MIDWEST REGIONAL TURF CONFERENCE

MARCH 3-5, 1986

Purdue University

PROCEEDINGS OF THE

1986

MIDWEST REGIONAL TURF CONFERENCE

MIDWEST REGIONAL TURF FOUNDATION MEMBERSHIP, 1985-86

Indiana:

William E. Allman, Anderson
Anderson Country Club
Randy A. Ballinger, Upland
Bellinger's Prof. Gr. Maint., Lafayette
Ted M. Bishop, Linton
BPOE Lodge #649, Richmond
Briar Ridge Country Club, Dyer
Broadmoor Country Club, Indianapolis
Cannon Turf Supply, Indianapolis
Canterbury Green Country Club, Fort Wayne
ChemLawn Corporation, Carmel
Christmas Lake Golf Course, Santa Claus
Connersville Country Club
Cory Orchard Supply, Indianapolis
Country Club of Indianapolis
Country Club of Terre Haute
Crooked Stick Golf Club, Carmel
Donald A. Cross, Hobart
Delaware Country Club, Muncie
Randy A. Denny, Warsaw
Edgewood Country Club, Anderson
Elanco Products Co., Indianapolis
Elcona Country Club, Elkhart
Elks Blue River Country Club, Shelbyville
Engledow, Inc., Indianapolis
Evansville Country Club
Donald A. Fassnacht, Lafayette
Tim Fleagle, Warsaw
Forest Hills Country Club, Richmond
Forest Park Golf Course, Valparaiso
Fort Wayne Board of Park Commissioners
Fort Wayne Country Club
Dale C. Foster, Fort Wayne
Fox Prairie, Forest Park G. C., Noblesville
Frankfort Country Club
French Lick Springs Golf & Tennis Resort
Friendswood Golf Course, Camby
Gary Country Club
Green Carpet Lawn Service, Huntingburg
Greenhurst Country Club, Auburn
Greensburg Country Club
Harbour Trees Golf Club, Noblesville
Hickory Hills Golf Club, Brownstown
Highland Golf & Country Club, Indianapolis
Hillcrest Country Club, Indianapolis
Hillview Country Club, Franklin
Honeywell Public Golf Course, Wabash
Hoosier Turfgrass Association, Huntington
Huber Ranch Sod Nursery, Schneider
Indiana Farm Bureau Co-op, Mt. Vernon
Indiana G.C.S.A., Indianapolis
Indiana Turf Equipment, Indianapolis
Indiana Univ. Golf Course, Bloomington
Irving Bros. Sand & Gravel, Marion
Jansen Landscaping, Elkhart
Dennis M. Keefe, Muncie
Kenney Machinery, Indianapolis
Killbuck Recreation Assoc., Anderson
Knox Fertilizer & Chemical Co.
Kokomo Country Club
Lafayette Country Club
Lawn Cure of S.E. Indiana, Hanover
Lawn Life, Zionsville
Lebanon Chemical Co., Fort Wayne
Maplecrest Country Club, Goshen
Martinsville Country Club
Mead-Johnson Co., Evansville
Meridian Hills Country Club,Indianapolis
Meshingomesia Country Club, Marion
Mooresville Golf Club
Morris Park Country Club, South Bend
Mutual Security Life Ins., Fort Wayne
New Albany Country Club
Old Oakland Country Club, Indianapolis
Old Orchard Golf Course, Elkhart
Orchard Ridge Country Club, Fort Wayne
Otter Creek Golf Course, Columbus
Perma-Green Supreme, Merrillville
Red Hen Turf Farm, New Carlisle
Scheetz Enterprises, South Bend
Seymour Elks Country Club
Shamrock Turf Nurseries, Hanna
South Bend Country Club
Speedway 500 Golf Club, Indianapolis
Sycamore Springs Golf Club, Indianapolis
Tippecanoe Country Club, Monticello
Tippecanoe Lake Country Club, Leesburg
Turf Specialties, Fort Wayne
Valparaiso Country Club
Vincennes Elks Country Club
Michael Walton, Huntington
Western Hills Country Club, Mt. Vernon
Woodland Country Club, Carmel
Woodmar Country Club, Hammond
Youche Country Club, Crown Point

MIDWEST REGIONAL TURF FOUNDATION MEMBERSNIP, 1985-86

Illinois:

Aurora Country Club
Beverly Country Club,Chicago
Bryn Mawr Country Club, Lincolnwood
Builders Plumbing Supply, Addison
Butler National Golf Club, Oak Brook
Champaign Co. Forest Pres. Dist, Mahomet
City of Danville, Harrison Park G. C.
Country Club of Peoria
Danville Country Club
Edgebrook Country Club, Sandwich
Edgewood Valley Country Club, LaGrange
Excelawn Corp. of America. Lombard
Exmoor Country Club, Highland Park
Flossmoor Country Club
Geneva Golf Club
Glen Oak Country Club, Glen Ellyn
H & E Sod Nursery, Markham
George Haddad, Peotone
Hinsdale Golf Club, Clarendon Hills
Illinois Lawn Equipment, Orland Park
Inverness Golf Club, Palatine
C. W. Jennings, Western Springs
LaGrange Country Club
Roger Lemke, Wheeling
Lincolnshire Country Club, Crete
Liqui-Green, Peoria
Medinah Country Club
Jim Mello, Romeoville
Midlothian Country Club
Mueller Farms Sod Nursery, Ontarioville
Niles Township High Schools, Skokie
Northmoor Country Club, Highland Park
North Shore Country Club, Glenview
Robert F. Parmley, Wheeling
Prestwick Country Club, Frankfort
Rockford Country Club
Roseman Mower Corp., Glenview
Seaboard Seed Co., Bristol
Shoreacres, Lake Bluff
Silver Lake Golf Club, Orland Park
Eugene Strama, Paris
Sunset Ridge Country Club, Northbrook
Thornton Sod Nursery, Elgin
Timber Trails Country Club, LaGrange
Wadsworth Golf Construction, Plainfield
Bruce R. Williams, Highland Park
Woodward Governor Co., Rockford

Ohio:

BPOE Lodge #93, Hamilton
W. L. Braverman, Cleveland
Mike Breeden, Celina
Tom Brehob, Cincinnati
Camargo Country Club, Cincinnati
Century Equipmenty Co., Toledo
City of Dayton, Bureau of Golf
Columbus Country Club
Country Club, Inc., Pepper Pike
Crest Hills Country Club, Cincinnati
Elyria Country Club
Findlay Country Club
Gate of Heaven Cemetery, Cincinnati
Stephen P. Gipson, Chesterland
Greater Cincinnati G.C.S.A.
Arthur Hills, Toledo
Inverness Club, Toledo
Kenwood Country Club, Cincinnati
Kings Island Golf Co., Cincinnati
Robert Klein, Tiffin
LESCO, Rocky River
Leisure Lawn, W. Carrollton
Lyons Den Golf, Canal Fulton
Mayfield Country Club, S. Euclid
Miami Valley G.C.S.A., Middleton
Moraine Country Club, Dayton
Northern Ohio G.C.S.A, Westfield Center
Oakwood Club, Cleveland Heights
Glen A. Pottenger, Troy
Rawiga Country Club, Seville
O. M. Scott & Sons, Marysville
Tamaron Country Club, Toledo
Valleywood Golf Club, Swanton
Walnut Grove Country Club, Dayton
Floyd Wiget, New Lebanon
The Woods Golf Club, Van Wert

MIDWEST REGIONAL TURF FOUNDATION MEMBERSHIP, 1985-85

Kentucky:

Audubon Country Club, Louisville
Big Spring Country Club, Louisville
Harmony Landing Country Club, Goshen
Owensboro Country Club
Standard Country Club, Louisville

Michigan:

Bay City Country Club
Country Club of Detroit
Down River Lawn Service, Trenton
Bob Dugan, Romulus
Gene Johanningsmeier, South Lyon
Lawn Management Co., White Pigeon
McKay Golf & Country Club Prop., Lansing
Maple Lane Golf Club, Sterling Heights
Midwest Course Management, Ann Arbor
Oakland Hills Country Club, Birmingham

Missouri:

Bellerive Country Club, Creve Coeur
Bogey Hills Golf & C. C., St. Charles
City of St. Ann
Forest Hills Country Club, Chesterfield
Forest Park Mun. Golf Course, St. Louis
Mallinckrodt Chemical Co., St. Louis
Mississippi Valley G.C.S.A., St. Louis
Monsanto Co., St. Louis

Wisconsin:

Brynwood Country Club, Milwaukee
Milwaukee Country Club
Milwaukee Met. Sewerage Dist.
North Hills Country Club, Menomonee Falls
Ozaukee Country Club, Mequon
Stevens Point Country Club
Tuckaway Country Club, Franklin
Wisconsin G.C.S.A.
Bruce Worzella, West Bend

Out of Midwest Region:

Aquatrol Corp. of America, Pennsauken, NJ
W. A. Cleary Chem. Co., Somerset, NJ
David Strang, Burlington, IA
Toro Co., Bloomingotn, MN

FORWARD

The 1986 Midwest Regional Turf Conference was a very successful event. Leading authorities in their respective fields spoke on a wide variety of topics pertaining to turfgrass management. The success of the Conference was directly due to the fine presentations given by the speakers. The time and effort that the speakers devoted to their oral presentations and written summaries is greatly appreciated.

The Turf Conference Proceedings contain a brief synopsis of 19 presentations. A copy of these Proceedings has been mailed to all those attending the 1986 Conference, one person within each member organization within the Midwest Regional Turf Foundation not in attendance at the Conference, and to a list of those involved in educational activities.

We would like to thank the members of the Midwest Regional Turf Foundation for their continued support of the turfgrass program at Purdue University. Your support enables us to conduct a wide range of research projects designed to help solve the problems faced by turf managers. In addition, your support is used to sponsor educational events that expose turf managers to the latest research in turfgrass science. We will continue to strive to improve the activities of the Midwest Regional Turf Foundation to meet the changing needs of the turfgrass industry.

RECOGNIZING BACTERIAL WILT

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Bacterial wilt is a relatively new disease of turfgrasses in North America. The disease was found to be the solution to the C-15 problem/C-15 decline which was known as a devastating and unresolved problem on 'Toronto' creeping bentgrass (C-15) for more than a decade.

Since the 1930's 'Toronto' creeping bentgrass was propagated on golf course putting greens throughout the midwestern United States. During the 1970's the C-15 problem destroyed many 'Toronto' greens. In 1980, the C-15 problem/decline gained national recognition when the 'Toronto' putting greens were destroyed by the disease at Butler National two weeks prior to the Western Open.

An intensive investigation began at many universities. With the aid of the electron microscope at Michigan State University bacteria were associated with the xylem tissues of diseased Toronto creeping bentgrass. Xylem vessels of plants are responsible for the uptake of water and nutrients. The plugging of these xylem vessels by large numbers of bacteria naturally resulted in rapid wilting and death of turfgrass plants. The disease was subsequently named "Bacterial Wilt" of Toronto creeping bentgrass.

Significance. Prior to bacterial wilt on Toronto, no bacterial wilts of turfgrasses were previously known in North America. Using various analytical techniques, the bacterial wilt pathogen has now been characterized as Xanthomonas campestris pv. graminis. This bacterium measures approximately 1/25,000 inches long, 1/50,000 inches wide and reproduces every 4-6 hours. Until it was isolated from Toronto creeping bentgrass in the United States, this bacterium was only found in Europe. Originally discovered in Switzerland in 1975, the bacterium has now spread to the British Isles, Netherlands, Germany, France, Norway, Denmark and New Zealand. We presume that the bacterium was introduced from Europe to the United States, where it has virtually destroyed Toronto creeping bentgrass as a propagated turfgrass.

During the summer season of 1983 and 1984, bacterial wilt was found on Seaside and Nimisilia creeping bentgrass and annual bluegrass. Whereas Toronto, Seaside and Nimisilia are not propagated to any appreciable extent on home lawns, annual bluegrass is a naturally occuring turfgrass found in most regions of the temperate zone. We have now found bacterial wilt on these turfgrasses in eight states: Indiana, Illinois, Kansas, Michigan, Minnesota, Ohio, Pennsylvania and Wisconsin. (Table 1). This indicates that the bacterium is not only spreading to new host plants, but also to new geographical locations. The occurrence of bacterial wilt on annual bluegrass and the bentgrasses strongly suggests that Kentucky bluegrass and other grasses may also succumb to the disease.

Bacterial wilt of turfgrasses is analogous to several other diseases. The accidental introduction of pathogens that cause Dutch Elm Disease and Chestnut Blight has practically eliminated American species of these trees in the United States. Another pathogen, Xanthomonas campestris pv. citri, the cause of citrus canker in the southern United States, is closely related to Xanthomonas campestris pv. graminis, the cause of bacterial wilt of turfgrasses. Millions of dollars, along with very strict quarantines,eliminate the citrus canker bacterium whenever and wherever it is detected. Unfortunately the turfgrass industry is not sufficiently organized. Bacterial wilt of turfgrasses continues to spread to additional states (Table 1) and new varieties of turfgrasses.

Even though bacterial wilt can be suppressed with the antibiotic oxytetracycline, the chemical is expensive and many not be effective for a long duration as resistance to the bacterium is highly probable. Except for fumigation, followed by seeding and sodding with alternative turfgrasses, no other control measures are feasible.

Diagnosis of Bacterial Wilt. Bacterial wilt undoubtedly occurs on other turfgrasses in many regions of the United States, however absence of knowledge of the disease usually prevents accurate diagnosis. Unlike many turfgrass diseases, bacterial wilt does not occur in rings or patches. Bacterial wilt is strictly random, affecting individual plants in large areas. One of the most important diagnostic features of the disease is a very rapid wilting. Leaf blades become shriveled, twisted and bluegreen in color. These symptoms may be confused with other insect root feeding or localized dry spot. Unfortunately, accurate diagnosis can currently be accomplished only by trained personnel at the university diagnostic laboratories. Diagnosis of bacterial wilt at university diagnostic laboratories can be deterined only on fresh samples. Therefore, turf samples should be mailed in an overnight service. Accurate diagnosis is essential if management strategies are to be effective in combating this devastating disease. If further information is desired, please contact the authors:

Plant Diagnostic Clinic
141 Plant Biology
Michigan State University
E. Lansing, MI 48824-1312

Phone: (517) 355-4536
or (517) 353-9082

Table 1 - Some golf and country clubs where bacterial wilt has been diagnosed by Michigan State University.

State	Golf or Country Club	
Indiana	Youche	Crooked Stick
	Old Oak	Hillcrest
	Bloomington	Meridian Hills
	Highland	Harbour Trees
	Phil Harris	Fort Wayne
Illinois	St. Charles	Riverside
	Butler National	Bloomington
	Cog Hill	Decatur
	Village Links	Park Hill
	Kellogg	Olympia Fields
	Timber Trails	Midlothian
	Medina	Pottawatomie
	Edgewood Valley	Glen Flora
	Glenn Oak	Waukegan
Kansas	Milburn	
Michigan	Alpine	Evergreen
	Bay Pointe	Birchwood Farms
	Leland	Old Channel
	Goodrich	Plymouth Park
	Maple Lane	Edgewood
	Raisin River	Plum Hollow
	Royal Oak	
Minnesota	Hazeltine	
Ohio	The Golf Club	Muirfield Village
	TRW	Silver Lake
	Firestone	Brandywine
Pennsylvania	Alcoma	
Wisconsin	Westmoor	
	Meadowbrook	
	North Hills	

SUMMER PATCH DISEASES

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There is a group of diseases that produce patches on desirable turfgrass species primarily by attacking the root system of the plants. There are many other patch diseases of turf, but they primarily attack the foliage, crowns, rhizomes and stolons.

Table 1 - The Patch Disease, Causal Organism and Primary Host

Disease	Organism	Primary Host
Summer Patch	Phialophora graminicola	Annual bluegrass
Necrotic Ring Spot	Leptosphaeria korrae	Kentucky bluegrass
Take All Patch	Gaeumannomyces graminis	Creeping bentgrass

Summer Patch. It has become more and more evident over the past few years that summer patch caused by Phialophora graminicola is a primary disease of annual bluegrass during the warm weather. It can also be found on Kentucky bluegrass and the fine leaf fescues, but far less frequently.

On annual bluegrass the initial symptoms are a yellowing of the turf in patches usually six inches to a foot in diameter. This is followed by a thinning of the turf with the remaining turf turning bronze in color. If warm weather persists all the turf in the patches may die. Most of the creeping bentgrass cultivars are resistant and oftentimes creeping bentgrass can be seen recolonizing centers of these patches.

Cultural Management.

Preliminary data indicate that soil temperature and soil moisture may be important in the development of this disease. Excessive irrigation during hot periods or absence of irrigation following the hot period may make the diseases more severe.

Necrotic Ring Spot. It now appears that necrotic ring spot caused by Leptosphaeria korrae is the primary patch disease found on Kentucky bluegrass. It is appearing more and more like this is the disease that used to be referred to as Fusarium blight. The symptoms can be observed throughout the growing season of the spring and fall. The plants that were infected by L. korrae in the cooler weather are in a weakened condition and very susceptible to summer heat stress or drought stress. Subjecting the necrotic ring spot plants to either of these stresses will lead to the death of the weakened plants and the recurrence of symptoms even though the pathogen may not be active at this time.

The initial symptoms are patches six inches to two feet in diameter with straw and red colored blades intermingled in the patch. Patches may have green grass in the center with the straw and red colored blades in the outer area of the ring giving a frog eye appearance. When symptoms appear in the warm weather the red blades are often limiting.

Cultural Management

Nitrogen is important in the recovery of the patches caused by necrotic ring spot. Between three and five pounds of actual nitrgoen/1,000 sq. ft./season is necessary to promote recovery of necrotic ring spot patches. Just as important in the recovery of the patches and preventing new ones from developing are proper cultural practices. These include coring to relieve compaction and layering that results when sod of one soil type is laid on top of soil of another type, which is a very common practice on home lawn and commercial properties. This results in shoot rooting during the warm weather when the roots of the turfgrass plant are confined to the upper layer. Coring and reincorporating the soil back into the thatch will, over a period of years, alleviate this problem. It will also help manage any potential thatch problem which is important in managing necrotic ring spot because thatch has a poor moisture holding capacity and turfs growing in a thick thatch are more susceptible to drought stress.

Biological Management

The light frequent waterings on a daily basis around mid-day have certainly been shown to help manage necrotic ring spot. The turf appears to be benefitting culturally from the cooling of the turf and biologically for the build up of beneficialy microorganisms in the moist thatch that may be antagonistic to L. korrae.

Turf Restore, Green Magic and Strengthen and Restore are products that appear to be supplying some biologic management of necrotic ring spot. These products contain antagonistic microorganisms in the case of Lawn Restore or their by-products in the case of Green Magic and Strengthen and Restore. They have been effective in promoting the recovery of necrotic ring spot patches and preventing the development of new ones. The key word is management. They are not a one-shot cure, but used systematically on a regular basis, they will manage this disease and provide a healthy turf. In addition to the antagonistic microorganisms and their by-products they contain the major and micronutrients necessary for a healthy turf.

Take All Patch. Take All Patch caused by Gaeumannomyces graminis occurs primarily on creeping bentgrass. The disease also used to be referred to as Ophiobolus patch when the disease was believed to be caused by Ophiobolus graminis. Annual bluegrass appears to be resistant to the disease and can be seen recolonizing the center of Take All Patches. The disease is a cool weather disease although like necrotic ring spot, the symptoms may reappear during warm weather, especially if the infected turf is allowed to go under drought stress.

The symptoms first appear as irregular shaped patches ranging in size from 6 inches to up to a few feet in size. Newly established turf appears to be especially susceptible to Take All Patch.

Cultural Management

The literature suggests that both sulfur and phosphorus have helped manage Take All Patch. Avoiding drought stress is probably also important in helping reduce the severity of the disease.

Chemical Management of the Patch Diseases

Disease	Fungicide
Summer Patch	Tersan 1991 Fungo 50 Cleary's 3336 Bayleton Rubigan
Necrotic Ring Spot	Tersan 1991 Fungo 50 Cleary's 3336 Chipco 26019 Rubigan
Take All Patch	Tersan 1991 Fungo 50 Cleary's 3336 Rubigan

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USING GARDEN FLOWERS FOR LANDSCAPE ENHANCEMENT

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Herbaceous plants, that is, non-woody plants - are plants that either die completely at the end of a growing season or die back to ground level in winter, reappearing in spring. They are often classified by their life span:

- Perennials have a life span of more than two years. Some kinds (peonies, for example) may be very long-lived, others may "run out" in a few years.

- Biennials live two years, growing vegetatively the first year, then flowering, producing seeds, and dying the second year.

- Annuals live for only one growing season.

Another category are what we loosely call "bulbs" - plants with underground storage organs such as corms, tubers, rhizomes, and of course, true bulbs. Bulbs may be either hardy, those that can be left in the ground as perennials, or tender, those that must be lifted in autumn and the rootstock overwintered indoors.

Generally, these garden flowers are relegated to a sunny bed or border. Annuals are bedded out in masses of color for the summer months, and perennials are mixed in borders for a sequence of bloom from April until frost. But the creative landscapist sees many other roles for these plants. Here are a few examples:

Specimen plantings: Some herbaceous plants are so striking in form, foliage, flowering interest, size, or a combination of these factors, that they may be used in isolated plantings where their unique qualities are well displayed. Yucca and some of the taller ornamental grasses lend themselves to this function, as do peonies and a number of garden perennials.

Ground covers: While some ground covers are woody plants, many of the best are herbaceous perennials. For areas where mowing grass is difficult, such as on rough ground or slopes, perennial ground covers offer an excellent alternative to lawn. Some of them are useful in controling erosion on banks. Some of them are evergreen, holding their leaves throughout the winter. Many are excellent for shady areas, some even flowering well in shade.

Accents: Because they can supply so much color, garden flowers are useful accents in the landscape, both to call attention to features the designer wishes to emphasize and to distract attention away from less attractive areas.

Solutions to site problems: Perennials offer a wide choice of tolerances to varying light and soil conditions. Many plants are available which will grow well in shade, including ferns, ground covers, wildflowers, and a goodly number of specimen plants and garden flowers. For areas with moisture problems, whether too wet or too dry, well adapted perennials can be found, not only to furnish some greenery but to supply other colors with their flowers.

Fillers for small spaces: Annuals, perennials, or herbac ous ground covers are excellent fillers for awkward areas where lawn may be impractical, such as between pavements - sidewalks, driveways, streets - or between buildings and pavements where narrow strips of soil are sometimes left, or next to walks or fences. The ground-covering perennials can be used to fill the area solidly and keep out weeds, or a mixed planting of various annuals and perennials can be employed for flower or foliage color if a few maintenance chores can be managed.

Edging around construction details: Perennials with creeping or trailing growth habits can be used to soften the rigid appearance of pavement edges, retaining walls, terraces, and steps.

Screens: Tall-growing annuals or perennials, including vines which can climb fences, trellises, or other supports, can be employed to screen off an undesirable view or to give privacy. Such plants are an excellent choice for temporary landscaping, before permanent shrubs or trees have reached mature heights.

Naturalizing: Plants that will naturalize, or native wildflowers adapted to the location, may be used where a low-maintenance, informal, mixed planting is desired. Select plants that, once established, will be able to survive and reproduce on their own.

Portable gardens: Annuals in movable pots and planters can be grouped or displayed singly. The designer can achieve great flexibility by shifting their location, rearranging the grouping, or displaying them only on special occasions or only when the plants are at their prime.

Mixed plantings: In flower beds and borders, usually one uses annuals in masses for summer color, while perennials are put in separate gardens, where the mixed perennials will flower sequentially. However, a more interesting flower garden results from a mixture of annuals and perennials. Low shrubs can also be included for contrast and winter interest.

Specialized gardens: The designer may wish to create rock gardens, herb gardens, water gardens, or various other types of collections. Site conditions may suggest or direct the choice of specialty garden.

For early spring color: Consider using biennials, early perennials, and the hardy bulbs.

As with all plants, there are some ground rules to follow before using herbaceous plants. One must learn the specific requirements and tolerances of a plant, and then place it accordingly. Select plants to fit the site, plants which will tolerate the prevailing conditions. With proper selection, herbaceous plantings require little maintenance and can greatly enhance the landscape.

Following is a list of flowers for adding color to the landscape as well as performing some of the functions discussed above. Most of these plants are well known and widely available. A few of them have shortcomings. Consult a reliable book or authority for information about ones with which you may not be familiar.

Annuals

Wax (or fibrous-rooted) Begonia - *Begonia semperflorens-cultorum*
Plumed Celosia - *Celosia cristata*, Plumed Group
Coleus - *Coleus* x *hybridus*
Flowering Tobacco - *Nicotiana* cultivars
Geranium - *Pelargonium* x *hortorum*
Gloriosa Daisy - *Rudbeckia hirta* var. *pulcherrima*
Impatiens - *Impatiens wallerana*; and New Gunea *Impatiens* hybrids
Madagascar Periwinkle or Vinca - *Catharanthus roseus* (*Vinca rosea*)
African (or American) Marigold - *Tagetes erecta*
Triploid (or "Mule") Marigold - *Tagetes erecta* x *T. patula*
French Marigold - *Tagetes patula*
Pansy - *Viola* x *wittrockiana*
Petunia - *Petunia* x *hybrida*
Mealycup Sage - *Salvia farinacea*; and Scarlet Sage - *Salvia splendens*
Spider Flower - *Cleome hasslerana*
Black-eyed Susan Vine - *Thunbergia alata*
Sweet Alyssum - *Lobularia maritima*
Creeping Zinnia - *Sancitalia procumbens*
Zinnia - *Zinnia elegans*
Classic Zinnia - *Zinnia angustifolia*

Tender Tubers, Rhizomes, etc.

Tuberous Begonia - *Begonia* x *tuberhybrida*
Caladium - *Caladium* x *hortulanum*
Canna - *Canna* x *generalis*

Perennials

Astilbe or False Spirea - *Astilbe x arendsii*
Fringed or Wild Bleeding-heart - *Dicentra eximoa*
Butterflyweed - *Asclepias tuberosa*
Chrysanthemum - *Chrysanthemum x morifolium* (perhaps better handled as an annual)
Coral Bells - *Heuchera sanguinea*
Daylily - *Hemerocallis* cultivars
False Indigo - *Baptisia australis*
Goldentuft or Basket-of-Gold - *Aurinia saxatilis* (*Ayssum saxatile*)
Hosta or Plantain Lily - *Hosta* species and cultivars
Bearded Iris - *Iris* cultivars
Russell Hybrid Lupine - *Lupinus* nybrids
Peony - *Paeonia* cultivars
Purple Coneflower - *Echinacea purpurea* (*Rudbeckia purpurea*)
Rose Mallow - *Hibiscus moscheutos*
'Goldsturm'Rudbeckia - *Rudbeckia fulgida* 'Goldsturm';
Blue Oat Grass - *Helictotrichon sempervirens* (*Avena sempervirens*)
Fernleaf Yarrow - *Achillea filipendulina*
Maiden Grass - *Miscanthus sinensis* 'Gracillimus'
Striped Eulalia Grass - *Miscanthus sinensis* 'Varigatus'

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DISEASES OF FLOWERS AND OTHER HERBACEOUS ORNAMENTALS

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Disease	Remarks
Leaf, stem and flower spots	Caused by a variety of fungi. Infection is most apt to occur during wet spring periods. Apply fungicides on a regular 10 to 14 day schedule during May and June. Do not overcrowd plants.
Botrytis blight	Causes blasting of flower buds and spotting and decay of flowers and foliage. Botrytis is most severe if prolonged cool, wet periods occur during April and May. Apply fungicides on a regular 10 to 14 day schedule during spring months. Keep dead leaves and flowers picked up. Good sanitation is critical for good control.
Powdery Mildew	Frequently is most apparent in late summer and fall. Spray at the first sign of mildew; continue spraying every 10 to 14 days with an appropriate mildew fungicide. Avoid planting in the shade, maintain good weed control and thin dense plantings to promote rapid drying conditions.
Water Molds (Pythium and Phytophthora)	Water molds are most apt to be a problem in wet, poorly drained, heavy soils. They cause root rot and crown rot of numerous plants as well as damping-off of seedlings and younger plants. Good water management is the key to preventing water mold problems. Improve surface and subsurface drainage in poorly drained areas; avoid planting highly susceptible plants in wet areas; do not overwater flower beds but allow the soil to dry slightly between waterings. Fungicide drenches are generally not recommended for outdoor flower beds.
Vascular Wilts (Verticillium and Fusarium)	These fungi cause wilting, stem and leaf discoloration, and eventual plant death. Both fungi are soil inhabitants and thus able to survive for extended periods of time in the soil. Infected plants cannot be saved and should be destroyed to prevent further disease build-up. Rotate away from infected sites or only plant wilt resistant flower cultivars. Soil fumigation is required before replanting susceptible cultivars in infected soil.

Disease	Remarks
Bacterial Blights	Bacteria damage plants by causing leaf spots, soft rots, blights, wilts, cankers, and galls. Fungicides will not control bacterial diseases; streptomycin and certain copper compounds give 'limited' control of bacterial diseases but are generally not recommended for outdoor flower plantings. Starting with 'clean' stock material and good sanitation practices are essential control practices.
Viruses	Plant stunting, leaf mosaic and ring-spots are common symptoms associated with virus diseases. There are no chemical cures for virus infections. Control insects, especially leaf hoppers, aphids, and thrips, that transmit viruses. Rogue infected plants. Keep down broadleaf weeds.

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FLOWER PLANTING - DESIGN AND CARE

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I. Design
   A. Function of flower planting in landscape - "What should the flowers do?"
      1. attract attention - (accent containers, focal point) to draw the eye to sign, entranceway, etc.
      2. add visual interest - increase visual diversity of out-of-the-way places
      3. screen objectionable views
      4. handle problem spots or awkward spaces
   B. Form of flower planting
      1. stylistic theme: formal vs. informal
      2. context: background vs. islands
   C. Visual characteristics of plants and arrangements
      1. form, texture
      2. size, mass, scale
      3. uniformity vs. variety, visual movement, bloom sequence
      4. color
         a. color wheel relationships
         b. warm vs. cool

II. A. Soil preparation
      1. conversion from turf
      2. depth, timing
      3. pH, organic matter
      4. fertilizer - soil test 2# (5-10-5)/100 sq.ft. or 1# act. N/1000 sq.ft.
   B. What to plant
      1. direct seeding
      2. transplants
   C. Establishing transplants
      1. timing, depth
      2. starter fertilization (high P)
   D. Summer care
      1. watering, pinching, dead-heading, staking
      2. fertilizer at 6 weeks
         1/2# act. N/1000 sq.ft. as 5-10-5
      3. weed control
         a. mulching, hand weeding
         b. chemical
            i. registered materials - label crops
            ii. accurate application, timing and rates essential
            iii. Dacthal, Treflan, Surflan, Fusilade/Poast, Betasan

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FLOWER PLANTING - INSECT IDENTIFICATION AND CONTROL

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Herbaceous plant materials can provide striking accents to various areas of golf courses, parks and country clubs if proper selection, design and maintenance are considered. Insects and other pests attacking annuals and perennials are usually general plant feeders, with a few that are specific to a given plant. Most are very small and their presence is not noticed until considerable damage has resulted. It is very important, therefore, to regularly check your planting for pests and begin control before they become problematic.

Five of the most common pests are aphids, spidermites, slugs (snails), beetles and plant bugs.

Aphids are small, soft-bodied insects which feed in colonies and can cause curling, twisting, and deforming of leaves, stems, buds and flowers. They also secrete honeydew in which black sooty mold grows and they are vectors of some plant diseases. These insects produce young continuously during the spring, summer and early fall and they feed on hundreds of plant hosts. Control strategies include syringing with water, using yellow sticky traps to catch flying aphids in the spring, insecticidal soaps and various chemicals (including resmethrin, permethrin, Orthene, diazinon, malathion, Dursban and Methsystox).

Spider mites are eight-legged insect relatives which can cause extensive damage to flower plantings. Their presence is indicated by whitened foliage, webbing between plant structures and stunted or distorted growth. Like aphids, spider mites can complete many generations each season and feed on numerous ornamentals. Control options include removing and destroying badly infested plants, insecticidal soaps and miticides (ex. Kelthane, Ovex, Pentac, Vendex). It is suggested that one avoid prolonged use of Sevin to protect herbaceous plantings since this material may cause mite buildup.

Slugs and snails are the "giants" of the pests considered here with the Leopard slug reaching 5-6 inches in length. These are nocturnally feeding mollusks that leave large holes in leaves and flowers and can completely destroy seedlings. A silvery slime trail on sidewalks, plants or the ground is a reliable sign of their infestation. More than one year is required for these pests to attain full size so you can expect previous year's slugs to be present with new individuals each season. Cool, wet conditions are ideal for slug or snail buildup. Cleaning up hiding places, weed control, barriers, beer traps and baits (mesurol or metaldehyde) are tools to effect control.

Numerous beetles feed on flowers - the Japanese Beetle, Cucumber Beetles, Blister Beetles and Rose Chafer are common in our area. All have in common a single generation each year and the ability to destroy the beauty of your plantings when adult numbers are high. Using Sevin or malathion when damgage or beetles are first seen is recommended. Additional strategies for the Japanese Beetle are discussed by D. L. Schuder under "Difficulties with Grub Control".

Although there are numerous plant bugs, the Four-Lined Plant Bug is highlighted here. It is an attractive yellow and black, one-quarter inch long bug that causes conspicuous, depressed spotting of leaves mimicking plant disease. This bug has only one generation each year and feeding damage should be watched for beginning in May. Sevin is the only control available to date and should be applied once your planting is established/fully leafed-out AND when damage and/or bugs are seen.

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DIFFICULTIES WITH GRUB CONTROL

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For several years the number of grub control problems has been on the increase. This probably is due to the fact that the long residual insecticides such as dieldrin, aldrin, chlordane and heptachlor have been banned. The problem will probably increase even further as the effective concentration of these materials decreases in our soils.

There have been problems with the control of grubs with the materials available, mostly related to water. Diazinon, Dursban and Dylox all had to be watered into the soil to move the toxicant into the rootzone where the beetle larvae feed. The first two were difficult to move through thatch and highly organic soils, while the latter sometimes involved a pH problem and the use of a buffering agent was needed.

Research work in all of the states in the midwest showed that diazinon worked most effectively if you start with higher concentrations of the granules, e.g. 14G and watered them in with at least one-half inch of water. The higher concentration applied at the same rate per acre allowed an effective concentration of the chemical to penetrate into the rootzone to contact and kill the grubs.

Oftanol was thought to be a panacea for most turf problems, for both above and below ground insect pests. However, in 1985, there were many failures, apparently due to enhanced microbial degradation of the chemical.

Kaufman, et al have illustrated this phenomena for several herbicides. Here it may be desirable at times so that farmers can rotate crops without chemical carry-over and subsequent crop damange, but it renders Oftanol ineffective for grubs.

Another highly effective chemical, 'Triumph' (experimental compound 12223) developed by Geigy and now owned by Union Carbide, has not been approved by EPA despite the urgings of research entomologists from the midwest who found it an excellent addiiton to the pesticide arsenal.

The picture was complicated by the fact that on January 6, 1986, EPA published their intent to ban diazinon for use on golf courses and sod farms. In Indiana there are 225 products containing diazinon labled for turf, while on the national level there are 825 products labeled for grass application. Loss of these products would be a terrible blow to the industry. Further, since the domino effect usually takes place the product could be lost for 'flea control', vegetable insect control, etc.

The milky spore disease effective for the permanent control of Japanese beetle grubs has complications. Research in Maryland and at Ohio State University has revealed that the "Milky Spore" brand did not contain viable spores of the bacteria. 'Doom' and 'Japademic', two brands supplied by the Fairfax Laboratories are apparently still effective and still recommended.

Some recent publications and even the 'labels' on some of the Japanese beetle traps are in error. These traps are highly effective in capturing Japanese beetles because they have a synthetic virgin female pheromone to attract the males and a floral pheromone to attract the females. The traps should be placed around the edge of the property to be protected so the beetles are attracted away from the susceptible plant materials. Schuder noted that the traps reduce the adult population about fifty percent each year, and thus prevent economic damage both as grubs in the turf and as adults feeding on the 300 other hosts.

Schuder concluded that grub control materials still effective when watered into the soil include Turcam (Ficam) and Dursban.

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NATIVE PLANTS - A VIABLE ALTERNATIVE

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There is an alternative to the highly maintained, elite, cool season turf used on the majority of our golf courses today. The reason I would propose the alternative is that we are running out of good water supplies for irrigation, fertilizers are becoming cost prohibitive, and what will be the long term effect on our environment with the pesticides we are now using.

The alternative I would propose is the use of native American grasses and wildflowers. These native plants can be used effectively and with long-term cost savings on the golf course. Areas that should be considered as possible sites for installation are the rough areas, along a winding entranceway and as a screen between the boundaries of the golf course and neighboring properties.

In time the areas installed will mature and start to look like the few remaining remnant areas of the Midwest that represent the rich looking mesic, xeric or wetland prairies of yesterday that the pioneers saw when the traveled through or settled this area of the Midwest.

An installation of native American grasses and wildflowers will continue to germinate and mature over a period of three to five years, eventually approaching what I would refer to as a "climax praire" or as close as possible to a native prairie which was created by the Good Lord. Not one of the native American grasses or wildflowers can be or is in fact a noxious weed to a golf course or even to commercial agriculture, and I would refer even to Hill's Prairie Thistle, which is not on the endangered speceis list.

Three basic methods of installation are used when installing native American grasses and wildflower mixes:

1. Hand seeding - For small areas where mechanical installation is either cost prohibitive or impractical, hand seeding should be considered. The soil should be prepared in the best way possible to a depth of about two inches and the seed scattered very carefully by hand. Getting down on one's hands and knees is best in order to prevent the small lightweight seed from being blown away from the area intended for installation. When seeding is completed, rake the seed into the soil and firm or pack the soil in the best way possible. Applying a mulch cover of wood fiber, paper or weed-free straw/hay will help retain soil moisture.

2. Hydraulic seeding - For areas that are impractical to hand seed or are inaccessible or too steep for the Rangeland Grass Drill, hydraulic seeding should be considered. Hydraulic seeding is best accomplished with a two step application. The first application should include the applicable native mix and a small amount of mulch used as a tracer. The second application should include the appropriate amount of mulch to provide for soil moisture retention and erosion control on steeply inclined or rolling areas.

Note: It should be noted that when hand seeding or hydraulic seeding the seed rate should be icreased. Previous installation and test results indicate that a rate of one and one-half to two times the rangeland drill method is applicable to make up for the possible inadequacies of hand seeding or hydraulic seeding.

3. Seeding with Rangeland Grass Drill - There are two methods of installation to be considered when using the Rangeland Grass Drill. The first method involves the complete plowing or rototilling of the area to be seeded followed by disking and dragging leaving two inches of loose soil for a good seed bed. The area can then be seeded in one of two ways. One, drill the native American grasses and a portion of the cover crop in one direction at a depth of one-quarter inch and the wildflowers with the remaining cover crop at an angle to (diamond shaped) the first pass at a depth of one-eighth inch. The second way is to install the complete mix at a depth of one-eighth to one-quarter inch using the angle or criss-cross method perviously mentioned. Pulling a chain crosswise behind the drill or light dragging and cultipacking or rolling the soil firm will enhance the establishment of a native installation. Although it will add to the cost of installation the application of an appripriate mulch cover, as previously stated, will further enhance the installation.

The second method of installation when using the Rangeland Grass Drill is with the "zero till" attachment. The existing vegetation should be evaluated for competetiveness whether it is noxious Eurasian, woody or dense sod formers such as Kentucky bluegrass. If the existing vegetation is considered competitive, spray the total area or applicable areas with Roundup. Drill the native seed mix into the existing vegetation at a depth of one-eighth to one-quarter inch. After installation is completed mow the existing vegetation with either a rotary or flail mower down to the soil line. The mowed vegetation will provide the cheapest mulch cover you can find.

Native American grass and wildflower mixes are available in a variety of heights, for special soil conditions, and also for various macroclimates. Also included with a good native mix is a cover crop of oats or specific cool season grasses and also annual and short lived perennial flowers that are prairie related. The annual and short lived perennial flowers provide the initial color display in the first years prior to the germinaiton and flowering of the native wild flowers. Both the cover crop and annual/short lived perennial flowers also provide initial erosion control and help hold back weedy competition in the first few years of a native installation site.

The heights available are basically dwarf (12"), low profile (3') and regular (5-6') which are mesic (flat or slightly rolling areas with good drainage) and xeric or dry (rocky, gravelly or sandy areas that are excessively drained). Wetland or marsh mixes and also ravine or woodland understory mixes are also available. Maintenance of a native installation is accomplished with yearly burning, mowing, combined burning and mowing or spot treatment with herbicides.

From the beginning of the installation let people enjoy and appreciate the development stages. Put walking paths or cart paths through the area. Don't fence it in. That occasional foot traffic will help firm the area and put additional stress on Eurasian competition.

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POISONOUS PLANTS AROUND THE HOME - A SUMMARY

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For better or worse, man has always had green plants to provide him with food, fiber, shelter and medicine. There was a time when people resorted to the plants available to them directly by gathering them from their immediate natural environment. Their survival base, i.e., green plants, was there for the taking. These people knew the plant they used and knew what plants would harm as well as nourish them.

Today we measure our survival base in dollars. Our food is obtained from our gardens and markets and is both processed and stored at enormous expense. Modern man is not equipped like his ancestors to collect food plants directly from his environment. He still uses them the way he always did, but his knowledge of them is limited to their functional and ornamental use.

At least three areas of concern about poisonous plants can be identified:

1. We decorate with them
2. We eat plants that contain toxic substance
3. There are many plants around the environment that are toxic if we ingest them, or as in the case of poison ivy, come into contact with them.

These concerns must be viewed in the proper perspective. The idea that a person is going to die if he ingests a portion of a poisonous plant should not be promoted. According to the 1984 Annual Report of American Association of Poison Control Centers, there were 63,328 plant ingestions reported in the U.S. There was only one fatality. Even one fatality is to be regretted, but the death rate from poison plant ingestions is characteristically very low.

There are at least 700 kinds of plants that prove to be toxic upon ingestion.

1. Alkaloids - Alkalai-like, nitrogen containing organic compounds. They affect the nervous system. Symptoms include thirst, pupil dilation, irritability, delirium, weak, rapid pulse, convlusion and coma.

2. Glycosides - Compounds yielding one or more sugars and one or more other compounds (algycones) when hydrolyzed (or split). Symptoms include short breath, gasping, excitement, staggering, prostration, paralysis, convulsions and coma.

3. Oxalates - The only organic acid in plants which is toxic to animals and man. Poisoning not clear. Absorbed into bloodstream causing nervous symptoms, reduced blood coaguability and acute nephritis.

4. Resins - A group of not too well known chemicals causing irritation of nervous or muscle tissue. They occur in plants such as azalea, black locust, castor bean, marijuana, milkweeds and water hemlock.

We decorate with poisonous plants.

A number of plants in and around the home cause problems to children and adults as well. Two frequently encountered house plants are Philodendron and Diffenbachia (also known as Dumbcane). One has to eat quite a bit of Philodendron to show symptoms, but just one bite into a Diffenbachia can make a person extremely uncomfortable. It causes severe burning and swelling of the mucous membranes of the mouth and throat. The castor bean, a large, mottled seed from a tropical weed, is frequently used in necklaces. These seeds are definitely toxic and have caused death. The number of seeds ingested varies from several to two dozen. One ornamental plant said to be poisonous but has been shown to be innocuous is the Christmas Poinsettia, a relative of the castor bean.

Plants outside the home for which frequent exposures are reported include yew, holly and rhododendron (including azelea). The seeds of yews have a sweet, bright red fleshy covering (an aril) which is attractive to young children. They contain a toxic alkaloid. Six or more of these co-called yew berries can cause illness in a child. Holly berries are potentially toxic but will not always cause illness.

We eat plants containing toxic substance.

Quite a number of food plants are known to contain toxic substances. The foliage and green skins of potatoes contain solanine, a very toxic alkaloid. Carrots contain a powerful nerve poison (carotoxin), a hallucinogen and substances that mimic female hormones. Radishes, broccoli and onions contain substances that block the thyroid gland's use of iodine. Black olives contain large quantities of sodium and a carcinogen, benzo(a) pyrene. This does not suggest that we should stop eating these plants. The very substances that could be singularly dangerous to man are countered by other substances which offset their potentially toxic effects. This is why we can continue to eat them. Quite a number of plants contain carcinogens (cancer causing agents) but are no threat to us because they are "tied up" by substances that undo their cancer-inducing effects. The fact that edible plants contain toxic substances would make it very difficult to pass a law requiring that all plants containing toxic substances be labeled as such.

Toxic plants are all around us.

One does not have to go far from home to encounter poisonous plants. They can be found in parks, vacant lots, fence lines, along rights-of-way and country lanes. Poison control centers frequently receive calls in summer for ingestion of pokeberries (fruits of Phytolacca americana) which are known to contain small amounts of toxic glycosides. Small children can eat up to 20 berries without becoming ill. Seeds of Jimsonweed (Datura sp.) are sometimes ingested by people who think they can have a pleasant hallucinogenic experience. The experience is always unpleasant and the victim may require hospitalization. Jimsonweed, like many of its nightshade family relatives, contains several toxic alkaloids.

Other common encountered plants that can cause symptoms if eaten include:

Bittersweet (Celastrus) - fruits
Black Locust (Robina) - seeds, twigs
Black Nightshade (Solanum nigrum)- unripe fruits, foliage
Elderberry (Sambucus) - unripe fruits, foliage
Horse Nettle (Solanum carolinese) - unripe fruits
Wild Black Cherry (Prunus serotina) - unripe fruits, foliage and twigs

Many plants cause skin rash or dermatitis. Poison Ivy is one of the best known dermatitis producing plants. It causes discomfort in nearly 75% of the population. It is found almost anywhere, in suburbs and countrysides as well. The rash that develops from Poison Ivy is caused by a heavy, non-volatile oil called urushiol. It fools the body's immune system which reacts to it as a foreign body. It is this response that causes the itching, running blisters.

Most encounters with plants that produce symptoms of illness are accidental. The plant contacted or eaten was not known to be toxic. In most cases, there is very little danger of death, even though people sometimes become very ill.

The following suggestions are offered as sensible approaches to dealing with poisonous plants:

Things We Can Do

1. Know by name, on sight, all potentially dangerous plants.
2. Get immediate identification of any unknown plant ingested.
3. Obtain a sample of any unknown ingested plant for identification.
4. As in the case of Poison Ivy, avoid the smoke of burning brush.
5. Do not make up homemade medicines from native or cultivated plants.
6. Be familiar with the plants used by children as playthings.
7. Post the phone number of the nearest poison control center by your phone.

Selected References:

1. Botanical Dermatology, Plants Injurious To The Skin. John Mitchell and Arthur Book. Greengrass Ltd. 691 West 18th Avenue, Vancouver, B.C. V5H 2H4
2. Human Poisoning From Native And Cultivated Plants. James W. Hardin and Jay M. Arena. 1973 (2nd Edition). Duke University Press, Durham N.C.
3. Poisonour Plants of the United States and Canada. John M. Kingsbury. 1964 Prentice-Hall, Inc., Englewood Cliffs, N.J.

A CONSULTANT'S IDEAS ON LANDSCAPE MAINTENANCE

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For good maintenance results 1-5 year plans should be made and followed. In actual fact, they are seldom even considered in the design process.

Eighty percent of all landscape maintenance problems are soil associated. The landscape maintenance contractor needs to understand what kinds of things can happen in the soil that will cause him problems. He also needs to know principles of plant growth and how to use as many good physical management techniques as possible.

Soil composition should be 50% solid, 25% water and 25% air. This allows roots to get the oxygen, nutrition and water they must have to grow well. Soil type knowledge is the key to good management. You then know what plants will grow well in specific situations. It will explain why some plants decline. Soil type is approximately known through county soil survey maps which are available at no cost from some level of county government. From them you will learn:

- what soil associations you have
- underlay (subsoil) and how poor a growing medium it probably is, especially when it is on top in urban situations
- seasonal water table and how you have to drain to control it
- drainage of low places, seeps, basements and crawl spaces
- erosion which causes plugging of storm sewers and other outlets

What can be wrong with a soil?

- compaction
- drainage
- construction debris
- poor construction practices, particulalry poor soil preparation
- subsoil being lifted atop the regular soil structure
- fertility out of balance

Plant specificity

- sun/shade
- wet/dry roots
- high/low management
- salt tolerance

Other things that can be wrong

- tree guy wires still on
- lack of water
- hardware disease , mower, line trimmer damage
- ornamentals planted too close to a solid edge (sidewalk, wall, etc.)
- poor pruning practice
- wrong plants for a given location

If plants are dying you have to find out why before you can correct the situation.

You must balance expected results, available budget, and level of use.

Best method of maintaining a site starts with:

- core aerification. This is practice #1. It controls thatch and some compaction
- slit seed when budget allows
- use disease, drought, insect tolerant varieties, the proper mowing height and fertilization; use chemicals only when absolutely necessary

Set up a master maintenance plan for five years so that everyone understands what is to happen when, what it will cost, and the benefits to be received. A superb 'curb appeal'.

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CREEPING BENTGRASS/ANNUAL BLUEGRASS COMPETITION

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Currently there is much emphasis in the golf course industry on transitioning from annual bluegrass to creeping bentgrass fairways. Using herbicides to effect this change has for the most part proven unsuccessful. These studies were designed to determine the effects of various cultural practices on the competition between these two species. The aim of this research is to develop a comprehensive strategy for converting to creeping bentgrass and then maintaining it. Two field studies were initiated in 1984 to examine the effects of seven cultural practices on the competition between annual bluegrass and creeping bentgrass.

The study area is a mixed annual bluegrass-creeping bentgrass stand maintained at 0.5 inches height of cut with a triplex mower. Irrigation treatments are watering at 110% open pan evaporation (OPE), 75% OPE and at wilt. Within each irrigation treatment half the block has clippings removed and the other half has clippings returned. Fertilizer was applied at two rates, 2#N/M/YR and 6#N/M/YR. Plant growth regulator (PGR) treatments applied in the spring were Embark (1/8#ai/A), Cutless (1.5#ai/A in 1984, 1.0#ai/A in 1985) and a check. In mid-August half the plots were broadcast overseeded with "Penncross" bentgrass at a rate of 1#/M. Before treatments were applied, species counts were obtained to determine the amount of the annual bluegrass in each plot. Species counts were obtained again in the fall of 1984 and 1985 to determine the effect, if any, the treatments or combination of treatments had on species composition.

Results of analysis of variance for year one, two and combined years are shown in Table 1. The significant irrigation x clipping treatment x fertility interaction shown in Table 1 indicates that the response observed is due to a combination of these three factors and not any one factor by itself. AT 75% OPE (Figure 1) the high N fertility level with clippings returned caused the smallest decrease of annual bluegrass. High N with clippings removed and low N treatments, regardless of clipping treatment, resulted in a net decrease in annual bluegrass. The 110% OPE treatment (Figure 2) with clipping removal, regardless of fertility level, showed a net decrease in annual bluegrass greater than that when clippings were returned. When plots were irrigated at wilt (Figure 3) low fertility and clipping removal resulted in the greatest decrease in annual bluegrass when compared to all other treatment combinations. The other two main factors in the study, plant growth regulator application and overseeding with bentgrass, did not cause a significant change in the amount of annual bluegrass in the plot area.

A second study was initiated to investigate the effects of compaction and coring on annual bluegrass-creeping bentgrass competition. Compaction treatments were applied using a water filled roller three times per week. Compaction treatments were initiated in the summer of 1984 and coring treatments (1x/YR, 3x/YR and a check) were initiated in 1985. The above treatments were applied in conjunction with the previously described irrigation and clipping removal treatments for a four factor investigation. Data analysis found that compaction treatments significantly increased the annual bluegrass population (Figure 4). Unfortunately, it is not possible to separate the effects of compaction from wear, because the roller used in this study clearly applies a significant amount of wear to the test area. Wear stress, therefore, should also be considered as a contributory factor in the observed response.

Measurement of soil water potentials (related to soil moisture content) were done on the 75% and 110% OPE irrigation treatments in late June of 1985 (Figure 5). It is interesting to note that these two treatments which differ by 35% in the amount of water applied maintained soil moisture at levels well above the minimum requirement for healthy grass growth. It appears that a more frequent, light irrigation may save water and maintain soil moisture at well above acceptable levels. Further, more extensive work is planned to investigate this possibility.

The studies concerning annual bluegrass-creeping bentgrass competition will be continued at Michigan State University during 1986.

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FIGURE 1. The effects of two clipping treatments, returned (C+) and removed (C-), two N fertility treatments, 6 lbs N/M/YR (6#) and 2 lbs N/M/YR (2#) under daily irrigation at 75% of open pan evaporation on the percent change in annual bluegrass. Hancock Turfgrass Research Center, East Lansing, MI.

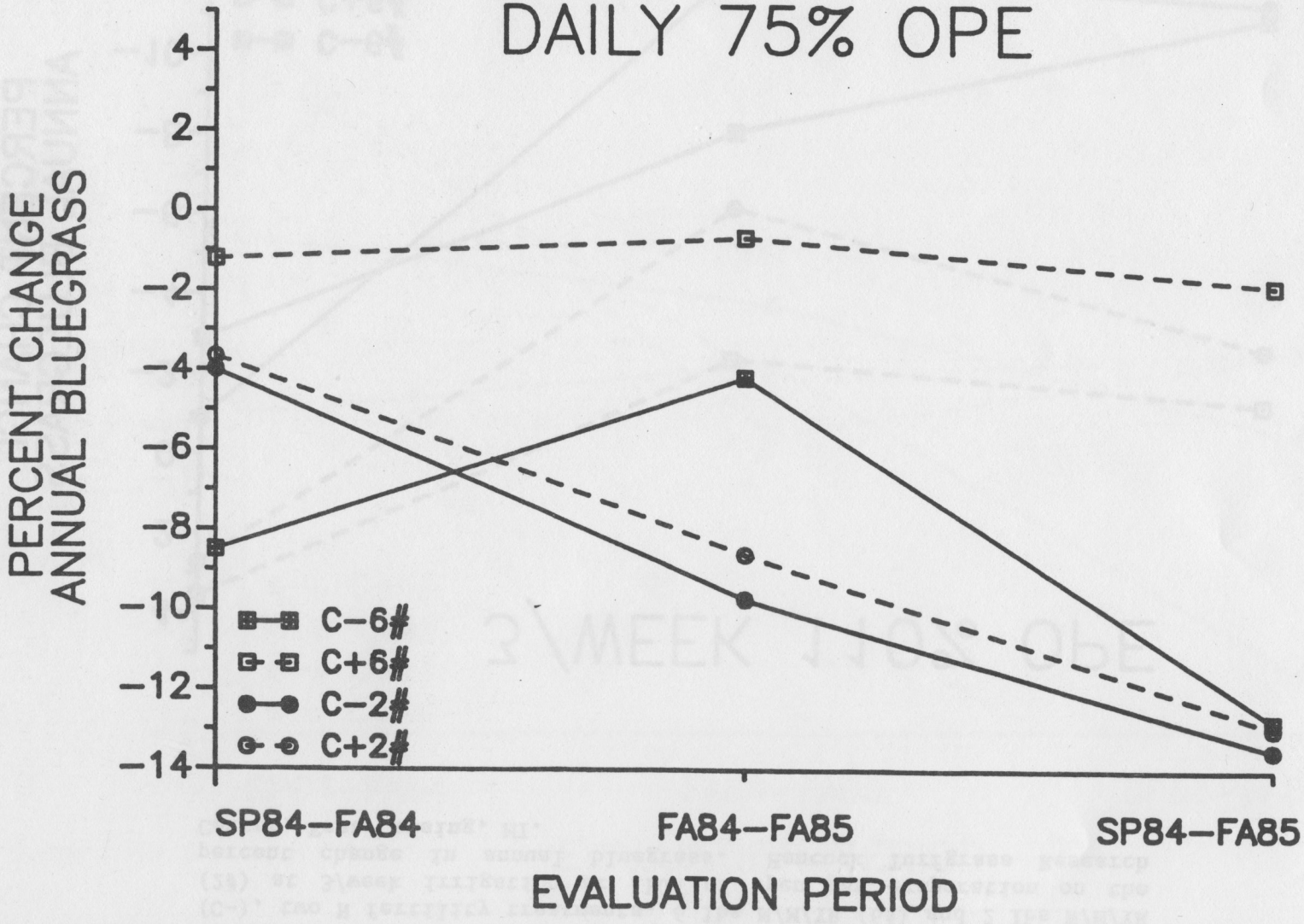


FIGURE 2. The effects of two clipping treatments, returned (C+) and removed (C-), two N fertility treatments, 6 lbs N/M/YR (6#) and 2 lbs N/M/YR (2#) at 3/week irrigation at 110% of open pan evaporation on the percent change in annual bluegrass. Hancock Turfgrass Research Center, East Lansing, MI.

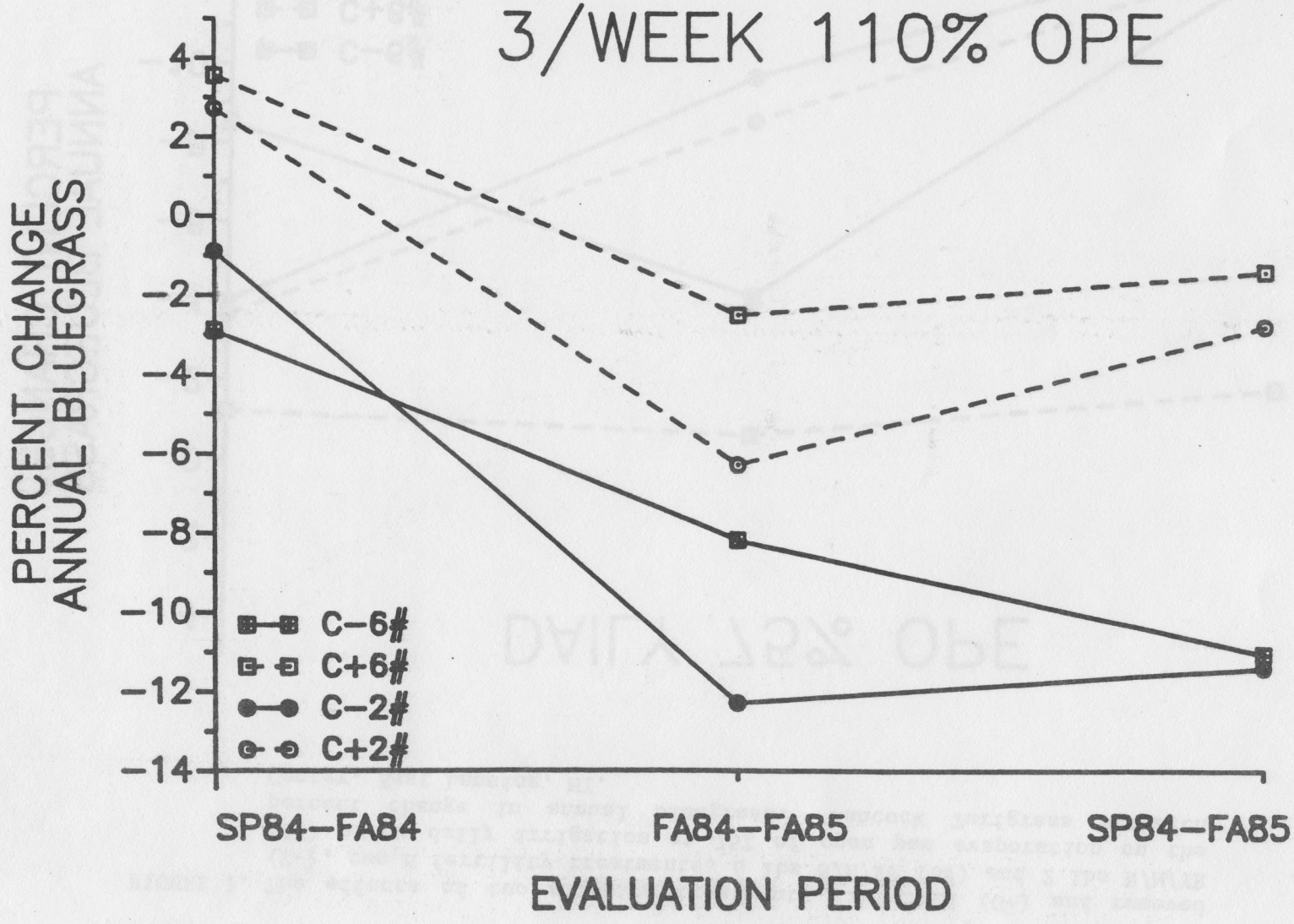


FIGURE 3. The effects of two clipping treatments, returned (C+) and removed (C-), two N fertility treatments, 6 lbs N/M/YR (6#) and 2 lbs N/M/YR (2#) under irrigation at severe wilt on the percent change annual bluegrass. Hancock Turfgrass Research Center, East Lansing, MI.

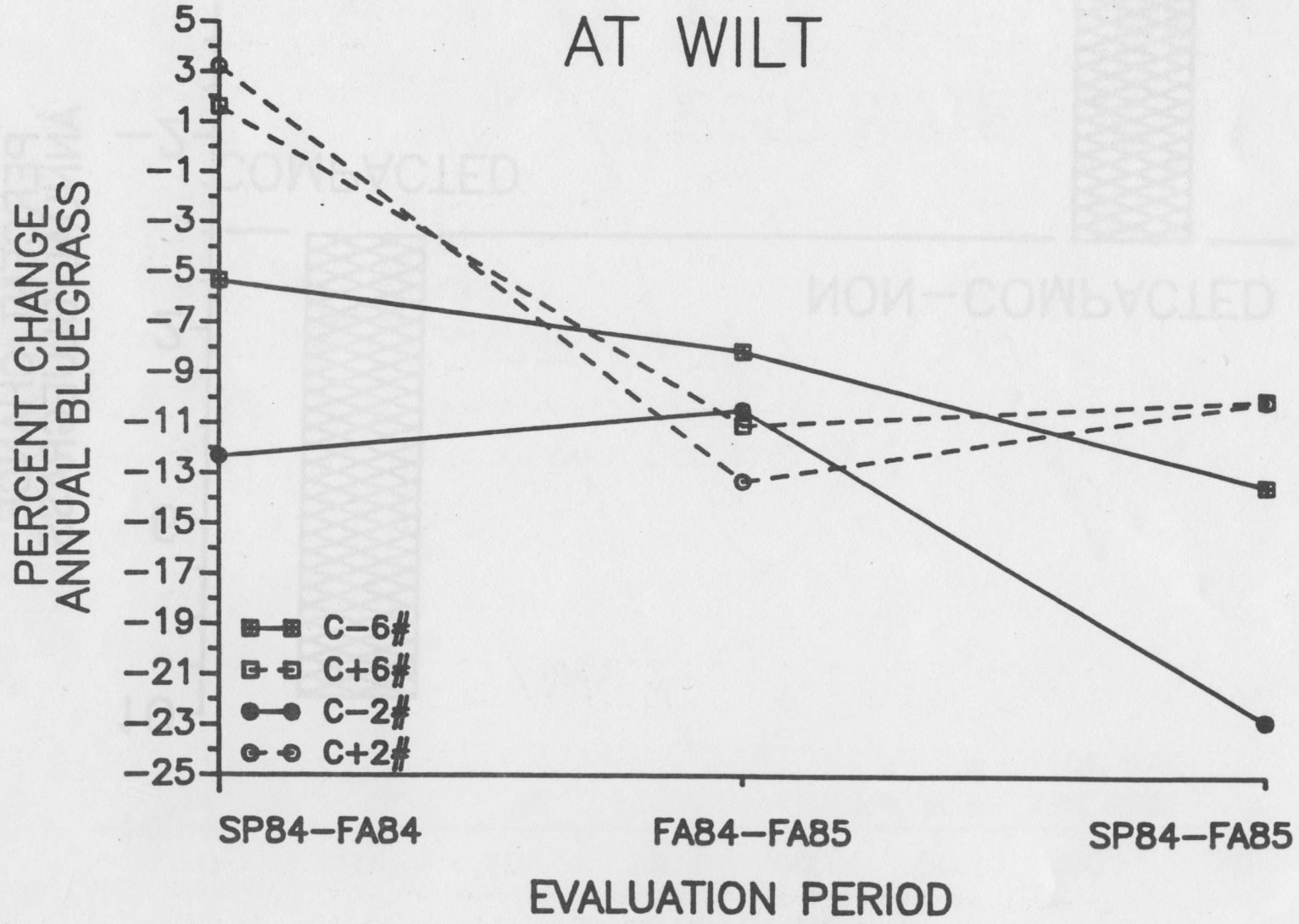


FIGURE 4. Effects of compaction on annual bluegrass population. 1985. Hancock Turfgrass Research Center, East Lansing, MI.

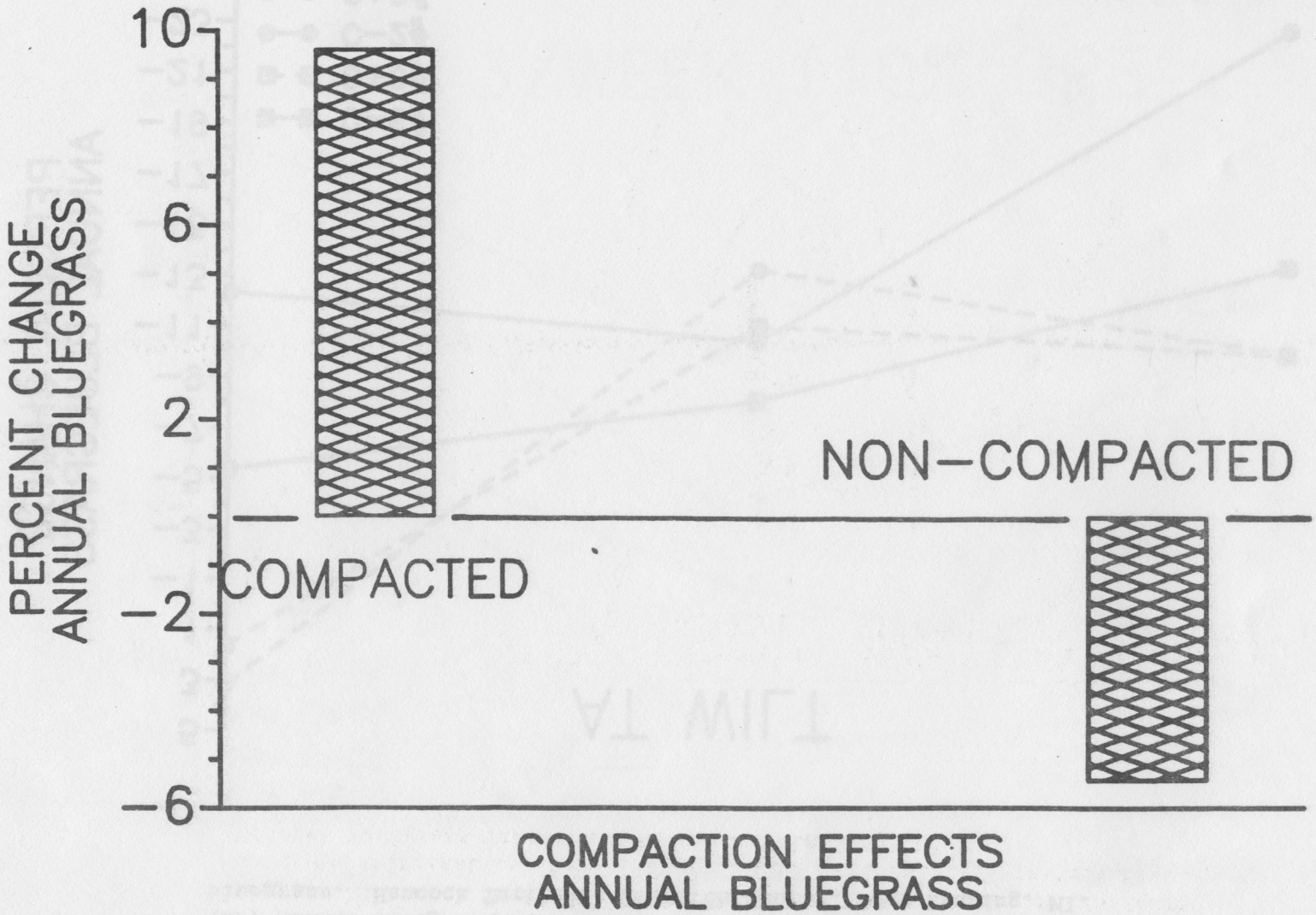
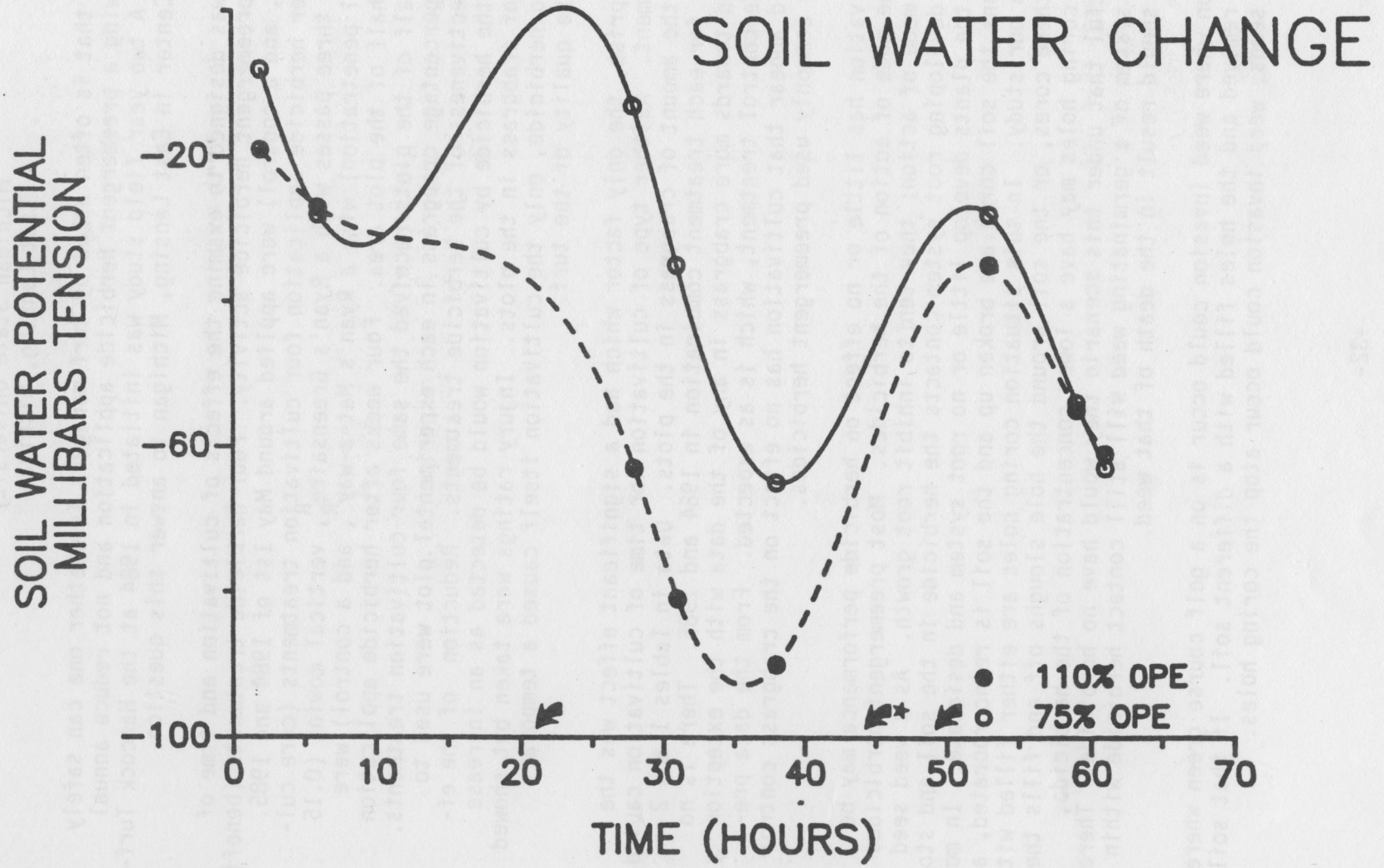


FIGURE 5. Effects of two irrigation treatments, 75 and 110% of open pan evaporation, on change in soil water potential over time. Time zero equals 9:00 a.m. June 28, 1985. Arrow and starred arrow indicate point of irrigation for 75% and 110% treatments, respectively. Hancock Turfgrass Research Center, East Lansing, MI.



EFFECTS OF CULTIVATION ON PREEMERGENT HERBICIDE ACTIVITY

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A question that is often asked by turf managers is whether one can safely cultivate following a preemergent herbicide application and not reduce annual grass control. A two year field study was initiated in 1984 at the Hancock Turfgrass Research Center in East Lansing, Michigan to answer this question.

The study was designed to examine the effects of cultivation and time of cultivation on preemergent herbicide activity. Four herbicide treatments (benefin, bensulide, DCPA, and a control) were applied around May 1st of 1984 and 1985. Immediately after herbicide application four cultivation treatments (core cultivation one or three passes with a Ryan's Greensaire®, vertical mowing (0.15 cm depth of soil penetration) with a Ryan's Mat-a-way®, and a control) were applied to one half of the plot area. Four weeks after herbicide application the other one half of the plots received the same four cultivation treatments. Evaluations of percentage crabgrass in each experimental plot were used to measure the effectiveness of the herbicide treatments. Reduction of the effectiveness of the herbicide by cultivation would be detected as an increase in the amounts of crabgrass in the plots. Injury ratings were taken but showed no effect due to herbicide, only the cultivation itself caused a temporary disruption in the quality of the turf.

To our surprise, the only factor which had a significant effect was the herbicide treatment. Neither type of cultivation nor time of cultivation caused an increase in the amount of crabgrass in the plots. Data in Tables 1 and 2 show the values for each treatment combination in 1984 and 1985. There is no observable trend towards more crabgrass in any of the data with the exception of the herbicide control treatment, which is as expected. From the data presented, it would appear that cultivation has no effect on the crabgrass control afforded by the commonly used preemergent herbicides.

That cultivation has little or no effect on herbicide performance may be explained by the mode of action of the herbicides. Most preemergent herbicides have a similar mode of action; they tend to inhibit root growth. As a weed seed germinates its developing root system contacts the herbicide in the soil and stops growing. Thus the plants develop little or no root system and desiccate. In most core cultivations the soil cores are broken up and the soil is reincorporated, as was the case in our study. In this situation coring holes are either filled with the soil from these cores, or the soil around the hole sloughs off and fills the hole. Thus the coring holes may have a lower concentration of the herbicide, but it is doubtful that under this scenario they would have no herbicide. Therefore, the root system of a germinating weed will still contact herbicide within the soil which should result in the death of that weed.

A situation where weed invasion could occur is on a golf course green where soil cores are removed and the holes filled with a different soil. If that soil contained weed seeds, weed invasion could occur atop the coring holes.

TABLE 1. EFFECT OF CULTIVATION, TIME OF CULTIVATION, AND PREEMERGENT HERBICIDE ON CRABGRASS POPULATIONS RATED AUGUST 15 1984.

	CULTIVATION TREATMENTS							
	At Herbicide Treatment				4 Weeks After Herbicide Treatment			
Herbicides	CC1X[+]	CC3X	VM	Control	CC1X	CC3X	VM	Control
DCPA	0≠	2	-	0	3	1	0	0
Bensulide	2	3	7	7	4	5	8	5
Benefin	5	3	5	7	2	8	4	7
Control	46	42	27	47	33	47	58	32

LSD(P=0.05)=17.9

[+] - CC1X, CC3X, VM, Control, Indicate core cultivation one pass, core cultivation three passes, vertical mowing, and no cultivation, respectively.

≠ - percentage crabgrass per treatment.

TABLE 2. EFFECT OF CULTIVATION, TIME OF CULTIVATION, AND PREEMERGENT HERBICIDE ON CRABGRASS PROPULATIONS RATED AUGUST 20, 1985.

	CULTIVATION TREATMENTS							
	At Herbicide Treatment				4 Weeks After Herbicide Treatment			
Herbicides	CC1X[+]	CC3X	VM	Control	CC1X	CC3X	VM	Control
DCPA	0≠	0	2	0	0	2	0	2
Bensulide	2	0	4	3	2	1	6	8
Benefin	1	1	2	2	4	6	2	3
Control	23	19	28	28	18	7	23	27

LSD(P=0.05)=10.7

[+] - CC1X, CC3X, VM, Control, Indicate core cultivation one pass, core cultivation three passes, vertical mowing, and no cultivation, respectively.

≠ - percentage crabgrass per treatment.

LIGHTWEIGHT MOWING... THE REST OF THE STORY

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Fairway mowing practices have come a long way since single unit putting green mowers were used on narrow approaches to greens in the early 1960's. One of the first superintendents to do this was Nelson Monacle at Portage Country Club in Akron, Ohio. There, bunkers shielded some greens to the extent that the approaches were almost too narrow for pull-behind gang mowers to navigate. Mr. Monacle simply continued the collar mowing height outward to the front of the bunkers, giving the fairway mowers a broad turning radius and eliminated the poor playing conditions immediately in front of the greens. This has evolved into widespread use of lightweight, self propelled 3- and 5-unit mowers today. In the regions where cool season grasses predominate on fairways, their use has encouraged the spread of bentgrass into areas long since colonized by Poa annua. The speed of this takeover action is amazing, far exceeding any expectation.

The credit for this sudden dominance has been given to reduced soil compaction and the collection of clippings practiced by many golf course superintendents. Weight reduction is not merely in using lighter weight machines, but in the pounds per square inch of the load bearing tires and mowing units exerted on the turf surface. It is incredible that this in itself allows soil to "de-comapct" in a short period of time. Recent research in agriculture has shown that simple freeze-thaw cycles in winter do little to benefit soil structure.[1]

The collection of clippings may help reduce the amount of viable Poa annua seeds returned to the soil for future infestations. Clipping removal may also lessen the 'mulching' effect they have in maintaining high humidity in the microclimate where the turf is growing, since the ideal habitat for disease development is disrupted to a degree.

Perhaps all three of these phenomena have a cumulative effect on helping bent growth be adequately assertive to invade Poa annua colonies. It is difficult to believe, however, that such rapid, radical population changes can be credited to these actions alone. After all, Poa annua is subject to the same disease stresses as bent, so reduction of the clipping mulch is beneficial to both species. If the Poa annua density is high and the bent density is high, of what immediate value is seed removal?

When bentgrass growth so rapidly invades Poa annua are we not seeing it achieve canopy dominance? The lightweight mowers "float" on the turf. This allows the lateral spread of bentgrass stolons to grow over the top of the more soil-bound Poa annua so that the takeover is from the top down. The roots formed at the stolon's nodes are quite functional in the surface thatch and as long as it is moist the bent runs happily along.

Now comes the problem. As the floating mowers ride over this growth, rather than through it as the heavier gang mowers did, fluffy turf growth, with the subsequent thatch development, is inevitable. Further, if most of the bentgrass roots are above the soil surface, just how stress resistant is that turf? The lightweights present the opportunity to achieve a long-sought goal, but a price must be paid.

The price is large area thatch management, through close irrigation control, thoughtful fertilization and cultivation. The most important part, from the start, is cultivation. Mechanical dethatching as we know it today is not yet a viable alternative on 25 acres or so of fairway turf. Cultivation, as valuable as it is, is still a hard sell in many golf operations, so preventive thatch management rather than curative renovation is the most sensible road to travel.

Turf cultivation means the use of aeration machinery. Hole punching and core dispersal are currently the most programmable thatch management operations. The machines vary widely, but core aeration is the goal. It accomplishes two important things. First, it creates a hole in the compacted soil surface which allows roots to grow downward into the soil. Perhaps more important, it provides a means for oxygen to enter the root zone. A root system cannot develop without it. Compacted soils reduce root growth because of inadequate air space, not excessive water.

The second benefit of core aeration is bringing soil to the surface which is usually rich in organisms capable of decomposing the thatch. Most of the microorganisms in natural soils subsist on dead things - plants and animals - both macroscopic and microscopic. When intermixed with the dead leaves, stems and roots in the turf, they can thrive if other conditions are right.

The other conditions, incidentally, include a little moisture and a near neutral pH level. The microorganisms cannot grow under totally dry conditions, but should not be soaking wet, either. Decomposition of organic matter generates some weak acids so light liming may be a great help in some instances. When in doubt, check the pH of the thatch layer. An old practice is to apply hydrated lime sparingly. This has nothing to do with changing the soil pH, just ameliorating the growth medium of the decomposition organisms. Thatch management is not aided by sulfur applications except perhaps under highly alkaline circumstances.

Core aeriation is not the best loved turf management practice on any golf course - by either the players or the maintenance staff. It is therefore a great deal easier for all concerned to being a thatch management program early on when large equipment, frequently used, will do an adequate job. Equipment sized for greens undoubtedly does a more thorough job, but it is very time consuming and requires several machines to accomplish the desired end. These add up to a very high cost which might be averted by preventive use of properly sized equipment.

Most fairway aeration machines do not have enough tines to cut enough cores with one pass over the area. But there's nothing wrong with going over a fairway several times - like four - if the turf is adequately rooted. Poorly rooted areas may require a different regime or the initial use of green-size machines until deeper roots are developed.

Core breakup and trash removal are constant problems associated with core aeration. Dragging with chain harrows, steel doormats or pieces of chain link fencing has been the standard procedure used to break up the cores and disperse the soil. Timing is critical on heavy soils, because if the cores are too wet, breakup is poor and a lot of mud is dragged around. If the cores become too dry they can't be broken up by drags at all. Some superintendents now use the verticut units in triplex putting green mowers for core breakup, after removing some of the blades. Others use an adaptation of large hammerknife mowers to do the job. Choice of equipment depends largely on the smoothness of the terrain.

The trash remaining on the surface must also be dealt with. Leaf sweepers and vacuums seem to do the best, although some superintendents simply blow the materials into the rough. The former seems to be the best overall.

A total program also must include turf recovery and prevention of weed establishment. Recovery should be initiated before the damage is done. Fertilizer should be applied a week or two prior to aeration so that all grasses are growing vigorously and their top growth and root growth are not inhibited. All that soil brought to the surface will provide escape for any number and type of undesirable seeds. They will certainly make the best of the opportunity, unless controlled by preemergence herbicides. Their application should immediately follow the cleanup operation.

Other post-aeration opportunists are cutworms, and other insects. The holes are delightfully adapted as daytime hiding places. If their presence is anticipated, the proper insecticides should be used. A proper insecticide is one which will control the surface or root feeders selectively and not seriously affect the earthworm population. These wonderful animals are the best thatch controllers, topdressers, and soil aerators we have, even though their castings are a problem in closely cut turf.

These comments are made not to discourage lightweight mowing of fairways to help bentgrass encroachment into Poa annua turf. They are simply a reminder that bentgrass requires a careful preventive maintenance to provide the high quality playing conditions that are expected of it. And remember that curative treatment of heavily thatched bentgrass turf is much,much worse.

Bentgrass is preferred to Poa annua because of its ability to withstand a wider range of environmental stress, especially those which occur during the golfing season. In general, bentgrass is more resistant to heat, drought, disease and salinity than annual bluegrass. It is also more cold tolerant. The playing qualities of the two species are quite similar when both are well maintained and in a vegetative mode of growth. Simply put, bentgrass is more dependable than Poa annua, even though it demands more stringent maintenance practices.

[1] Dickey, Elbert C.; Peterson, Thomas R.; Eisenhauer, Dean E. and Jasa, Paul J. Soil Compaction I - Where, how bad, a problem; Crops and Soils, August-September, 1985.

MANAGEMENT PRACTICES AFFECTING BENTGRASS PUTTING GREEN SPEED

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Putting green speed is a familiar and much discussed topic among golfers and golf course superintendents. With the introduction of the Stimpmeter in 1977 by the United States Golf Association, putting green speed could be measured rather than relying on the subjective judgments of golfers. The Stimpmeter was introduced to aid golf course superintendents in achieving a uniform speed among all greems on the course.

Unfortunately, the intended use of the Stimpmeter and the actual use are quite different. Instead of using the Stimpmeter to help achieve uniformity in speed among greens , Stimpmeter measurements are often used to force an increase in speed. The speed measured on a golf course is often compared to the guidelines established by the U.S.G.A. and to speed measured at other local courses. The prevailing opinion is that faster greens provide more of a challenge to the golfer and are better greens. Therefore, golf course superintendents are under increasing pressure to provide faster greens for play.

Before discussing putting green management and speed we should consider the notion that faster greens are better greens. A high quality putting green will have many attributes, one of which is a reasonable putting green speed. Each golf course should decide what is a reasonable speed for greens, based on the desires of the members, the amount of play the course receives, the money and equipment available to maintain the greens and the superintendent's knowledge and experience. In addition to a reasonable putting speed, a high quality green should be uniformly turfed and free of disruptions from disease and insects. The green should have a high shoot density of the desired species and individual leaves and tillers should be oriented vertically to eliminate graininess. Also, the green should offer some resiliency to shots played to it. Each of the attributes mentioned above contribute equally to a good golf green. To emphasize putting green speed at the expense of the other components of a good golf green would be a poor management strategy resulting in the diminished quality of the green.

With the above caution in mind we will proceed with a review of the results of a study conducted at Penn State University to determine the effect of management practices on putting green speed. All experiments were conducted on creeping bentgrass and speed was measured using a Stimpmeter.

Of all the factors evaluated,mowing height had greatest impact on speed. Three mowing heights, 2/32, 3/32, and 6/32 inch, were tested on a season long basis. It was demonstrated that as mowing height is lowered putting green speed increases. Putting green speed increased from an average of 7 feet 10 inches at 6/32 inch mowing height to 9 feet 11 inches at 3/32 inch mowing height to 10 feet 5 inches at 2/32 inch mowing height. For each 1/32 inch change in mowing

height putting green speed will change by approximately 8 inches in the opposite manner. An increase in mowing height will cause a decrease in speed while a decrease in mowing height will cause an increase in speed. It is very tempting to lower the mowing height to increase putting speed. Extremely low mowing heights should be avoided. At extremely low mowing heights shoot density will decline, weed encroachment will increase and the turf will be very susceptible to any stress.

Another interesting aspect of this research was the variation in putting speed from week to week. Speed will fluctuate from season to season and even day to day. These fluctuations are thought to be due to climatic and weather changes. It would be unreasonable to expect putting green speed to remain constant through an entire week, let alone an entire golfing season.

Regular mowing is an important tool in developing and maintaining a high quality putting green. Over a three month period it was found that as the number of mowings per week increased from three to seven, putting green speed also increased. However, with each increase in the number of days per week the turf was mowed the amount of the increase in putting green speed grew smaller. The practical significance of this is that a decrease in mowing frequency from 7 to 6 days a week will have a very minor long term effect on putting speed except on the day the green is left unmowed.

Double mowing is a common and effective way to increase putting green speed for a tournament. The maximum effect of double mowing is seen after three consecutive days of double mowing. When comparing single vs. double mowed research plots, one day of double mowing increased speed 4 inches, two consecutive days of double mowing increased speed 6 inches, and three consecutive days of double mowing increased speed about 8 inches. After three consecutive days of double mowing further consecutive days of double mowing only served to maintain the 8 inch gain in putting green speed. The day double mowing was stopped the 8 inch gain in putting speed was lost. If double mowing is to be used to increase speed for a tournament, to achieve maximum effect, double mowing should begin two days prior to the start of the tournament and continue for the length of the tournament.

Nitrogen fertility management is another key aspect of putting green maintenance. When trying to decide on the proper nitrogen level, putting green speed is one of the factors that should be considered. The relationship between nitrogen level and putting green speed is that for each pound of actual nitrogen applied per 1000 square feet during the season putting green speed will decrease approximately 4 inches. The decrease in speed is due to increased growth stimulated by nitrogen fertilization. The increased growth increases resistance to a rolling golf ball, causing a decrease in putting green speed.

Aerification and topdressing are two common practices necessary for proper putting green maintenance. Each practice has a dramatic effect on putting green speed. As expected, aerification without being followed by topdressing caused a decrease in putting green speed. Aerification with 1/4 inch diameter tines decreased speed 2 inches and aerification with 1/2 inch diameter tines decreased speed 5 inches. The decrease in speed due to aerification lasted 28 days when the aerification was not followed by topdressing.

Light and heavy topdressing, following aerification, decreased speed up to 5 and 9 inches, respectively, for eight days following topdressing. After eight days light and heavy topdressing increased speed up to 6 and 15 inches, respectively, for the next 21 days. Possible reasons for the increase in speed measured eight days after topdressing are that it took several days for the topdressing to work through the turf canopy down to the soil surface and over the eight day period excessive topdressing was picked up and removed by mowing.

Although aerification and topdressing initially cause a decrease in speed this does not mean these practices should be discontinued. Both aerification and topdressing are essential to maintaining a high quality putting green. The information presented here should be used to schedule aerification and topdressing operations when a short term decrease in speed will not be too disruptive to play. Topdressing is often used to increase putting speed for a tournament. If topdressing is used for this purpose schedule the topdressing application eight to ten days prior to the first day of the tournament so the maximum benefit of the topdressing is realized.

Some of the common management practices and their effect on speed have been discussed here. Uniform speed among all greens should be the goal of superintendents when using the Stimpmeter. If there is a demand for greater putting green speed it is important to remember that many factors affect speed and the overall management of the greens should be designed to increase putting green speed. It would be poor management to rely solely on a single management factor to alter the speed. Although there have been no long term studies on greens managed to maximize putting green speed, it appears that most management factors that increase speed diminish the quality of turf grown on the green.

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TURFGRASS WATER USE AND IRRIGATION SCHEDULING

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Turf managers are well aware of the need to implement proper irrigation practices. In order to implement these practices the turf manager must first understand the role of water in turfgrass plants, how much water is lost from a turf site, and which techniques are available to the turf manager to determine when to irrigate.

Water has a major role in all the physiological processes of a plant. The most obvious role of water in a plant is as a constituent of individual cells. As a constituent of a cell water performs the role of maintaining turgidity. When turgidity is lost, a plant wilts. About 80-90% of a plant, by weight, is water. Water is an essential component of the photosynthetic process, although only about 2% of the water taken up by a plant is used in photosynthesis. Water also serves as a catalyst for many reactions in the plant. Nutrients and carbohydrates are transported throughout the plant in a water medium. The physiological process that uses approximately 90% of the water taken up by a plant is transpiration. Transpiration is the process by which a plant cools itself. A plant without the capacity to cool itself will die due to a lethal buildup of heat.

Since 90% of the water taken up by turf is used for transpiration it is important to understand this process. Water is taken up by the roots and transported through the stem and into the leaves. On the leaf surfaces are small structures called stomata. Stomata are small pores in the leaf which can be opened and closed by the plant. Stomata are essential so CO_2 can move into the leaf to be used in photosynthesis. When stomata are open, water vapor from the leaf moves out into the atmosphere. The amount of water vapor moving out of the leaf is dependent on the amount of water vapor in the atmosphere. If the water vapor content of the atmosphere is low the potential for water loss through tranpiration is high. When atmospheric water vapor content is high, transpiration potential is low.

Environmental factors that favor a low transpiration rate, hence a low water use rate, are cool temperatures, cloudy, humid conditions and little or no wind. Those factors which favor a high transpiration rate, hence a high water use rate, are medium to high temperatures, low humidity, full sunlight and moderate wind.

It is very difficult to state accurately what the water use rate for a given turf site may be. Many factors influence water use rate including species and variety of turf, mowing height, mowing frequency, nitrogen fertility rate, level of potassium present and irrigation practices. As a broad generality, in many areas of the country on a "typical" day turf will use between 0.2 and 0.3 inches of water per day. In semi-arid regions turfgrass may use up to 0.45 to 0.55 inches of water per day.

Techniques to schedule irrigations for turfgrass areas can be broken down into three catagories; plant based, soil based and atmosphere based. The most common plant based irrigation scheduling technique is visual observation. The turf manager decides whether or not to irrigate based on turf color, signs of footprinting in the turf and evidence of wilt. To complement the visual observations a turf manager may use a probe to help determine the moisture content of the soil and listen to weather reports. There are several other plant based irrigation scheduling techniques that are primarily used by researchers and these include irrigation based on plant temperature, plant water potential and stomatal resistance.

There are numerous instruments to measure soil moisture content. The instrument that can be used most effectively on turf sites is a tensiometer. Tensiometers are fairly inexpensive and easy to use. They do require daily servicing and are accurate only for soils that have a fairly high moisture content. Research results from several universities around the country have shown irrigations scheduled by tensiometer to be more effective than irrigation based on a set schedule or relying on the turf manager's judgment and experience. Not only were tensiometers effective in reducing the amount of water paplied to the turf, there was no decline in turf quality.

The third catagory of irrigation scheduling techniques is based on atmospheric demand for water. Evaporation pans have been the most effective of the atmospheric methods for use on turf sites. An evaporation pan is an open, circular pan that is filled with water. The amount of water lost from the pan due to evaporation is measured daily. The amount of water used by a turfgrass stand is a certain percentage of the water lost from the evaporation pan. This amount of water can then be replaced to the turf system through irrigation. Research conducted in California has shown irrigation scheduling based on the use of an evaporation pan to result in a reduction in water applied to the turf without a decline in turf quality when compared to irrigations scheduled by a turf manager.

Since turf managers do have an awareness of the need to conserve water, an understanding of water use by turf will allow turf managers to make better informed decisions concerning their irrigation practices. Techniques are currently available to aid irrigation scheduling decisions and through research, the future will bring improved instruments and technologies to aid in irrigation scheduling.

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MASTER PLANNING FOR ATHLETIC FIELDS

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As the title suggests, PLAN AHEAD - not PLAN AHead. Make a five year construction and maintenance plan and stay as close to it as possible. Be flexible for changes that may need to be made. There are considerations to have while deciding on a plan:

1. Type of use - what sport(s)?

   a. Single purpose - easier to maintain (Dodger Stadium, Wrigley Field, most college and high school varsity fields)
   b. Multi purpose - harder to maintain (Mile High Stadium, Denver) adequate budget, PAT System, Movable left field stands
      Silver Dome, college, high school, Little League playing fields - you name it and it's played there at some time of the year.

2. You must balance expected results, available budget and level of use

3. Good design and maintenance mean:

   a. better footing for players
   b. fewer injuries
   c. truer bounce of balls
   d. aesthetics - prettier turf

4. Injuries are controlled by:

   a. proper planning and construction procedures
   b. use intensity
   c. past and present maintenance practices
   d. all of the above

5. What factors affect every athletic field?

   a. who is in charge? someone must be in charge. Little League is typical of no one in charge.
   b. in-house personnel, contractor personnel, or both?
   c. soil composition - 50% solid, 25% air, 25% water - 80% of all growing problems are soil associated.
   d. soil type
      1) drainage - Public Enemy #1
         a) on top
         b) internal
         c) seasonal water table
         d) soil survey,maybe available from some level of county government.

e. will athletic field soil be
   1) natural
   2) modified
   3) soilless (sand)
f. compaction - Public Enemy #2
   1) avoid - soilless
   2) relieve - core aerify or shattercore aerify
g. fertility - budget
   1) soil samples
   2) proper interpretation
h. turfgrass selection - even if <u>everything</u> else is done right, this makes or breaks the playing surface
   1) available fertilizer $'s
   2) drought, insect, disease and weed tolerance
   3) root and crown depth
   4) mixes or blends of seed
   5) retain tag from seed bag for records
   6) sod, lay properly and butt
i. thatch - too much is a problem
   1) 1/4-1/2" best
   2) relieve with core aerification
j. diseases
   1) what disease(s) can strike this variety at what time of year?
k. insects
   1) same as j.
l. weeds
   1) same as j.
m. irrigation - budget
   1) portable, hand labor
   2) in-ground automatic with moisture sensors
   3) somewhere in between
   4) proper coverage and rates
n. soil preparation
   1) crowned or flat field
   2) properly mix soil layers
   3) avoid layers at all costs
o. seed or sod
   1) cost effectiveness
   2) 1-1/2-2" soil base sod for immediate play
   3) sod - high, low or medium management varieties
p. five-year plan - fewer surprises
   1) core aerify
q. mowing heights
   1) must be predetermined according to sport and grass type
r. markers and bench areas
   1) heavy, heavy traffic
   2) how to protect them
s. band
   1) worse than sports teams on area(s) they traffic
   2) practice somewhere other than varsity or sport practice fields
t. figure out daily/weekly cost of field preparation.

u. practice fields get much, much more exposure
   1) 10 Pennsylvania high schools - one season
   2) 32,000 practice field exposures
   3) 3,300 varsity field exposures
   4) a 10-1 ratio
   5) therefore - improve both your varsity and practice fields
v. core aerify, core aerify, core aerify
w. keep complete records
x. where do you get the money when budgets are tight?
   1) sell the school board or other governing body
   2) boosters and parents
   3) fund raise
y. plan your plan and follow it as money allows
z. properly done you get a nice looking playing field that is a pleasure to play on and to watch - real "Curb Appeal".

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INDIANA COALITION FOR ENVIRONMENTAL CONCERN

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What is ICEC?

Let me give you a background sketch. A year ago at this conference, at the urging of Dick Kercher, a small group of representatives of the turf industry and lawn care company owners got together at an informal luncheon meeting to discuss the need for a statewide organization which would address the concerns and problems facing our businesses and the industry in general, including all pesticide users, manufacturers, and distributors. The concensus was unanimous; the need very definitely existed.

We then spent the next few months in our areas of the state talking to our constituents to determine if a real interest in the formation of such an organization existed beyond our small group. We met again on June 21, 1985. The feedback from all areas of the state was very positive. Interest and need for an organization did indeed exist. At this meeting we were informed that the Indiana State Chemist Office would encourage the formation of an organization of this type. Thus was born ICEC - Indiana Coalition for Environmental Concern. Officers were elected. President, Bob Kapp; Vice-president, Jeff Lefton; Directors: Jim Scheetz, Allen Wehr, Steve Frazier, Ned Kelly. Dr. Ray Freeborg was appointed Executive Director. Dick Kercher and Allen Boger serve the organization as advisors.

A meeting of all interested persons was held November 11, 1985 in Indianapolis with almost 60 persons in attendance. Again, the enthusiasm and support for a state organization was evident.

Where are we today?

The wheels have been put into motion to proceed with the incorporation of the organization. A newsletter is being put together and will be sent out to members and potential members on a regular basis. The object of the newsletter is to keep people informed of the activities of the organization, as well as to report the issues facing the industry that we must deal with both individually and as a group. We are striving to increase our membership and broaden our base so we have a strong unified association to deal with problems confronting the industry. One example would be the insurance problem we are all faced with right now. That is - there is no available pollution insurance. I am sure you are all aware this insurance is a prerequisite for the issuance of an applicators license. We are currently working with the state association of pest control operators, studying the possibility of forming a group for the purpose of obtaining pollution insurance. We are also working with an insurance company from Iowa in this regard.

They are to send us questionnaires to be distributed to our membership and completed by those companies or individuals who elect to participate so they can determine the risk factor involved with such a group. I ask anyone wishing to participate in an association insurance program to leave your name and address with me and we will make sure you receive a questionnarie to complete.

We also have another membership meeting scheduled for August 7, 1986 at the Holiday Inn North in Indianapolis. The meeting agenda and topics of discussion will be mailed to all interested persons as soon as they have been finalized.

Since the last meeting we have formulated our objectives. They are:

- To bring together persons engaged in the manufacture, marketing and/or application of pesticides.
- To educate the users of pesticides via training seminars and newsletters on the proper handling, application and storage of pesticides.
- To provide a forum for the discussion of public policy affecting pesticide uses and to gather and dissemiante public policy information of interest to the industry.
- To monitor, evaluate and contribute to local, county, state and federal regulations and legislation.
- To maintain a business climate conducive to growth and prosperity and to support educational programs and related activities which maintain and improve the interests of the industry.
- To maintain a liaison with regulatory agencies and to assist these agencies in the performance of their duties.

Why should I belong?

It is true we are not all faced with the same situations in our various geographical areas. They vary from the highly urbanized areas to the more rural locations. However, what happens in a specific case and area can have a drastic impact and effect on the entire state and the industry within the state. We, as an industry, are faced with increasing scrutiny by various groups throughout the country. There are no guarantees we will not be challenged right here in our own state, in our own community, by misinformed groups who feel they have a cause or a concern. We must be prepared to answer their fears and concerns with truthful and accurate data and research. We as individuals do not have the resources to accomplish this task. As a group, well educated and trained in our profession, we can answer their allegations and put their fears to rest.

You may feel I am being overly dramatic or overly concerned, that it can't or won't happen in Indiana. Believe me, it can. All one has to do is look at the topics and headlines in the industry publications: "Water Quality - The 1986 Issue?"; "Regs Make It Rocky In Maine"; "Pollution Liability Exclusion - Industry Faces Uncertainty"; "LCO's Must Respond to Growing Legislation". News of more regulations, restrictions, proposed legislation at all levels of government cross my desk more frequently than ever before. What is next and where will it apply? The days of going it alone are gone forever. We must band together for survival of our own businesses and for the welfare of our industry.

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MIXER-LOADER, APPLICATOR AND RESIDENTIAL SITE USER EXPOSURE TO PHENOXY HERBICIDES

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Introduction

The continued growth of the lawn care industry has resulted in the increased use of herbicides. The increased potential for exposure to cause health problems is causing concern within the lawn care industry and in industrial and residential communities.

A recent report (1) concerning pesticide usage showed that pesticide sales in 1984 were 1.9 billion dollars, up from 1.2 billion in 1981. The increased sales have been attributed to the rapid growth of the lawn care industry. Indications are that the lawn care companies are among the leading users of pesticides. Twenty-two of the larger lawn care companies treat over 600,000 lawns per year, and the commercial lawn care industry continues to increase its use of pesticides in the treatment of residential lawns.

A major concern is related to the use of phenoxy herbicides such as 2,4-D and 2,4-DP to treat residential lawns. There is some evidence of skin irritation and/or eruptions encountered by applicators when 2,4-D or 2,4-DP is used in tank mixes with fertilizers such as liquid urea formaldehyde. More conclusive information on exposure to phenoxy herbicides is essential to properly evaluate risk potential to the lawn care applicator as well as to the home owner.

The objectives of this study were to measure both inhalation and dermal exposure potential of applicators during mixing and application and to measure the potential of residential site owners to remove phenoxy herbicide residues by foot traffic immediately after application and at four hours after application.

Materials and Methods

Tests were conducted with two liquid application commercial lawn care companies in Chicago, Illinois. The companies were selected to permit measurement of exposure potential following use of a high volume application 15.9 l m^{-2} (4.0 gallons/1,000 square feet) of water plus herbicide and fertilizer and a low volume 3.8 l m^{-2}, (1.0 gallon/1,000 square feet) of water plus herbicide and fertilizer.

Concentrations of 2,4-D phenoxy herbicide encountered via inhalation were determined using a Bendix Model, BDX44, personal air sampling pump. Air flow rates were established in the laboratory. Frequent checks of the rotometer flow rate and adjustments in rate were made in the field as needed to maintain a constant air flow volume throughout the study.

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The field monitor used to collect inhalation samples was a three-piece Gelman No. 4336 cassette with a cellulose support pad and NG4, 37 mm (0.8 pore size) Gelman membrane filter.

Dermal exposures were determined by adhering cotton absorbant pads either to the body or to the clothing. Estimates were made of body sites where the greatest exposure was expected and pads then placed at these sites. Hands were washed with isoproply alcohol to remove residues of 2,4-D after application and at the end of the day. Residential site owner exposure measurements were made by placing absorbant pads on the shoe sole and taking ten steps on the lawn immediately after application and again four hours after application at two different sites on each lawn. Pads were Johnson & Johnson cotton gauze sponges (HR1 8137-007-623). Gauze pads were folded 10.2 x 10.2 cm (104 sq. cm.) 12 ply. These were made from Type VII (20 x 12) gauze.

All studies were conducted under conditions considered normal for the application procedure. Field monitor cassettes with filters and exposed absorbant pads were collected immediately after completion of the work assignment and placed in sterile "Zwirl Pak" plastic bags and sealed. Bags were then placed in a cold temperature storage facility maintained at -12° C (10° F) until analysis.

Test 1

Cooperator: Tempo 21
Applicator: J. L. Troyer
Date of Application: 18 Sept. 1984
Herbicide: Phenban - Active ingredients:

- Dimethylamine Salt of 2,4-D Dichlorophenoxy-acetic acid	38.26%
- Dimethylamine Salt of Dicamba (3.6-dichloro-o-anesic acid)	5.00%
Inert ingredients	56.74%

Applicator equipment:

Truck with 1,000 gallon tank capacity. Operated by Meyer centrifugal pump. Tank filled to 550 gallons. This was made up of 115 gallons 13-4-6 fertilizer + 1.2 gallons of Phenban + 433.8 gallons of water.

Herbicide application rate was to be 1.02 oz. of formulation/1,000 sq.ft. Total volume of water and fertilizer + herbicide applied was 4.0 gallons per 1,000 sq.ft.

Weather: 18 Sept. 1984 - 8:30 am.m to 2:00 p.m.
Temperature - 62° to 68° F. (17° to 20° C).
Wind speed - 5-13 mph. (Note: When wind speed of 13 mph developed spraying was discontinued at 1:30 p.m.)
Clear to partly cloudy, 10% chance of rain.

Test 2

Cooperator - Nice N'Green
Applicator - Steve Mello
Date of application - 19 Sept. 1984
Herbicide - Phenban (same lab. no. and source as that used for Tempo 21 test).

Applicator equipment:
Model GMC 5-15 truck with 200 gallon tank. Operated by 12 volt electric pump. Tank filled with 168 gallons of water plus fertilizer. Fertilizer included 38.4 gallons fo 30-0-0 liquid urea formaldehyde. Also 181 oz. of Phenban herbicide. The remaining 89.9 gallons was water. Herbicide rate was 1.02 oz./1,000 sq. ft. Volume of water plus herbicide applied was 1 gallon/1,000 sq. ft.

Weather: 19 Sept. 1984 - 8:40 am.m to 3:20 p.m.
Temperature - 70-76° F (21° to 24° C)
Wind speed - 5-7 mph
Clear day.

Results

Table 1 - Inhalation and dermal exposure of two lawn care applicators to 2,4-D herbicide.

Exposure	Test 1	Test 2
	µg of 2,4-D ester	
Inhalation		
Mixer-loader	N.D.+	N.D.
Applicator	N.D.	N.D.
Blank	N.D.	N.D.
Dermal		
Mixer-loader		
Right wrist	62	80
Left wrist	120	N.D.
Applicator		
Right wrist	3000	23
Left wrsit	160	80
Chest - on shirt	130	220
Chest - on skin	16	36
Back - on shirt	5	60
Back - on skin	N.D.	8
Thigh - on pants (right)	1900	11,000
Thigh - on skin (right)	6	74
Thigh - on pants (left)	1900	16,000
Thigh - on skin (left)	33	N.D.
Right ankle - on skin	34	78
Left ankle - on skin	27	61
Shirt, external, top of left shoulder		45
Blank		N.D.

+N.D. = no detectable concentrations. The detection limit from gauze pads was 2 micrograms, assuming complete recovery from the pads. Detection limit for air inhalation was 0.5 ppm.

Table 2. Total 2,4-D ester removed from the hands following exposure.

Tempo 21	2.4-D $\mu g\ ml^{-1}$	2,4-D ml sample	2,4-D ester $\mu g\ sample^{-1}$
Mixer-loader			
Right hand	4.6	65	299
Lef hand	6.6	75	495
Applicator			
Right hand	13.0	50	650
Left hand	13.4	110	1500
Nice N'Green			
Mixer-loader			
Right hand	1.6	65	104
Left hand	231.0	60	13,860
Applicator			
Right hand	2.9	85	246.5
Left hand	N.D.	85	(2

Table 3. Total 2,4-D ester remobed from the hands following exposure

Site user exposure	
Site 1[+]	Total 2,4-D ester µg
Right sole (time 1A)	410
Left sole (time 1A)	470
Right sole (time 1B)[++]	350
Left sole (time 1B)	280
Site 2	
Right sole (time 2A)	34
Left sole (time 2A)	34
Right sole (time 2B)	47
Left sole (time 2B)	33
Blank	21

[+] Ten (10) steps were taken at these sites immediately after application

[++] Ten (10) steps were taken at these sites four hours after application.

Discussion

Mixer and Application Exposure

Inhalation exposure levels of 2,4-D ester were not detectable for either mixer-loader or applicator in either the high volume (Tempo 21) or low volume (Nice N' Green) application. (Table 1). Potential for inhalation exposure for the Nice N' Green mixer-loader was greatest as the mixing procedure at this site required handling the herbicide container with the Phenban® herbicide and pouring it into the spray tank prior to application. Although the potential for inhalaiton exposure was greatest for the mixer-loader at Nice N'Green, the actual measurements indicate no detectable inhalation levels of 2,4-D ester for the mixer-loader at either Nice N'Green or Tempo 21.

Dermal exposure measurements on the wrists, chest, back and ankle were relatively low compared to those pads placed on clothing. (Table 1). Pads on clothing had higher exposure levels than those placed directly on the skin at similar exposure sites as would be expected since the pads placed on the body proper were covered with clothing.

Greatest exposure was encountered on the hands as indicated by the hand wash with isopropyl alcohol (Table 2). The Nice N'Green mixer-loader had 100 µg 2,4-D ester on the left hand. The higher concentration on the left hand was attributed to spill during tank mix preparation. Following tank preparation the Nice N'Green mixer-loader washed his hands, then proceeded to the application phase. This may account, in part, for the non-detectable level measured on the applicator after the work was completed. Gloves were not worn at any time.

Thigh pads were placed on the inner thigh immediately below the scrotum. Thigh exposure, especially on the pants leg, was the highest whereas that actually getting to the skin was much reduced. For example, the Tempo 21 test showed 1900 µg 2,4-D ester on both the right and left pant legs. The actual dermal exposure levels were 6 and 33 µg 2,4-D ester on the right and left thighs, respectively. The exposure levels were 74 µg on the right and 16,00 µg ester on the left pant leg. The dermal exposure levels were 74 µg on the right and non-detectable on the left thigh. Thus the thigh area still appears to be the part of the body with the greatest exposure potential.

Throughout the Nice N'Green test there was evidence that the base of the spray gun had a small leak and drops would form and then fall. These would occasionally land on the pants lef of the applicator as he walked across a lawn. Therefore, by the end of the treatment cycle, the pants legs were saturated with the spray solution. Upon removal of the pants there was evidence of dermal irritation with eruptions on the lower thigh. The applicator stated that these had been developing over a period of time.

Position of Spray Hose

In addition to the above tests, a pad was placed on the shoulder of the Nice N'Green applicator where the hose is positioned during application. This site was selected because of the potential for exposure. In this test the amount on the pad was 45 µg 2,4-D ester indicating a lower level of contamination than was anticipated.

Resident Exposure

Immediately after application pads were placed on the right and left shoe soles and then ten steps were taken on the grass. This same test was repeated again at the same site four hours later.

Results show that the highest potential exposure is immediately after application with 410 µg 2,4-D ester on the right sole and 470 on the left following the Tempo 21 application and 350 on the right sole and 280 µg 2,4-D ester on the left sole following the Nice N'Green treatment (Table 3). Four hours later the Tempo 21 pick up was reduced by 92% to 34 µg for the left sole. The Nice N' Green treatments were reduced by 87% for the right and by 88% for the left sole. This would indicate that within a four hour period, under the weather conditions prevailing at the time the tests were made, there is a limited exposure potential for the homeowner. This was also observed by Thompson et.al. where only 5% of the 2,4-D originally applied could be dislodged with cheesecloth at day 0 (2).

Conclusion

As in previous tests the exposure potential via inhalation is minimal. Also, most body sites remain relatively free from exposure to the pesticide applied. The greatest exposure areas continue to be the hand, and to a lesser extent the wrist, and of greatest concern, the thigh-scrotal area. Dermal eruptions observed following low volume applications need to be investigated to determine cause and whether there is an increase in body burden of the pesticide and formaldehyde. This remains to be determined in future tests.

The dermal irritations observed appeared to be enhanced by a faulty spray gun rather than by differences between the high vs. low volume application. This should also be resolved with additional testing.

Literature Cited

1. Lawn Care Industry 9(5):12
2. Thompson, D. G., G. R. Stephenson, and M. K. Sears. 1984. Persistence, distribution, and dislodgeable residues of 2,4-D following application to turfgrass. Pesti. Sci. 15:353-360.

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PROTECTIVE CLOTHING

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Among the considerations in the use of pesticides is the use of the appropriate protective clothing. The motivation for use of such equipment is based in several areas.

The first is degree of risk. A greenhouse pesticide applicator is going to protect himself quite thoroughly due to his confinement. A spray applicator working on turf or an arborist spraying trees may, in most cases, not need much protection.

The second motivation is the product label. The Dursban® label calls for the use of goggles, respirator, long sleeved shirt, long-legged pants, rubber gloves and hat. On the other hand, the Diazinon AG500® label calls for the applicator not to breathe the spray mist, not to get it in his eyes or on the skin and clothing.

A third and somewhat complicated area is the possibility of exposure to a pesticide as it comes from the manufacturer's package or from spray mist. In general terms, organophosphorus carbamate insecticides are readily absorbed through the skin. The rate is differential according to where the pesticide residue falls. The hands and forearms show the slowest absorption rate while pesticide spilled or deposited in the thigh-scrotal area may be absorbed nearly as fast as drinking it. The face, ears and neck would fall somewhere in between. That little noticable effects from short term exposures are immediately sustained, provides no grounds for complacency. It is the long term, day after day, effects that should be of concern. Very few pesticides have been studied for their long-term effects on humans and it is precisely for this reason that care should be taken.

Surprisingly little is known about the degree to which various fabrics are resistant to the passage of pesticides. The rubber and synthetic laminate materials are doubtless doing a good job when they are worn. They are, however, thermally uncomfortable. The Federal Register (1974) describes protective clothing as "at least a clean hat with a brim, a clean long-sleeved shirt and long-legged trouser or a coverall garment, all of a closely woven fabric." Orlando (3) has shown that such fabrics actually facilitate pesticide penetration, but found that treating the same fabric with Scotchguard increased protection by 1.2 times that of untreated cotton fabric. Orlando further demonstrated that Tyvek® and Goretex® (synthetic fabrics) provided 25 times more resistance to the passage of pesticides than did untreated chambray.

An exposure study by Fenske (2) utilized a fluorescent dye mixed with the insecticide, Diazinon 50 WP. Using a long-wave ultraviolet light to detect exposure patterns on six orchard workers engaged in normal spray applications, insecticide residues were recorded with a high resolution television camera that was interfaced with a microcomputer. By this means, the amount of pesticide deposited, as well as its pattern of distribution on the body of the applicator, could be quantified and visualized. All six workers wore protective clothing. Measurable quantities of tracer were detected under the coveralls on five of the six men.

Complacency which can be brought about from the uneventful use of hazardous materials is something to be guarded aginst. The unexpected does happen. A study by Daniel and Freeborg (1) demonstrated that a granular insecticide formulation does not always result in reduced applicator exposure. They were surprised at the high levels of Diazinon (granular) deposited in the thigh-scrotal area of one worker as shown by the following data:

	Wrist		Thigh		
Test No.	Right	Left	Right	Left	Formulation
3	5.9	5.9	39	189	Emulsifiable
4	43.4	130.2	592	237	Granular

Amounts shown indicate micrograms per 100 sq.cm.

Further studies of this nature might suggest the regular use of a light-weight vinyl apron. The choice of when and whether to use protective clothing is, in most cases, still an arbitrary one, except where the product label is specific. While little is known about what fabrics resist the penetration of pesticides, there is a great deal of research accomplished that addresses the problem of pesticide exposure. The basic difficulty with that research is that not enough of it is being translated into terms meaningful to people who use pesticides. It is suggested that an organization such as the Midwest Regional Turf Foundation should devise its own protective clothing recommendations for people in turf care and landscaping industries. They need not be imposed as absolute, but would reflect the wisdom of industry leaders based on knowledge of the hazards involved. It's worth thinking about.

Selected References

1. Daniel, W. H., R. P. Freeborg, and V. J. Konopinski. Evaluation of the utilization of RPAR'd pesticides applied to residential and public turf sites and potential exposure to applicators. A paper given at the meetings of the American Chemical Society in St. Louis, Missouri, April, 1984.

2. Fenske, Richard A., John T. Leffingwell and Robert C. Spear, Evaluation of fluorescent tracer methodology for dermal exposure assessment. ACS Symposium Publication. September, 1984.

3. Orlando, J. et al. The penetration of formulated Guthion through selected fabrics. Journal of Environmental Science and Health, Volume B16, 1981, p. 617.

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Disposal of Small Quantities of Hazardous Materials

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In May 1985 Purdue University's Center for Public Policy and Public Administration received a $100,000 grant from the U. S. EPA to provide education and technical assistance to Indiana's small quantity hazardous waste generators. This assistance program was originated to explain how the amendments to the Resource Conservation and Recovery Act (RCRA) impacted newly regulated industry and to assist generators with questions concerning compliance with these new laws.

The 1984 Hazardous and Solid Waste Amendments to RCRA lowered the quantity exemption for hazardous waste generators. In short, these amendments regulated several thousand companies formerly exempt from regulation. If your company or business produces between 100 and 1,000 kilograms of non-acutely hazardous waste per month of operation, you are now regulated by the EPA. Several turf industries may be included in this group.

Steve Hansen, administrator of Indiana's Education and Technical Assistance Program for Small Quantity Hazardous Waste Generators, has spoken with several hundred generators falling within the 100 to 1,000 kilograms per month category and has developed a series of presentations specific to the industries of current interest. Mr . Hansen's program at the Midwest Regional Turf Conference held at Purdue University included generic information on the small quantity generator regulations and information specific to turfgrass managers.

Mr. Hansen explained the hazardous wastes typically produced by the turfgrass industry. These include:

- Pesticide containers not triple-rinsed
- Off-specification pesticides
- Pesticide formulation mixtures left over from tank mix preparation
- Contaminated soil from chemical spills
- Vehicle maintenance waste

He also explained how to determine if turf industries indeed did produce enough hazardous waste to fall wintin the 100 to 1,000 kilograms per month range. There was also a discussion of generators' liabilities, hazardous waste disposal options and other services available to small quantity generators in Indiana.

Mr. Hansen has additional educational materials and can be reached at:

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