line irrigation systems with all the "bells and whistles" may cost more to begin with but are likely to save money and water in the long term. This assumes that when new systems are purchased, designed and implemented, the superintendent embraces the technology, finding ways to utilize sophisticated controls integrated with weather stations and even soil moisture sensors. Essentially an extensive approach like this is striving to add precision and remove any ambiguity associated with the "art or feel" of irrigation.

In the mid-1990's Apple Computer conducted a survey of various age groups regarding their perception and use of computer technology. There was an important finding relative to the irrigation technology discussion. Most people new to computer technology use less than 10% of the computing power available to them in a personal computer. In fact, the study concluded that persons over the age of 50 used a computer basically as a typewriter.

On the other end of the spectrum are the people who embrace new technology and see the benefits. Erick Holm, CGCS the former Superintendent of the Onondaga Golf and Country Club in Fayetteville, NY has been able to integrate the latest technology (science) with his feel (art) for golf turf irrigation.

Erick went from limited flexibility with irrigation zones and heavy reliance on hand watering to maximum flexibility with less need for hand watering. The old irrigation system had six heads per zone while the new system provided individual head control. In two summers with similar weather conditions and different irrigation systems Onondaga reduced the amount of total man hours for hand watering from 290 to 85.

Site-specific irrigation will require systems with maximum flexibility.

Erick was able to utilize important computer software to predict water loss measured as evapotranspiration (ET). Once a baseline water need was established, Erick adjusted greens different than fairways to a certain percentage of ET. Another adjustment was programmed to compensate for any microenvironmental factors and a final adjustment for a specific head that might be related to turf or soil conditions. This is the true meaning of site-specific irrigation and is the antithesis of the global adjustments made without regard for site conditions.

What's Next?

"Soil monitoring is the final frontier in golf turf irrigation" proclaims Paul Roche, the Irrigation Manager for the S.V. Moffett Company in Rochester, NY. On the other hand Paul agrees that many superintendents are not using irrigation systems to their full potential.

Paul is an active user of a personal digital assistant (PDA) and has been demonstrating the benefit of PDA's when integrated with GPS/GIS. "We just finished creating over 15 layers of information for the Oak Hill CC as part of the new irrigation system and in preparation for the 2003 PGA Championship." The superintendent will have access to cables, drainage and irrigation system information at his fingertips.

Whether or not all this technology will eliminate the "art" associated with golf turf irrigation is doubtful. However, there remains a huge gap between the amount of technology available and using the technology to its full potential. When technology use results in significant reductions in water use, there should be no obstacles to full implementation.

Frank S. Rossi

Is the industry doing all it can to use the minimum amount of water or are we simply making global adusts on the irrigation software?

Efficiency is derived from limiting water loss from leaching or runoff and by making irrigation site-specific.

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Human Dimension

Motivating jobs and work environments win praise from employees. Of course, what one person finds motivating another may find boring, frustrating and debilitating.

Lack of training can prevent a motivated employee from performing well. What sense is there in hiring a motivated person to do a job and then not training the person to do the job properly?

Making Employee Motivation a Partnership

We begin our discussion of a complex topic with a simple question: How can I motivate my employees? We propose a simple yet unique answer: You can't do it alone! Employee motivation works best as a partnership between employer and employees. In this paper, we will develop this basic argument into several practical take home suggestions for human resource managers and employees to use in improving employee motivation.

We recognize that employee motivation, more accurately the lack of motivation, often frustrates employers. It comes as a surprise to some employers that employees' lack of motivation often frustrates them as well. We observe these frustrations being compounded by the obvious fact that most any approach to motivation will sometimes work for some people. The kicker is that no approach works all the time for all people.

Some Background Points about Motivation

Motivation is the inner force that drives employee behavior. The intensity of one's inner force to do a task or accomplish a goal describes the level of motivation. Two people may both say and believe they want to be excellent employees. The intensity of their desire to be excellent measures their motivation. Employers pay more attention to what employees do than what they say or believe. Motivation is the force that causes employees to deliver on what they say.

Most employees prefer to be motivated. Why would an employee choose the frustration of not being motivated? Motivating jobs and work environments win praise from employees. Of course, what one person finds motivating another may find boring, frustrating and debilitating. And employees sometimes bring a lot of baggage to the workplace from their childhood experiences, previous employment and failures to find their motivating niches in life.

Motivation is complex. No simple set of guidelines guarantees motivated employees. Motivation provides a never-ending struggle for both employers and employees.

Self-motivation plays a crucial role. Achievers tend to continue achieving. Past accomplishments, challenging career goals, expertise in one or more areas, pride in one's abilities and self-confidence contribute to self-motivation.

An unmotivated person can become motivated. On the other hand, a motivated person can lose motivation. The opportunity to motivate employees is never completely lost nor is the accomplishment of motivated employees ever guaranteed to continue indefinitely.

Not all performance problems are explained by lack of motivation. Lack of training can prevent a motivated employee from performing well. What sense is there in hiring a motivated person to do a job and then not training the person to do the job properly? Lack of appropriate equipment, tools, facilities and supplies can also prevent a motivated person from performing well. Lack of clear expectations, unclear "rules of the game" and muddled messages about desired outcomes can lead to poor performance.

Satisfying Needs

The simplest and most intuitive approach to motivation is to satisfy an employee's needs. This approach has four parts:

- Employees have needs that they desire to satisfy, ***which in turn***
- Leads to actions that will fulfill their needs, ***which in turn***
- Leads to rewards from the employer and satisfaction from doing the job, ***which in turn***
- Reinforces their actions and causes them to be repeated.

Note the necessity of identifying needs. An employer can get help from employees to identify their needs. Then the employer can choose the "right" employee rewards for doing a job and especially for doing a job well. Providing the "right" rewards reinforces the employees' actions thus causing the employees to repeat the actions to get the rewards again.

To illustrate, Kirk and Kendra are employees who both have a need to be thanked and appreciated. Kirk's employer Jennifer, recognizing the need, gives him specific tasks and responsibilities. When Kirk performs the tasks well, Jennifer regularly shows appreciation by

saying thank you and giving merit increases in pay. Kirk's needs are satisfied. To continue having his need for thanks and appreciation satisfied, he is motivated to continue to do the tasks well.

On the other hand, Kendra's employer John fails to understand her need for thanks and appreciation. Kendra works hard to complete the tasks but John never thanks her or recognizes her accomplishments. Instead, John is quick to criticize Kendra's small mistakes. He offers no thanks or recognition for her correction of the mistakes. At some point, Kendra is likely to lose motivation to continue to do the tasks well. The reason according to this simple needs theory of motivation is that no need is being satisfied.

Note also the necessity of an employee being willing and able to perform the assigned tasks. Unwillingness, for whatever reason, to perform the tasks, means the link between needs and rewards breaks down.

This simple model of motivation makes clear that employee needs play a critical role in motivation. Experienced labor managers, however, easily see practical problems. What at first seems to be a simple model is in fact complex and difficult to apply. Motivation success requires more than the employer's sole reliance on satisfaction of needs. Reinforcement of desired behaviors and cooperation between employer and employee need to be added to the power of needs.

A Partnership Between Employer and Employee

We return to our basic argument: employee motivation works best as a partnership between employer and employee.

Synergy is the concept that the whole is greater than the sum of its parts. Synergy is exactly what we seek to complement the needs approach and positive reinforcement. It means that employer and employee working together accomplish more than they accomplish by each working alone. Lack of synergy in motivation occurs when employee and employer each face the motivation challenge alone. Employee brings his or her self-motivation, experience, good intentions and training to the job. Employer brings his insights about employee needs and rewards.

The motivation partnership means that both employee and employer are committed to synergy rather than waiting for the other to solve the motivation puzzle. The employer and employee share responsibility for motivation, i.e., cooperation not separation.

The Employee's Contributions to the Partnership

True partnership between employer and employee in the motivation challenge requires each to understand and play their parts well. The employee's most important contribution to the partnership is self-motivation. Most importantly, this self-motivation commits the employee to making the partnership work. Employees also need to search for a job and work environment that fit their knowledge, skills, abilities, needs and interests. A miscast employee almost certainly will eventually face the frustration of waning motivation. No matter how good the fit is between employee and job, the employee must be willing to learn. Even the most experienced employee new to a business should bring admission that "I don't know all I need to know." A highly skilled employee still needs to learn about new coworkers, policies, rules, norms of behavior and just how things "work around here."

Taking a job with a new organization means commitment to that organization's vision, mission, core values and goals. When an employee's goals, needs and beliefs don't fit with the employer's vision, mission, core values and goals, any proposed partnership between employer and employee is almost certainly to disappoint both parties.

The employee has the responsibility to communicate his or her needs, concerns and ideas to the employer. Listening to the employer's point of view is the other side of this communication coin.

On page 13 is a six-step worksheet to assist you in utilizing the information in this article. You can begin to use this worksheet by identifying an employee to work with to develop a motivation partnership and completing step 1.

The Employer's Contributions to the Partnership

Frederick Herzberg developed a two-factor theory of motivation that makes clear what the employer can bring to the motivation partnership. According to Herzberg, two factors affect

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True partnership between employer and employee in the motivation challenge requires each to understand and play their parts well. The employee's most important contribution to the partnership is self-motivation.

Motivation success requires more than the employer's sole reliance on satisfaction of needs. Reinforcement of desired behaviors and cooperation between employer and employee need to be added to the power of needs.

Employee Motivation

continued from page 11

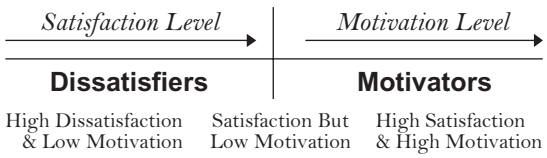
employee motivation: dissatisfiers and motivators. The employer has primary responsibility for both.

Examples of dissatisfiers are poor working conditions, unsafe equipment, exhausting physical work combined with excessively long work days and weeks, unfair pay, disagreeable supervisors, unreasonable rules and policies, unchallenging work and conflict with co-workers. According to Herzberg, these problems must be resolved before motivators can work. Resolving the problems increases employee satisfaction; however, it does not provide motivation.

Motivators are factors that influence job satisfaction and lead to motivation. Examples include achievement, recognition, satisfying work, responsibility and personal growth through training and new experiences. These motivators turn an employee from being neutral about the job into a motivated employee. (See figure 1)

Motivators are factors that influence job satisfaction and lead to motivation. Examples include achievement, recognition, satisfying work, responsibility and personal growth through training and new experiences.

Figure 1



The implications for the employer's side of the motivation partnership are clear. The dissatisfiers must be removed before motivators can work. Employees working in unsafe conditions with unfair pay will not be motivated by recognition and delegation of additional responsibility. However, making the workplace safe and increasing the pay to a fair level is not enough. These steps alone will fail to motivate employees. They will be satisfied but not motivated. These neutral workers can be turned into satisfied and motivated workers by using the motivators, e.g., recognition and delegation of additional responsibility. Each employer can work to identify the dissatisfiers among his or her employees. Removing the dissatisfiers provides opportunity to take advantage of motivators

Figure 1 illustrates the path to providing an environment where employees should be enthused about contributing their part of the employer-employee motivation partnership. When the employer is not contributing their part of the partnership many or most employees will be on the left side of the figure — highly dissatisfied and poorly motivated.

The employer must first remove the dissatisfiers like unfair levels of pay and unacceptable working conditions. Employees will move toward the center of figure as their level of dissatisfaction decreases. They will not yet show many signs of becoming motivated.

As the employer continues to implement her or his part of the partnership by providing motivators, e.g., positive reinforcement, recognition for achievement and increased responsibilities, most employees will move to the right of the figure. They are responding to the employer's fulfilling his of her part of the partnership by providing a motivational work environment.

Note that this is not a time when the employer jumps from the left to the right of the figure. The employer must first focus on removing the dissatisfiers.

Communication with employees is essential. What is a dissatisfier for one employee may not be a dissatisfier for another. A single workaholic employee may have no objection to a 60-hour workweek. Parents with small children may find 60-hour workweeks highly dissatisfying. What is a motivator for one employee may not be for another. Opportunity to learn new skills may be motivating for one employee and a worrisome burden for another employee.

If you are using the worksheet on page 13 to begin the development of a motivation partnership, complete steps 2 and 3 now.

Summary

Having motivated employees is a highly worthy goal for any employer. No human resource challenge likely exceeds worker motivation in importance or potential for employer and employee satisfaction. We have presented a nontraditional approach – making motivation a partnership challenge. We have made satisfaction of worker needs, positive reinforcement and removal of impediments to motivation a joint responsibility of employer and employee.

Begin your implementation of an employer/employee partnership by completing steps 3-5 in the worksheet. Continue by working with the selected employee.

Robert A. Milligan, Cornell University
and Bernie Erven, Ohio State University

Having motivated employees is a highly worthy goal for any employer. No human resource challenge likely exceeds worker motivation in importance or potential for employer and employee satisfaction.

- Analysis of Your Employer/Employee Motivation Partnership

Identify an employee with whom you would like to improve the employer/employee motivation partnership:

Step 1: Check the **employee's contributions** that are present in your current relationship.

____ 1. The employee is self-motivated
____ 2. The employee is committed to make our motivation partnership work
____ 3. The employee's job with me fits his or her knowledge, skills, abilities, needs and interests
____ 4. The employee is committed to our organization's mission, values and goals
____ 5. The employee listens to my points of view
____ 6. The employee communicates his or her needs, concerns and ideas with me
____ 7. The employee is willing to learn

Step 2: Check the **dissatisfiers** that are present in your current relationship

____ 1. Economic factors such as unfair wages and noncompetitive fringe benefits
____ 2. Security factors such as lack of grievance procedures and no seniority privileges
____ 3. Social needs such as lack of opportunities to know and spend time with peers, e.g., breaks and eating together, business sponsorship of parties and outings
____ 4. Status problems including lack of privileges, no job titles and lack of other symbols of rank and position
____ 5. Working conditions such as inadequate heat, light, ventilation and equipment; unfair work rules, company policies, discipline procedures and unreasonable hours of work per day and per week

Step 3: Check the **motivators** that are present in your current relationship.

____ 1. Challenging work
____ 2. Feelings of personal accomplishment
____ 3. Recognition for contributions to the organization
____ 4. Increasing responsibility
____ 5. Sense of importance to the organization
____ 6. Access to information
____ 7. Involvement in decision making

Step 4: Note the employee contributions that **you did not** check, the dissatisfiers that **you did** check and the motivators that **you did not** check. These should be the area you emphasize in implementing the partnership

Step 5: Chose Path A or Path B for improving the motivation partnership with your employee:

____ **Path A** → Ask the employee to complete Steps 1-4 on his or her own. Compare the results with your results. Discuss with the employee the 2 most important changes from the employee contribution, dissatisfier and motivator lists that would improve the motivation partnership. Start to make the changes.

____ **Path B** → Identify, on your own, the 3-5 most important changes from the employee contribution, dissatisfier and motivator lists that you believe would improve the motivation partnership. Start to make the changes.

Step 6: Evaluate your progress in the motivation partnership at least once each year.

Question: How do you motivate employees?

Answer: You can't do it alone! Employee motivation works best as a partnership between employer and employees.

Use this worksheet in conjunction with the information contained in the article to help develop a motivation partnership between employees and employer.

CUTT

Field Renovation Via Overseeding

Program Spotlight

Soil modification is only one component of a high traffic turf strategy.

Many scholastic fields host school and community sporting events over multiple seasons. These events occur on a less than desirable root zone and are managed with considerably less resources than a professional sport franchise. Consequently, innovative solutions to high traffic areas, especially the use of overseeding must be employed.

Each year National Football League (NFL) franchises that play their games on natural turf fields are faced with worn out turf between the hash marks. Much of this can be related to the decision to narrow the hash marks, eliminate a strong and weak side attack and open the game up offensively. However, from a turf perspective the decision has been devastating.

The easy (and expensive) solution has been to periodically replace the turf between the hash marks with sod. Often this requires a Herculean effort to remove the existing turf and install new sod in a seven-day period before the next game. Not only is this expensive, it is not a long-term solution that can be adopted by many scholastic sports turf managers.

Interestingly, the increased number of sand-based fields have not alleviated all problems associated with traffic stress. It can be surmised that soil modification is only one component of a high traffic turf strategy. Clearly, the ability to rotate traffic is critical, yet very little effort has been exerted to develop seeding programs to compensate for high traffic fields.

Overseeding Basics

Jim Puhalla, Jeff Krans and Mike Goatley authors of Sports Fields: A Manual for Design, Construction and Maintenance (Sleeping Bear Press, 1999) define overseeding in the cool season zone as a means of improving turf density. This might include coring or slit/slice seeding to improve soil and seed contact. In cool season turf this is performed on an actively growing turf as compared to warm season turf that is overseeded when dormant. The distinction between warm and cool season turf is critical as success for each requires an understanding of the ecology (relationship among the organisms and their environment) of a sports turf.

The presence of an actively growing turf creates challenges to successful overseeding. For example, existing turf has a competitive advantage over young seedling turf in procuring water and nutrients from the soil. Also, if overseeding is performed during the season, the seedling turf must withstand regular mowing and traffic. Therefore, successful overseeding may require a shift in thinking to sacrifice field playability for seedling turf success through field rest, reduced mowing frequency, increased irrigation for establishing seedlings, etc.

Unfortunately, many fields are incredibly overused leaving the existing turf in a non-competitive state. While this can be desirable from an overseeding perspective (bare soil, thin weak turf), overseeding will still be a challenge, especially if the field will not receive rest. Inevitably the success of an overseeding program depends on getting the seed in contact with the soil, resting the field and maintaining the field as a seedbed.

The process will involve thinning the existing turf if necessary with vertical mowing or scalping. After the turf is thin either from traffic or mowing, research here at Cornell University has demonstrated the benefit of multiple core cultivation, allowing cores to dry and pulverizing. The cores are destroyed and dragged with a mat or chain link fence. The area is seeded with a broadcast applicator or some prefer slit seeding.

Following the seed a starter fertilizer high in phosphorus is applied and the area is lightly rolled to ensure good soil-seed contact. The field is irrigated to establish the seedlings and because the field was scalped or thinned, often mowing can be withheld for at least three weeks. Traffic should be withheld for at least 4 to 6 weeks for a perennial ryegrass renovation and 8 to 10 weeks for a Kentucky bluegrass renovation.

Compared to most scholastic sports turf, it is hard to refer to a professional sports field as high traffic that hosts 8 to 10 games of one sport per season. Many scholastic fields host school and community sporting events over multiple seasons. These events occur on a less than desirable root zone and are managed with considerably less resources than a professional sport franchise. Consequently, innovative solutions to high traffic areas, especially the use of overseeding must be employed.

Aggressive Overseeding

Many sports turf managers at the scholastic and community level are challenged with excessive high traffic fields. These fields may start the season with full turf cover but after a few

weeks the turf thins in high traffic areas to expose bare ground. This leaves many questions regarding field safety as well significant weed invasion.

To address the need to maintain turf density during high traffic periods we initiated an experiment to investigate the effect of aggressive overseeding, i.e., high rates of seed applied weekly or monthly under traffic. The experiment was conducted at the Cornell University Turfgrass Research and Education Center, Ithaca, NY on three blocks of turf (Kentucky bluegrass "Coventry", perennial ryegrass "Manhattan III" and Tall Fescue "Jaguar III"). The turf was trafficked in two directions five days per week with a Brinkman traffic simulator. This traffic treatment resulted in significant turf thinning over the twelve weeks of the study.

Within each turfgrass block overseeding programs were applied on Friday of each week following mowing and trafficking. The treatments were six or ten pounds of perennial ryegrass or tall fescue seed per 1000 square feet applied weekly or monthly, and Kentucky bluegrass at two or four pounds of seed per thousand square feet applied weekly or monthly. The plots were not irrigated and were fertilized in May and September with one pound of nitrogen per 1000 square feet. The plots were rated for turf density, weed invasion and overall quality.

Non-overseeded plots were less than 50% covered with turf and in some cases up to 20% weeds. Among the species, Kentucky bluegrass and tall fescue had lower turf density then the ryegrass species without overseeding. Overseeding with Kentucky bluegrass proved completely ineffective under regular traffic most likely due to the long germination requirement.

Weekly overseeding with either perennial ryegrass or tall fescue at six pounds of seed provided excellent season long turf density. In fact, perennial ryegrass was able to maintain almost 90% density when overseeded weekly. Tall fescue overseeded plots were between 70 and 80% dense at the end of the experiment. There was no difference between the six and ten pound seed rates. Interestingly the monthly overseeding of perennial ryegrass provided equal to or better density than the weekly tall fescue overseeding independent of seed rate.

The economics of aggressive overseeding should be considered. We calculated that if ryegrass seed could be purchased at $0.70 per pound and applied weekly at the six pound rate it would cost $4.20 per 1000 square feet per week. The average soccer field is about two acres, but most likely less than 0.5 acre would need this type of program (goal mouth, center of field, etc.). Therefore, for a twelve week soccer season the cost would be about $90 per week for seed or $1100 for the season for seed.

Clearly, aggressive overseeding provides and excellent avenue for high traffic fields. We are currently evaluating spring and summer programs and investigating lower seed rates applied more frequently.

Primary Culture

Interest in athletic competition has significantly increased field use and traffic. A significant amount of effort has been invested to improve rootzones and topdressing amendments (eg. crumb rubber), yet, there is very little research in the area of overseeding. Rich Gaussoin and Dave Minner have been reporting success with using Bermudagrass in cool-season climates as a means of having turf cover during difficult times of the year.

High traffic fields demand an aggressive maintenance program that includes mowing, irrigation and fertility. Core cultivation and topdressing have emerged as key primary cultural practices in the last decade and now overseeding needs to receive the same attention. It makes sense that if bare soil is present weeds will invade and the integrity of the surface is compromised. Regular overseeding either as a renovation a few times per year or in-season to keep pace with traffic will insure a safe and durable sports turf.

Frank S. Rossi

Clearly, aggressive overseeding provides and excellent avenue for high traffic fields. We are currently evaluating spring and summer programs and investigating lower seed rates applied more frequently.

Breast Cancer Risk

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chemical has a unique pattern in the way it is handled by the body, and a different potential for whether or not it can contribute to breast cancer risk.

Chemicals in the Home & Workplace

We can be exposed to a variety of synthetic chemicals in many different settings, including in our homes and workplaces. There are some chemical exposures in the workplace that have been associated with a higher risk of breast cancer. More research is needed to help identify the chemicals of concern for different professions and workplace situations. There are relatively few studies of women in the workplace (most occupational studies of cancer risk have been done on men). There is a need for better quality studies to give us better answers. Many of the studies done so far had very limited data on exposure to specific chemicals, and usually only small groups of women were followed for a limited time period. Several groups that need further evaluation because of potential exposures to known or potential carcinogens include those employed in the chemical and pharmaceutical industries, laboratory and biomedical workers, cosmetologists and hair dressers, workers in printing and textile dyeing industries, airline personnel, health care workers, and metal plate workers. Of recent interest is whether breast cancer risk may be indirectly affected in night-shift workers exposed to "light at night" which may affect melatonin synthesis. Scientists are exploring whether changes in melatonin levels may affect levels of estrogen and breast cancer risk.

Researchers are also interested in measuring chemicals women may be exposed to every day in our homes. Researchers on Long Island, New York and on Cape Cod, Massachusetts are measuring levels of environmental chemicals in the homes of women with and without breast cancer. Such studies may help identify the types of chemicals in the home that may be linked to a higher risk of breast cancer.

Breast Cancer Risk?

There has been concern about exposure to pesticides because of their widespread use in agriculture for crop and livestock protection, for public health in controlling disease-bearing insects, for pest control in homes, schools, workplaces, gardens, and recreational areas such as parks and athletic fields. Currently, there are about 865 pesticide active ingredients registered with the Environmental Protection Agency (EPA), and thousands of products containing these chemicals alone or in combination.

Much of the concern about whether pesticides affect breast cancer risk stems from observations of higher rates of cancer in male workers with high exposures to pesticides. There are higher rates of some cancers in male farm workers, including lip and skin cancer, non-Hodgkin's lymphoma, and cancer of the stomach, brain and prostate. Some of these cancers are due to excessive exposure to UV radiation from the sun (lip and skin cancer). There are many types of exposures on the farm that may affect cancer risk, including exposures to pesticides, solvents, fuel exhaust, and toxins (called mycotoxins) from molds in stored crops. While some scientists have found higher cancer rates in farmers exposed to certain pesticides, other studies have not supported an association. An ongoing, large-scale study that will help provide better answers to whether specific chemicals used in agriculture affect cancer risk is the "Agricultural Health Study" (for more information go to http://www.aghealth.org/index.html).

There are very few studies that have evaluated whether farm women have a higher risk of breast cancer. In a study of North Carolina farm women, overall breast cancer rates were lower in women who lived or worked on a farm compared to women who did not work or live on a farm. These farm women tended to have healthy life-styles that could have reduced their risk of breast cancer. However, in this study, one group of farm women who did not wear protective clothing when applying pesticides had a two-fold higher risk of breast cancer compared to women who did take proper precautions. The results of this small study suggest that breast cancer risk may be increased in some farm women with high exposures to pesticides, and illustrate the importance of reducing exposures to pesticides in workplace situations.

Organochlorine Chemicals

Organochlorine pesticides were used extensively during and after WWII because of their long-lasting effects in controlling insects. Most

Each chemical has a unique pattern in the way it is handled by the body, and a different potential for whether or not it can contribute to breast cancer risk.

Of recent interest is whether breast cancer risk may be indirectly affected in night-shift workers exposed to "light at night" which may affect melatonin synthesis. Scientists are exploring whether changes in melatonin levels may affect levels of estrogen and breast cancer risk.

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were banned during the 1970s and '80s in the US, Canada and Europe because of human health and ecological concerns. Some examples of organochlorine pesticides include: DDT (used in mosquito control and agriculture), dieldrin (used to control termites and other soil insects), chlordane and heptachlor (used to control termites and fire ants), lindane (currently used in agriculture and anti-lice shampoos), and hexachlorobenzene (fungicide with past use to prevent mold on crops). These long-lasting chemicals can concentrate up the food chain and are stored in body fat of animals, fish and humans. Some are endocrine disrupters that affect reproduction in wildlife, especially birds and reptiles. While there are links to some types of cancers (for instance, several organochlorines induce liver or thyroid tumors in laboratory animals), effects on breast cancer risk in humans have been studied only recently.

The organochlorine pesticide that has been studied the most extensively has been the insecticide DDT. Over time, DDT breaks down in the environment to a very long-lasting chemical called DDE. Early reports suggested that women with high levels of DDE in their blood or fat had a higher risk of breast cancer. However, the majority of the more recent, well-controlled studies have not been able to confirm these findings. Most of these studies have looked at breast cancer risk in white women living in North America and Europe. These studies of western women have not shown a higher risk of breast cancer in those with higher levels of DDT or DDE. Other populations, including different ethnic groups, have not been studied as well. The results from several studies suggest that breast cancer risk may be higher in African American women who have higher body levels of DDE. More studies are need to confirm these findings, and to see if breast cancer risk is higher for women who live in less industrialized tropical countries that still use DDT against mosquitoes for malaria control. For many of the other organochlorines, we have very limited data from human studies. Breast cancer risk was higher in Danish women with high blood levels of dieldrin, but the few studies done on American women have not confirmed this finding. For dieldrin, and other organochlorine pesticides, there are too few studies in women to make a conclusion of whether or not body levels can predict breast cancer risk.

Early Chemical Exposures

In utero exposures to estrogenic chemicals may increase breast cancer risk. A drug that acts like estrogen, called diethylstibestrol (DES), was prescribed to pregnant women form the mid-1940s to '70s, to prevent abortions. Daughters of women that were treated with DES have a moderately higher breast cancer risk. DES can also cause mammary (breast) tumors in mice. This is one of the reasons researchers are interested in whether early exposures to chemicals in the womb, or during childhood and adolescence when the breast is developing, affects breast cancer risk later in life (See BCERF Fact Sheet no. 9 on *Childhood Life Events and the Risk of Breast Cancer*). Results from animal studies have shown that early exposures to some chemicals can have permanent effects on the way the breast develops and its susceptibility to carcinogens. The developing mammary gland (breast tissue) of young rats and mice have bud-like structures composed of rapidly dividing cells. These dividing immature breast cells are more susceptible to the damaging effects of cancer-causing chemicals.

Early exposure to certain environmental chemicals may keep the mammary gland in an immature state for longer periods of time, increasing its susceptibility to carcinogens. So, many chemicals may not cause a tumor to develop directly, but they may work in subtle ways to increase breast cancer risk. For instance, in one study female rats were exposed pre-natally to an environmental contaminant, a dioxin called TCDD. When these dioxin-exposed rats were older, they were also exposed to a known breast carcinogen called dimethylbenz [*a*]anthracene (DMBA). The female rats pre-treated with dioxin developed more breast tumors than the rats not pre-treated with this dioxin. The researchers suggested that dioxin treatment prenatally changed how the breast tissue developed, keeping the breast in an immature state with a greater number of dividing bud structures for a longer period of time. Similarly, results of preliminary studies conducted by EPA researchers have suggested that prenatal treatments with the herbicide atrazine can also help keep rat breast tissue in an immature state for prolonged periods of time. While the implications for human cancer risk are not yet known, it is important that researchers fully explore the many ways chemicals may affect breast cancer risk.

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Early exposure to certain environmental chemicals may keep the mammary gland in an immature state for longer periods of time, increasing its susceptibility to carcinogens.

Breast Cancer Risk

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For example, women with high body levels of environmental chemicals called polychlorinated biphenyls (PCBs) usually do not have a higher risk of breast cancer. However, in one study breast cancer risk was higher in a group of women who had both a high level of PCBs and a variation in an activation gene called CYP1A1. This is an example of a "gene-environment interaction."

Gene-Environment Interactions?

Many chemicals have to become "activated" in the body to become carcinogens. Some people have differences (called also variations or polymorphisms) in certain genes that control these activation pathways. If a person has a variation in such gene, this may result in more activation and a higher level of the active form of the carcinogen. This may put the person at greater risk for developing certain cancers, including breast cancer. For example, women with high body levels of environmental chemicals called polychlorinated biphenyls (PCBs) usually do not have a higher risk of breast cancer. However, in one study breast cancer risk was higher in a group of women who had both a high level of PCBs and a variation in an activation gene called CYP1A1. This is an example of a "gene-environment interaction." More research is being done to identify important gene-environment interactions. This will help identify groups of women who may have a higher breast cancer risk if they are exposed to certain chemicals.

New Avenues for Research

We can expect to see more studies explore breast cancer. For instance, there is interest in whether certain antihistamines and anti-depressants affect breast cancer risk. There also is interest in whether environmental chemicals, such as certain phthalates used in plastics, play a role in premature breast development and later risk of breast cancer. New powerful molecular techniques have been developed that may help to identify "molecular" footprints, including chemicals that activate specific cancer genes or that turn off genes that can suppress cancer. Studies are ongoing to screen for and identify breast carcinogens in animal cancer bioassays. New screening techniques are being developed that will allow for more rapid screening of a larger number of chemicals. Researchers will continue to identify gene-environmental interactions that may help identify groups of women who may be at higher risk when exposed to certain chemicals, and identify endocrine disrupting chemicals which can support the growth of breast tumors. More research is needed not only to define the types of exposures encountered in the workplace and the home, but also to evaluate how exposure during critical periods of breast development may affect cancer risk later in life. A combination of human, animal, and molecular-based studies are needed to address how environmental chemicals may affect the risk of breast and other cancers.

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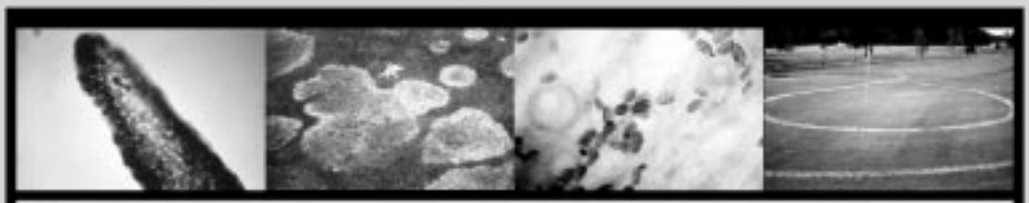

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Environmental Chemicals and Breast Cancer Risk: Why is There Concern?

Healthy Ecosystem

Breast cancer rates are the highest in North America, Northern Europe and Australia. Breast cancer rates are much lower in Japan, China, Africa and India.

There has been a growing interest in whether environmental factors, including whether exposures to certain chemicals or changes in lifestyle, may increase the risk of breast cancer. Risk factors consistently associated with a higher breast cancer risk are called "established" risk factors. Established risk factors include getting older, having regular menstrual periods earlier, going through menopause later in life, having your first child late in life, not having any children, having a mother or sister with breast cancer, past exposure of breasts to ionizing radiation, or having certain types of benign breast disease. But these factors only account for about 25 to 50% of breast cancer cases.

Geography, Migration and Rates of Breast Cancer

Breast cancer rates vary widely in different parts of the world. Rates are the highest in North America, Northern Europe and Australia. Breast cancer rates are much lower in Japan, China, Africa and India. It is not clear why there are geographical differences in breast cancer rates. Differences in age of childbearing, diet, lifestyle and exposure to environmental chemicals have been offered as possible explanations. Within one or two generations, the breast cancer rates of Japanese women migrating to the US increase, and become similar to the higher breast cancer rates of western women. Results of studies on twins in Scandinavia also suggest that a woman's environment plays a significant role in determining her breast cancer risk.

Exposure to Environmental Chemicals

We are exposed to thousands of naturally occurring and synthetic chemicals over a lifetime. Many chemicals are essential for life and are beneficial, while exposures to other chemicals can be harmful and affect our health. There are many ways we can be exposed to chemicals. This includes exposure in the air we breathe, in the food and beverages we eat, and by contact with our skin. The fetus can be exposed to chemicals that cross the placenta during pregnancy. Some environmental contaminants can pass from a mother's body to an infant through breast milk. Certain chemicals can be stored in fish or animal fat, can pass up and concentrate through the food chain, and be stored in our bodies for long periods of time. Other chemicals may be broken down and quickly eliminated from the body. Some chemicals first need to be "activated" by enzymes in the body to become cancer-causing chemicals (carcinogens). Other chemicals pose no cancer risk, while others may act as beneficial "anti-cancer" agents. It is impossible to make generalizations about environmental chemicals. Each

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