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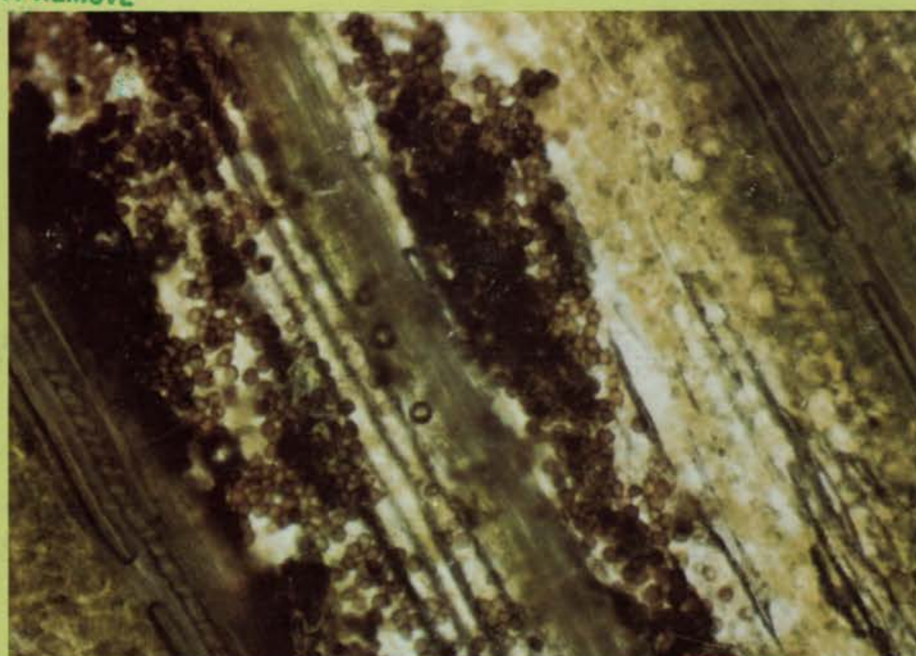

Stripe smut telespore masses

Female winter grain mite

Postemergent control of crabgrass

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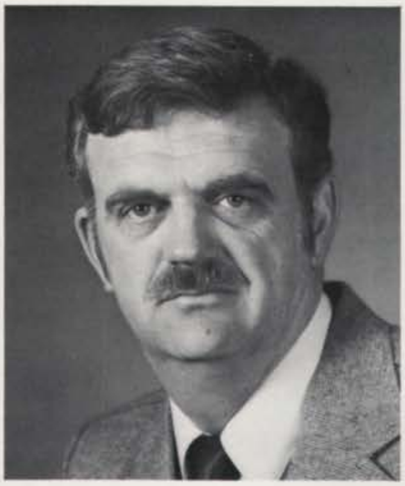
Stripe Smut

by Clinton F. Hodges



Clinton F. Hodges is a Professor of Horticulture and of Plant Pathology at Iowa State University. He received his B.S. in Horticulture and M.S. and Ph.D. in Plant Pathology at the University of Illinois. His research has concentrated on the epidemiology and physiology of leaf smut and Helminthosporium diseases of grasses. Research on leaf smuts has concentrated on their mode of establishment and spread in turf. Research on Helminthosporium has examined the interactions of light, nitrogen, fertilization, and herbicides with leaf spot development. Current research is involved with the physiology of Helminthosporium leaf spot development and its relationship to senescence processes in grasses. Other research involves the investigation of the physiology of morphological changes in grasses induced by leaf smuts.

The stripe smut disease of Kentucky bluegrass (Poa pratensis L.) is caused by the fungal pathogen Ustilago striiformis (West.) Niessl. The pathogen attacks the leaf blade and sheath of the plant and characteristically produces long sori (masses of teliospores) between the veins of the leaf (Fig. 1 and 2). When the teliospores of the sori have matured the epidermis of the leaf is ruptured and the teliospores fall to the soil. The rupturing of the epidermis causes the leaf blades to shred, turn straw colored, and curl at the tip (on uncut leaves).

The damage caused by stripe smut is often attributed to factors other than the causal pathogen. The reason for this is that stripe does not produce spectacular symptoms in a turf; it is generally characterized by a progressive decline in the density of the stand over a three to five year period after establishment of the turf from seed. The decline can be much faster if the turf is established from infected sod. The decline is characterized by areas of the turf gradually thinning. If the turf is intensely managed and mowed relatively high, the grass may appear some-

Fig. 1. Kentucky bluegrass (Poa pratensis) infected with stripe smut (Ustilago striiformis). The disease is characterized by masses of black teliospores (sori) that may extend the entire length of the leaf.

what uneven between mowings. This is due to an abnormal elongation of infected leaves (1). Close examination of infected plants in the affected areas will reveal sori in the leaves.

The symptoms of the disease are most noticeable in the cool periods of early spring and fall. Symptoms also are prevalent in midsummer on irrigated turf. The disease is most common in the northcentral and eastern portions of the U.S., and the severity of the disease generally increases from west to east in these regions. The disease also is common in portions of the Pacific northwest. For the custom lawn applicator, stripe smut presents a paradox. The desirable characteristics of a turf produced from fertilization and irrigation are primarily responsible for increasing the severity of stripe smut; in fact, without intense management, stripe smut rarely becomes a problem in turf. The remainder of this presentation is devoted to an explanation of how stripe smut gets started, how it becomes established in a turf, why it is favored by good management practices, and how the custom lawn applicator can contend with this disease.

THE INFECTION PROCESS

Ustilago striiformis possesses one of the most complex infection and disease cycles of known pathogens of Kentucky bluegrass. The teliospores of stripe smut fall to the soil surface and become soil-borne after rupturing the epidermis of infected leaves. It is at the soil surface where all primary infections (infection of healthy plants by germinating teliospores) occur. Unlike most fungal pathogens, U. striiformis cannot directly infect leaves or roots of grass plants. The germinating teliospores are restricted to infections of

Primary infection occurs at soil surface.

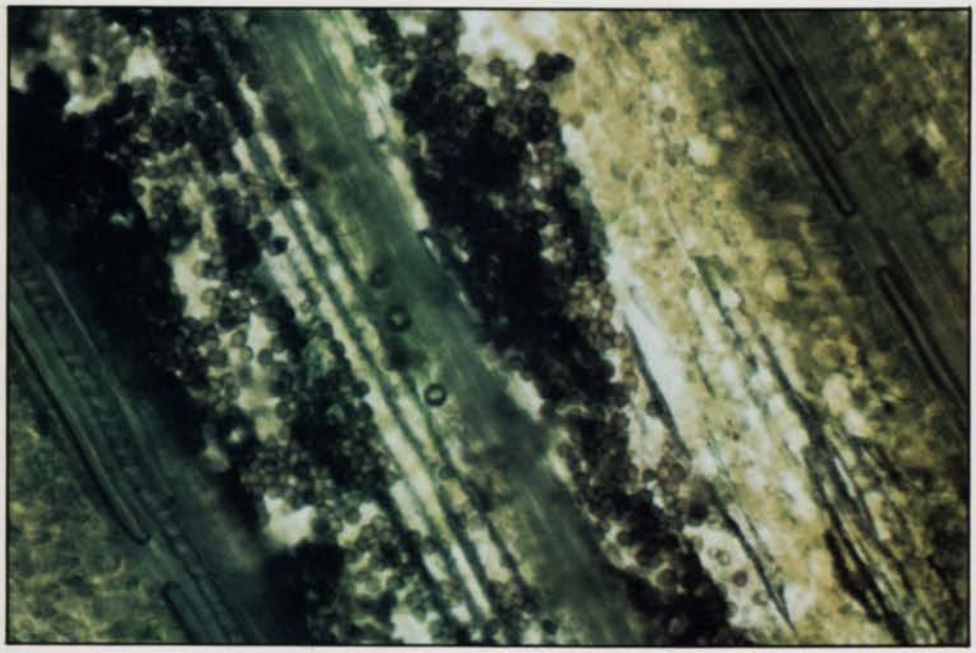


Fig. 2. Teliospore masses (sori) of Ustilago striiformis between the veins of an infected leaf.

the coleoptile (a sheath of tissue covering the first primordial leaf of a young seedling) and to axillary buds on the nodes of crowns and rhizomes (4). Primary infection by teliospores occurs only through growing points of the grass plant. This characteristic greatly restricts the ability of U. striiformis to establish infected plants. The coleoptile occurs only with germinating seed and is present only for a maximum of three days; hence, the number of primary infections via the coleoptile is relatively low. Most primary infection occurs through axillary buds on crowns and rhizomes of mature plants.

The restriction of primary infection to growing points would seem to substantially limit the number of plants infected in a given growing season. The primary infection process, however, is even more complex. The number of teliospores of U. striiformis capable of germinating at any given time is usually very low (a small fraction of 1.0%); teliospores may need a minimum resting period of 200 days

Fig 3. Germinating teliospores of Ustilago striiformis showing developing germ tubes (promycelia). Each promycelium consists of several cells each of which contain a single nucleus. Compatible nuclei from separate cells must be united to form binucleate infectious hyphae. Germinating teliospores infect only coleoptiles and axillary buds.

Stripe Smut

before any substantial germination is possible (7). When the teliospores germinate the germ-tube (or promycelium) consists of a number of cells, each of which contains a single nucleus (Fig. 3). When the germ-tube is in this nuclear condition it supposably is not infectious; two compatible nuclei from different cells of the germ-tube must be brought together in a single cell before the infection of a coleoptile or axillary bud can be achieved. This binucleate (or dikaryotic) mycelium is the infectious stage of the germinating teliospore that penetrates a coleoptile or axillary bud. The primary infection of Kentucky bluegrass by germinating teliospores of U. striiformis obviously is very complex and does not occur enmasse. This is, in part, why it takes several years for the disease to become epidemic and to start the decline of a Kentucky bluegrass turf.

THE ESTABLISHMENT OF DISEASED PLANTS

The slow rate at which primary infections occur seems incongruous with the ultimate ability of stripe to destroy a turf. How can such a specialized slow rate of primary infection result in serious disease? The answer to this question is that, once a primary infection has occurred through a coleoptile, or an axilliary bud, the mycelium of the pathogen grows into the crowns or nodes (on rhizomes) of infected plants. Once in the crowns or nodes, the mycelium proliferates (Fig. 4) and becomes systemic and perennial (5). Now the stage is set for rapid establishment of stripe-smutted plants. The systemic mycelium in the crown of an infected plant will grow into every leaf produced by that crown. More important, the systemic mycelium will grow into every axillary bud on the infected crown or rhizome node. The tillers and rhizomes produced from the infected crown or rhizome node. The tillers and rhizomes produced from the infected buds also are infected and subsequently established diseased plants. Thus, a large number of stripe-smutted plants can be produced

Primary infection is slow

from a small number of primary infections by teliospores. For example, let us assume that one plant is infected by a teliospore. During the growing season that one plant might produce ten infected tillers and rhizomes that establish ten diseased plants. Now as these ten diseased plants survive, they might produce another ten diseased plants each. It is possible, therefore, for a large number of diseased plants to be established from one primary infection via the systemic growth of the mycelium. The pathogen also is perennial; i.e., the systemic mycelium will survive in infected plants that overwinter and will start the cycle over in the spring.

THE EFFECT OF CULTURAL PRACTICES

The systemic and perennial character of U. striiformis in infected plants provides an efficient means of spreading the disease into new plants. However, in order for the disease to become epidemic, diseased plants must survive long enough to establish more diseased plants from tillers and rhizomes. This necessitates that a greater proportion of diseased plants survive in a given growing season than those that die. Under these circumstances, the turf gradually establishes a larger proportion of diseased plants from one season to another. At the same time more and more teliospores are being released from disease leaves to infest the soil and produce more primary infections. Even-

Fig. 4. Systemic and perennial mycelium of Ustilago striiformis (dark blue spots) proliferating in the crown tissue of Kentucky bluegrass. The mycelium will grow into each new leaf, tiller, and rhizome produced from the infected crown.

tually, the two mechanisms of infection; i.e., primary infection by teliospores and infection by systemic spread of mycelium into tillers and rhizomes, produce a large enough population of disease plants that the decline of the turf is set into motion. The number and death of diseased plants becomes greater than the rate of replacement by healthy plants.

There always exists some form of checks and balances in biological systems, and the development of stripe smut in a turf is no exception. Stripe-smutted Kentucky bluegrass plants are intolerant of drought (3) and high temperature (6). Most portions of the Kentucky bluegrass growing range are subject to midsummer drought and high temperature conditions which induce normal summer dormancy of this species. The majority of infected plants subjected to summer dormancy die; therefore, the increase in diseased plants in a low maintenance turf (little fertilization or irrigation) is substantially prevented. This is the primary reason that stripe smut rarely becomes a problem in a neglected turf. The implementation of management programs that stimulate a turf to grow throughout the growing season (via fertilization and irrigation) and prevent summer dormancy will contribute to the survival of diseased plants, and substantially increase the number of diseased plants from year to year. Hence, the paradox of good management practices being responsible for severe stripe smut damage in Kentucky bluegrass turf.

THE FEASIBILITY OF STRIPE SMUT CONTROL BY THE CUSTOM LAWN APPLICATOR

The control of stripe smut of Kentucky bluegrass is best facilitated by the use of relatively resistant cultivars, moderate cultural practices, and fungicides. There is a wide range of susceptibility to stripe smut infection among Kentucky bluegrass cultivars. Observations from our studies show Arboretum, Arista, Baron, Fylking, Merion, Newport, Olymprisp, Sydsport, and Windsor to be among the most susceptible cultivars (2). The relative susceptibility of cultivars is somewhat academic from the vantage point of the custom lawn applicator. More often than not, the cultivar, or mixture of cultivars, used in a turf serviced by the lawn applicator is unknown. If the cultivar is known, and if it is one of the more susceptible ones, the applicator can at least monitor the turf for a potential stripe smut problem.

The matter of cultural practices and stripe smut is perhaps most difficult for the custom lawn applicator. The lawn applicator is generally contracted with to maintain a lush, dense, green turf for the customer throughout

Do not over fertilize or irrigate turf infected with stripe smut

the growing season. It is these desirable characteristics of a turf that also enhance the systemic spread of the disease. Perhaps the only reasonable recommendation that can be made is to not over fertilize or irrigate turf where stripe smut exists. Both practices should be reduced to an acceptable minimum that results in a relatively slow but steady rate of growth.

It is apparent that the custom lawn applicator can do little about the cultivars present in a turf, or about the stimulatory nature of fertilization and irrigation, relative to stripe smut development. Stripe smut can be controlled, however, by several systemic fungicides primarily by preventing the systemic spread of the disease. The fact that the systemic spread of the disease occurs via tillers and rhizomes restricting the maximum rate of spread of the disease to the early spring and late fall when tiller and rhizomes production are at their maximums. Therefore, one or two applications of systemic fungicide, just

Stripe Smut

prior to tiller and rhizome initiation, in early spring and again in mid to late fall will greatly reduce the number of new smutted plants established by tillers and rhizomes. The systemic fungicides also will substantially reduce primary infections, most of which occur during the cooler periods of the spring and fall. Systemic fungicides shown to control stripe smut include benomyl (Tersan 1991), and the thiophanates (Cleary 3336, Fungo 50). It is generally recommended that the fungicides be applied at a rate of 6 to 8 oz. per 1000 sq. ft. and heavily watered into the top inch of the soil. There are four aspects of chemical control of stripe smut that the lawn applicator must heed. (i) The fungicides will be most effective when taken up by diseased plants before axillary buds have started to develop into tillers and rhizomes. The fungicide prevents the pathogen from growing into the bud and subsequently into the tiller or rhizome. Therefore, fungicides must be applied early in the spring and fall before the maximum rate of tiller and rhizome production is underway. If the fungicides are applied after this period less control is achieved. (ii) The fungicides must be heavily watered into the soil where they can be absorbed by the roots of the plants. If the fungicides are not adequately absorbed, control will be minimal. (iii) Do not expect eradication of stripe smut from the turf. A good fungicide program will contain stripe smut to the point where the number of diseased plants present will be minimal and not result in a decline in the quality of the turf. The program of control, however, must be continued year after year to prevent recurrence of the disease from the millions of teliospores deposited in the soil. (iv) Do not over apply the systemic fungicides. Use a single application in the spring and fall if possible, but do not exceed two applications in either season. There is some evidence that the stripe smut pathogen may have the ability to adapt to systemic fungicides, or to develop resistance to them (8). Over use of the fungicides may hasten these processes.

Do not over apply the systemic fungicides

OTHER LEAF SMUTS

Stripe smut is the most common and persistent of the leaf smuts of Kentucky bluegrass. However, occasionally flag smut also is encountered in Kentucky bluegrass. Flag smut is caused by Urocystis agropyri (Preuss) Schrot. and produces teliospore masses in the leaves like those produced by stripe smut. Flag smut, however, is a more severe pathogen of Kentucky bluegrass than stripe smut. Plants infected with flag smut have severely stunted root systems and produce very few rhizomes (1). The leaves of infected plants also are reduced in length. Most flag-smutted plants die in response to high temperatures and drought (3). Unlike stripe smut, intense cultural practices do not appreciably aid the survival of flag-smutted plants. Therefore, there is little increase of this disease by systemic spread of the pathogen into tillers and rhizomes. Most of the plants infected in a given season will die that same season. When flag smut appears it will generally kill the infected turf in irregularly shaped areas that vary in size. This is quite different from the slow decline induced by stripe smut. The areas killed by flag smut may not show the disease the following year, but once the disease has occurred in a given area it may recur several years later in the same location from the teliospores deposited in the soil. This characteristic may be related to a dormancy requirement for the soil-borne teliospores of flag smut. Because the leaf symptoms induced by stripe smut and flag smut cannot be distinguished in the field, it is necessary to identify the teliospores microscopically to determine which organism is present (Fig. 5). Both diseases can occur in the same turf. Flag smut can be contained by the same fungicide program used for stripe smut.

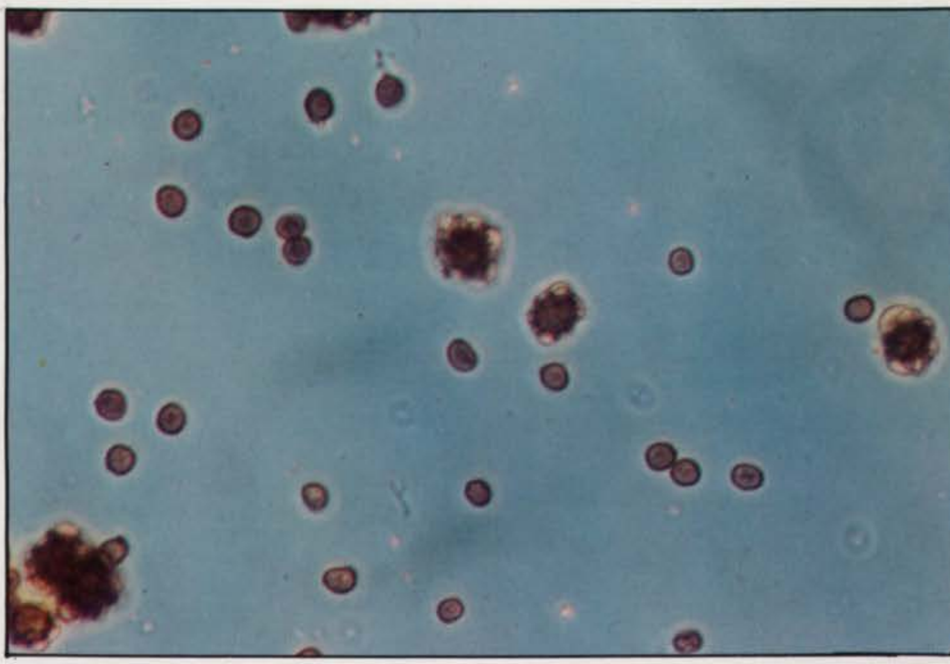


Fig. 5. Teliospores of Ustilago striiformis (stripe smut) and Urocystis agropyri (flag smut). The small teliospores of U. striiformis are easily distinguished from the large teliospores of U. agropyri under a microscope. Microscopic examination of teliospores is necessary to distinguish between stripe smut and flag smut.

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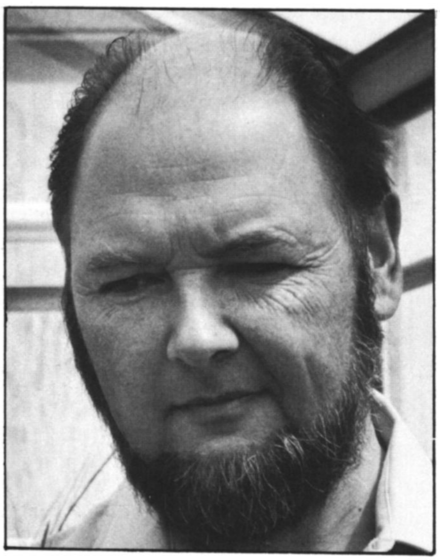
Part 1

Bluegrass Energy Distribution

by Richard J. Hull



Richard J. Hull is a Professor of Plant and Soil Science at the University of Rhode Island. He received his B.S. and M.S. degrees from the University of Rhode Island in agriculture and agronomy respectively and the Ph.D. in botany from the University of California at Davis. For five years, Dr. Hull studied the physiology of perennial weeds at Purdue University in Indiana. At Rhode Island, his research has concentrated on the nutrition of turfgrasses, woody ornamentals, and tidal salt marsh vegetation.

While lawn care operations are concentrated during those months usually regarded as the growing season, turfgrasses, being perennial plants, continue metabolic activity throughout the year. Evidence for this is the favorable response of cool season grasses to late fall fertilization. Powell et al. (1967) in studies at Virginia Polytechnic Institute were able to induce green-up of bentgrass and fescue turf by additions of nitrogen even during the coldest period of winter. They noted that stem carbohydrate content was not markedly reduced by winter nitrogen and net photosynthetic rates increased. Further north in Rhode Island, Wilkinson and Duff (1972) observed earlier spring green-up following late fall applications of nitrogen to Kentucky bluegrass turf. No measurable shoot growth was observed after late November or December fertilization but root absorption must have occurred during this time in order for spring growth to be stimulated.

The recognition of winter root growth in perennial grasses is not new. In 1941, Irene Stuckey observed cell divisions in the root tips of several pasture grasses during winter temperatures close to 0°C. At Beltsville, MD, Hanson and Juska (1961) measured a four-fold increase in Merion Kentucky bluegrass root weight between December 3 and April 6 following fall fertilization with nitrogen.

To those involved in lawn care, winter root activity provides an opportunity for efficient fertilizer application. Efficiency is increased because green color and nutrient absorption are stimulated; however, little additional shoot growth occurs so mowing demands are not increased. Also, weeds usually do not benefit from dormant season fertilization which means the turfgrasses are favored without contributing to weed competition. Labor use efficiency is also increased because

Figure 1

personnel needed to handle weed, insect and disease problems during the growing season can apply fertilizers when the schedule is less hectic. Of course, fertilizers should not be applied on snow or when the ground is frozen. If the fertilizer cannot enter the soil, root absorption will not occur and there is little evidence that roots grow or absorb nutrients in frozen ground.

This approach to turf fertilization appears to be agronomically sound and has been born out by field experience; however, a nagging problem remains unresolved. Root growth and nutrient uptake are both energy demanding processes. If the increased energy needs of fall fertilized grass are being met by utilizing carbohydrates stored during the previous season, the grass could enter the winter or resume spring growth in an energy depleted condition. This could result in increased winter kill or weakened spring regrowth. Such depleted grass would likely be more susceptible to disease attack and would not make sufficient spring recovery to enter the hot summer season in good condition.

Wilkinson and Duff (1972) observed some reduction in cold resistance of Kentucky bluegrass turf following fall fertilization but not enough to cause injury during most Rhode Island winters. The Virginia team (Powell et al. 1967) noted only slight reduction in stem carbohydrate content following winter fertilization and they speculated that increased photosynthetic rates might offset the greater energy demands resulting from stimulated root activity. They did not demonstrate photosynthate movement to roots in winter, however.

To further resolve this problem, we studied the annual energy distribution pattern in Merion Kentucky bluegrass grown in field plots managed under three fertility rates: 2.5-1-1, 5-2-2, and 10-4-4 lbs. of N, P_2O_5, and K_2O per 1000 sq. ft. per year. All plots received a portion of their nitrogen allotment in November: 1.5 and 2 lbs. per 1000 sq. ft. for the low and higher rates respectively. The phosphate and potassium were divided between April and September applications. Nitrogen was applied to the highest fertility plots at monthly intervals throughout the growing season, April through November. This resulted in lush dark green grass entering the winter season.

TABLE I. Net CO_2 fixation rates by Kentucky bluegrass turf managed at three fertility levels.

Fertilizer Rate	Date Measured: 8 June	18 July	8 August	14 December
lbs/1000 sq.ft.	mg $CO_2/m^2/min$			
2.5-1-1	36.3 b*	20.4 a	23.5 a	22.9 a
5-2-2	37.8 b	22.3 a	25.9 b	26.5 b
10-4-4	33.6 a	26.8 b	27.6 b	23.4 a

** Values in a column followed by the same letter are not significantly different at the 5% confidence level.*

Net photosynthetic rates were measured by placing a clear plexiglass chamber over the grass and monitoring the CO_2 decrease within the chamber by cycling the enclosed air through an infrared gas analyzer (Fig. 1). The chamber covered a 0.25 sq. meter (400 sq. inch) area of turf and was kept in place for 90 seconds while changes in the interior CO_2 content were measured. The initial slope of the CO_2 utilization curve was computed and used to calculate the net turfgrass photosynthetic rate expressed as mg CO_2 fixed per square meter of turf per minute. Measurements were made on bright cloudless days when variation in light intensity during the experimental period was minimal. The values obtained from this method provided a means of comparing net CO_2 fixation rates by field-grown turf subjected to various fertility regimes.

Typical photosynthetic rates obtained on three dates during the growing season and on December 14 are summarized in Table 1. Kentucky bluegrass turf was as photosynthetically active on a mild day in mid-December as it was in July and August. The greatest net CO_2 fixation rate was measured on June 8 indicating optimum conditions and healthy grass. During hot summer conditions net photosynthesis in Kentucky bluegrass declined because the high temperatures stimulated photorespiration (Watschke et al. 1972) which can release as CO_2 up to 50% of the primary photosynthetic product. Reduced photosynthetic efficiency during midsummer conditions is typical of cool season turfgrasses classified as C_4 plants (Krans et al. 1979). Such plants not only lose much of their photosynthetic output due to increased photorespiration but their CO_2 fixation reactions also become less efficient under high temperatures. This profoundly alters the energy available to turfgrass plants resulting in reduced shoot and root growth during hot weather. High nitrogen fertility stimulates shoot growth and provides a continuously renewed display of leaf tissue which results in greater net photosynthetic rates than in low fertility turf which grows little during midsummer (Table 1).

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"Bluegrass Energy Distribution" will be continued in the next issue.

Weed Control in Cool Season Turfgrass

by John A. Jagschitz

John A. Jagschitz, Associate Professor, Turf Research Farm, University of Rhode Island, Kingston, RI 02881.

Having a weed-free turf requires good management coupled with the use of efficient and safe herbicides. Maintaining dense, vigorously growing turf will help prevent weed invasion. When grasses become weak and turf thins, weeds can easily take over. To make grass grow at its best, use adapted and improved turfgrasses, properly fertilize, mow and water, control insects and diseases, reduce traffic, etc. If the cause of poor turf is not corrected, new weeds will take over again. Remember, weeds are the result of poor turf rather than the cause.

HERBICIDE USE

There are many herbicides and only a few are suitable for use in turfgrass. Select the herbicide that will kill the weed and not harm the grass. Follow the label directions and precautions and apply the herbicide properly. The pesticides listed in this article may be classified "for restricted use only" in accordance with regulations. It is unlawful to use any pesticide for other than the registered use. *Read and follow the label.* The trade names used in this article are for identification purposes and no product endorsement is implied, nor is discrimination intended against similar materials.

Using more herbicide than needed can injure the grass, however, sufficient material must be used or the weed will not be killed. Follow instructions to get the best results. Proper calibration of equipment is essential and the operator should be on the alert for potential disaster due to uneven distribution of the chemical. Apply herbicides so chemical drift will not damage other plants. Use herbicides when the wind is calm and reduce spray drift with low pressure and large size spray droplets. Careless use is not the fault of the herbicide; it is yours.

Selecting and using herbicides improperly can result in severe turf injury.

CHARCOAL TO REDUCE INJURY

Activated charcoal (GRO-SAFE) has been used on turfgrass to reduce injury from herbicide misuse, overdosage or spillage. The charcoal (300 lb/A) can be applied in water (500 gal/A) as a spray. The sooner the activated charcoal can be applied the better the chances for success. The charcoal particles must make physical contact with the chemical in order to be effective. Good results have been obtained where 2,4-D 2,4,5-T, bromoxynil, dicamba, endothall, linuron, silvex and simazine were used at excessive rates. Where toxic herbicide residues exist in soil and prevent safe seedings or inhibit sod establishment, charcoal can be added and raked into the soil. Improved grass stands have been obtained with charcoal in seedbeds which contain 2,4-D, amitrole, bandane, benefin, bensulide, DCPA, dicamba, endothall, mecoprop, nitralin, picloram, pronamide, prosulfalin, silvex, simazine and terbutol.

Proper equipment calibration and application techniques ensure good results.

Reduce herbicide injury from herbicide misuse, overdosage or spillage with charcoal.

Charcoal alleviated grass injury from "excess" rates of herbicides. Charcoal on left.

Beneficial effects of charcoal (right) used in seedbeds containing toxic herbicide residues.

Fumigants can kill weeds and weed seeds in soil before grass seedings (foreground treated)

Herbicides are useful for total vegetation control under cyclone fencing.

Renovation seedings can be aided by using herbicides that kill existing vegetation without interfering with grass establishment.

TOTAL PLANT KILL

Before a lawn is seeded weed control can begin. There are fumigants that kill weeds and weed seeds in the soil. Some of the fumigants in use are: methyl-bromide (DOWFUME), metham (VAPAM, VPM) and ethyl-isothiocyanate (VORLEX). They require warm soil temperatures to be effective. Depending on the material used and other factors, some seedings can safely be made within a few days while others may have to be delayed for 2 or 3 weeks. There are other materials that will kill vegetation and are useful for renovation purposes. These are helpful because they persist for only a short time in the soil and seeding within a few days is safe. Materials such as glyphosate (ROUNDUP) and paraquat (PARAQUAT CL) are useful for this purpose. These chemicals are also useful for spot treatment of weeds and for short term vegetative control under fences, around buildings, etc. If longer lasting residual kill is desired and there are no shrub or tree roots in the area, consider using materials which contain amitrole (AMIZINE) bromacil (HYVAR X), chlorates, diuron (KARMEX), hexazinone (VELPAR), prometon (PRAMITOL), and tebuthiuron (SPIKE). If possible water them gently or work them into the surface soil layer so rains will not wash them into lawn, shrub or garden areas.

WEED CONTROL IN SEEDLING TURF

In general, broadleaf herbicides are usually not safe to use in new seedings until the grass is several weeks old and has been mowed three or four times. Regular mowing will eliminate most annual broadleaf weeds. However, for heavy infestations, use bromoxynil (BROMINAL, BUCTRIL). It does not harm seedling grass and is most effective against broadleaf weeds in the seedling stage. In combination with dicamba (BANVEL), it will control a wider range of weeds. If nutsedge is also a problem, consider using bentazon (BASAGRAN) since it is very effective for nutsedge control and does provide some control of seedling broadleaf weeds. Bentazon is safe on most cool season seedling grasses with the possible exception of perennial ryegrass. In Rhode Island we have made some renovation seeding in athletic fields using a Jacobsen slicer-seeder and obtained safe seedings where we applied broadleaf herbicides 2 weeks before or just after seeding time. The herbicides included mixtures of 2,4-D with dicamba, mecoprop (MCPP) or silvex (2,4,5-TP). Normally it is best to wait about four weeks after herbicide use to make successful seedings. In one of the athletic field trials, the stand of knotweed was so competitive that grass establishment was negligible without herbicide use; however, treating seedling turf with these herbicides did result in the loss of some grass seedlings.

Weed Control


a. *Seeding renovation in area where vegetation has been killed (left "a" slide). Area one month later (right "b" slide).* *b*

Grass establishment after using herbicide for total vegetation kill and slicing machine seeding.

To control annual grasses such as crabgrass, a necessary step in spring or early summer seedings, use a herbicide called siduron (TUPERSAN). It is applied as a preemergent treatment to the surface of the seedbed after seeding and before the weedy grasses germinate or emerge. This is the easiest and most effective treatment for crabgrass control in new seedings If siduron is not used in the seedbed and crabgrass becomes competitive during grass establishment, postemergent treatments with methanearsonates (AMA, DSMA, MAMA, MSMA, etc.) alone or in combination with siduron or other preemergent herbicides should be used. Although some grass injury may develop or the establishment of the turf will be slower, the resultant grass stand should be considerably better than that obtained with competitive crabgrass. This topic will be discussed further under annual grass control in established turfgrass.

BROADLEAF WEED CONTROL IN ESTABLISHED TURF

Broadleaf weeds are best controlled in early fall or in the spring with postemergent herbicides. In early fall the grasses can fill the voids left by weeds before the crabgrass season in the following summer. To get the best control without turfgrass injury, the weeds and grass should be growing well at the time of treatment. Avoid the use of herbicides during drought or hot weather. Do not water or mow for at least 24 hours after treatment to allow the herbicide to enter the weed and kill it. To control most weeds use a mixture of 2,4-D with either one or two of the following: dicamba (BANVEL), dichlorprop

Regular mowing eliminates most annual broadleaf weeds in grass seeding.

Bromoxynil is safer than 2,4-D in new seedings where control of annual broadleaf weeds is desired.

Control of annual broadleaf weeds in grass seedings using Bromoxynil (note skip in center of picture).

Safe seeding in knotweed infested athletic field was obtained using a Jacobsen slicer-seeder where broadleaf herbicides were used before and at seeding time.

Control of broadleaf weeds in established turf is best obtained with a combination of herbicides (left).

Crabgrass control is essential in having a dense turf stand. Note crabgrass remains from previous year (right).

(2,4-DP), or mecoprop (MCPP). Combinations with high dicamba rates are very effective but require cautious use under trees or shrubs where root uptake may cause injury. This is more apt to develop if heavy rains occur soon after application and wash the dicamba to the root system. Mixtures containing dichlorprop may cause some injury to bentgrass. Knotweed and red sorrel may be controlled best with mixtures containing dicamba while oxalis may be controlled best with mixtures containing dichlorprop. DCPA (DACTHAL) has been effective for postemergent creeping speedwell control and preemergent control of prostrate spurge. Bromoxynil (BUCTRIL, BROMINAL) appears effective for postemergent control of prostrate spurge at a rate of 1 to 2 pounds per acre. With difficult to control broadleaf weeds apply a second application of the herbicide mixture about three weeks later to achieve better results.

ANNUAL GRASS CONTROL IN ESTABLISHED TURF

The easiest and best way to control annual grasses such as crabgrass is with preemergent herbicides. These are applied *before* crabgrass seed germinates and the plant emerges. They do not kill established crabgrass plants. Application is usually made in April or at the end of forsythia bloom. Good control has been provided by benefin (BALAN), bensulide (BETASAN, PRESAN, etc.), DCPA (DACTHAL), oxadiazon (RONSTAR) and siduron (TUPERSAN). Check the label as to the tolerance of various cool season turfgrasses to these herbicides. For example, oxadiazon is presently suggested for use

Easiest and best way to control crabgrass is with preemergent herbicides (right).

Crabgrass herbicides are evaluated annually at the R.I. Turf Research farm.

Annual preemergent herbicide applications since 1967 are being studied at R.I.

Weed Control

only in Kentucky bluegrass turf. One feature of oxadiazon is that it is very effective for goosegrass control. We have found bensulide and DCPA to perform well under conditions where crabgrass pressure and competition is extremely high and/or the germination period extends over several months. In some situations a second application at a one-half rate may provide better long term control.

Except for siduron, the preemergent crabgrass herbicides should not be used in seedbeds, on seedling turf, or where reseeding or sod installation is necessary within 2 or 3 months. As discussed earlier, use activated charcoal to help nullify harmful herbicide residues when some unforeseen situation makes it necessary to seed. We have obtained good crabgrass control with siduron even where some crabgrass plants (2 to 3 leaf stage) recently emerged from seed. If however, there are many crabgrass plants and they are taller than one-half inch, with more than three leaf blades, then it would be best to apply both a *pre-* and *post-* emergent herbicide. In young seedling turf siduron would be the recommended preemergent herbicide. We have had good results using one-half rate of siduron in seedling turf followed about four weeks later, when the turf is more mature, with one-half rate of any of the other four preemergent materials. The advantage of this could be cost savings as well as being able to choose a herbicide, such as bensulide or DCPA, which may have longer residual effectiveness. If the turf is mature, then choose any of the preemergent materials, keeping in mind the advantages and disadvantages of each.

There are several methanearsonates herbicides such as AMA, DSMA, MAMA, MSMA, etc. that can be used for postemergent control of crabgrass. They work most effectively on younger

Postemergent control of crabgrass (light green) in a Kentucky bluegrass lawn.

Selective control of nutsedge in cool season turfgrass is possible with herbicides.

Nutsedge is easily recognized when growing in Kentucky bluegrass turf.

plants and when used early in the season. One application along with the preemergent material should provide good seasonal control. If the crabgrass plants do not appear to be seriously injured after ten days then a second postemergent treatment should be made without delay. On mature crabgrass, and when used late in the season, two or three applications spaced 10 days apart are needed to achieve control. If the time interval exceeds 14 days it is possible for the crabgrass plants to survive the treatments. Some discoloration of cool season turfgrass is likely from the methanearsonate materials. These materials are also effective for nutsedge control, as is bentazon (BASAGRAN). Bentazon however, has little effect on crabgrass. Two applications of either material at low rates and at 10-day intervals are usually more effective for nutsedge control than a single application at higher rates. Nutsedge control is easier to achieve with early summer rather than spring treatments.

COMMENTS

Continued use, year after year, of preemergent herbicides for the prevention of crabgrass in turf areas may not be necessary. Research is presently being conducted in various states, such as New Jersey, Pennsylvania and Rhode Island, to learn more about this subject. Results may indicate that where excellent control of crabgrass is achieved for two or three years there is no need for further preventive herbicide programs. This could result in reduced herbicide use, savings in labor and energy and make for more efficient use of our resources.

Remember, if a dense vigorously growing stand of grass is maintained and herbicides are used judiciously, weeds should not be a major problem. Weeds do not cause poor turf; they are the result of it. A successful weed program will depend on good management and the proper use of herbicides. The information in this article was presented at the New Jersey Turfgrass Expo '80.

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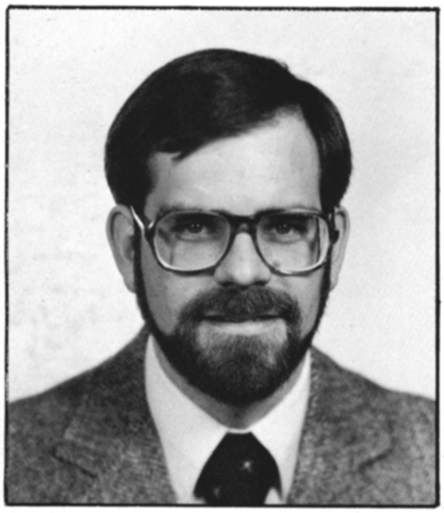
Crabgrass Control with Pre-Emergence Herbicides

by Dr. Peter H. Dernoeden, Ext. Turfgrass Spec., University of Maryland



Peter H. Dernoeden joined the Agronomy Department at the University of Maryland on February 11, 1980, as Assistant Professor of Turfgrass Science. Dr. Dernoeden will be responsible for extension and research in turfgrass management.

Dr. Dernoeden was born in 1948 and was raised in the greater Philadelphia area. In 1970 he was awarded a B.S. in Horticulture from Colorado State University. After working as an extension agent in Denver, he was called into the U.S. Army where he served as a field artillery surveyor for three years. Upon separation from the military he worked as a service specialist for a major sod producer in Colorado. In 1974 he returned to Colorado State University and earned an M.S. in Turfgrass Management. In 1980 he received his Ph.D. from the University of Rhode Island. His M.S. thesis dealt with cultivar resistance to drought in Kentucky bluegrass, and his Ph.D. thesis pertained to yellow tuft disease of turfgrasses.

Dr. Dernoeden is a member of the American Society of Agronomy, the American Phytopathological Society, Gamma Sigma Delta, Sigma Xi, and an alumnus of Alpha Gamma Rho. He is married and the father of one child.

Crabgrass (Digitaria sp.) is one of the most pernicious weeds in turf. The success of crabgrass, as a weed, can be attributed to several factors including the following: the ability of each plant to produce large numbers of seed; the ability of plants to persist through hot, dry environmental conditions, the same conditions which induce summer dormancy in many cool season turfgrasses; an efficient metabolism that enables plants to increase photosynthate production during periods of high temperature and high light intensities, while the capacity of cool season turfgrasses to produce photosynthate decreases; and the ability to rapidly colonize open areas in turf created by the injurious effects of disease, insects, compaction, wear, and environmental stress.

Any discussion of weed control should be prefaced by a consideration of how weed problems develop. Perhaps the most significant factor contributing to crabgrass encroachment in turf is poor management, which causes a reduction in turf density. Sunlight is required for germination of crabgrass seed, and also accelerates the germination process by warming soil. Therefore turfs having poor density are likely to develop crabgrass problems because sunlight will more easily penetrate a thinned canopy of leaves. This is corroborated by the general absence of crabgrass in dense, high cut turfs or turfs grown in shaded environments. Among the most prominent managerial abuses are: mowing too closely; light and frequent irrigation; and late spring-early summer fertilization.

Mowing a turf too closely leads to deterioration of stand density. Observations in a University of Maryland study have shown that tall fescue plots mown at 1 inch contained 70% weeds; whereas, plots mown at 3 inches had only 12% weeds. Hence, by increasing mowing height, weed encroachment can be greatly reduced. Light and frequent irrigations enhance crabgrass seed germination by ensuring that soil remains moistened for extended periods. By allowing soil to dry out between irrigations, crabgrass seed germination is inhibited. Application of fertilizer during late spring and early summer provides nutrients that may benefit weeds more at this time than the turfgrass. Also, application of high levels of nitrogen during this period may predispose turf to injury from heat and drought stress during summer. Other factors such as disease, insects and stress, that cause or contribute to loss of density promote crabgrass encroachment.

Poor density turfs are more likely to develop crabgrass

In spite of hard work and strict adherence to sound cultural practices, crabgrass frequently becomes a serious problem. For this reason, use of preemergence herbicides often becomes a necessity. Spring application of a preemergence herbicide is the most effective and easiest approach in controlling crabgrass. Postemergence control of crabgrass is usually not practical for lawn care companies, and is often too complicated for the homeowner. Postemergence control involves repeated applications of methanearsonates, e.g. DSMA and MSMA, on critical 5-10 day intervals. These compounds can be phytotoxic, especially when applied during hot weather. An alternative to methanearsonates is siduron. Siduron, however, is only effective as a postemergence herbicide when applied to crabgrass in the 1-3 leaf stage.

Crabgrass

Crabgrass seedlings
(Pre-emergent crabgrass seedlings)

Apply preemergent 1-2 weeks prior to germination

Crabgrass seeds begin germinating when soil temperatures rise above 60^{o} F, and when air temperatures rise above 65^{o}F for 5 consecutive days. Germination in northern regions generally begins mid to late May; however, in the transition zone, it can occur as early as mid-March. For a preemergence herbicide to be effective, it must be applied 1-2 weeks prior to germination. Most crabgrass seeds germinate during a 6-8 week period in late spring and early summer, but germination may continue as late as September. Preemergence herbicides kill crabgrass seedlings shortly after germination of the seed. Once substantial populations of seed have germinated, and first leaves have emerged, it is too late, except for siduron, to apply a preemergence herbicide.

Preemergence herbicides provide effective control for several weeks or months, depending upon dosage and product, by forming a continuous herbicide barrier in the soil. Once the barrier has been disturbed, efficacy of the herbicide is reduced or lost. It is therefore essential that cultivation practices, e.g. verticutting, aeration, dethatching, etc., be performed prior to application of a preemergence herbicide. Overseeding, like cultivation, must be completed and turf established before the herbicide is applied. A notable exception to this rule is siduron. Siduron, because of its selectivity can be safely used in the seedbed or on seedling turf.

Occasionally, overseeding becomes necessary before the preemergence herbicide has broken down and its activity lost. In this situation, it is better to seed into grooves using a slicer seeder than to broadcast the seed. The grooving operation will help disrupt the herbicide barrier and place the seed below, and out of contact with the herbicide. Some manufacturers recommend applying powdered activated charcoal 7 days prior to overseeding to help deactivate the herbicide.

The common names, trade names, formulations, recommended rates, minimum time before reseeding and other pertinent information regarding commercially available preemergence herbicides are listed in Table 1. The procedure and other information relative to application of these herbicides are listed in Table 2. All of these herbicides have been reported by several University researchers to provide good to excellent season long control of crabgrass using a single application of herbicide.

In Maryland, crabgrass seed germinates 3-6 weeks earlier than in more northern regions. For this reason, preemergence herbicides must be applied weeks earlier than in many other regions. Research, conducted during 1980 at the University of Maryland, indicated that a single application of oxadiazon or bensulide at recommended rates (4.0 and 7.6 lb ai/acre, respectively), provided excellent season long control of crabgrass. Reapplication of DCPA, at half rate (5.0 lb ai/acre), 7 weeks after the initial application at full rate (10 lb ai/acre) provided excellent control of crabgrasses, and reapplication of benefin at full rate (2.0 lb ai/acre) gave good control of crabgrass.

Table 1

Table 1. Rate, formulation and other information about preemergence herbicides.

Common Name	Trade Name(s)	Recommended Rate (lb ai/A)	Formulations*	Minimum Time Before Reseeding (weeks)	COMMENTS
Benefin	Balan	2.0	G	6	Not recommended for use on fine fescues or bentgrass turf. Use on established turf only.
Bensulide	Betasan Pre-san Lescosan Betamec Others	7.5-10.0	G, EC	16	Safe to use on all turfgrasses. Use on established turf only.
DCPA	Dacthal	10.0-10.5	G, WP	8	Not recommended for use on fine fescues or bentgrass turf. Use on established turf only.
Oxadiazon	Ronstar	4.0	G	16	Not recommended for use on fine fescue, bentgrass, and zoysiagrass turf. Use on established turf only.
Siduron	Tupersan	2-6 for Seedling turf 8-12 for Established turf	G, WP	N/A	Not recommended for use on bermudagrass or on several cultivars of bentgrass. May be applied at time of seeding or on seedling turf. Provides postemergence control of crabgrass in the 1-3 leaf stage.

*G=granular, EC=emulsifiable concentrate, WP=wettable powder.

Table 2

Table 2. The procedure for applying a preemergence herbicide and other information.

Apply at the recommended rate and be aware of sensitive turfgrass species (Table 1.)

Apply 1-2 weeks prior to crabgrass seed germination. Early spring, about the time when forsythia blooms begin to drop.

For uniformity of coverage, apply half the needed material in each of two directions at right angles.

Apply prior to a rain storm or irrigate with ¼" of water within 2-3 days of herbicide application.

After application, do not disturb the soil surface by cultivation practices. Sporting events may disrupt the soil surface and reduce efficacy of the herbicide.

Reapplication of some products, 6-8 weeks following the initial application, may be necessary to provide season long control of crabgrass in transition and southern regions.

Crabgrass Control

Reapplication of siduron at either half or full rate (6.0 and 12.0 lb ai/acre, respectively), did not provide an acceptable level of season long control of crabgrass. Test results vary from year to year and from region to region. Because of these variations, it is prudent to obtain recommendations based upon research conducted in your region. This information can be made available to you through the Cooperative Extension Service in your state.

SUMMARY

Crabgrass is an extremely important weed problem in lawn turf. Generally, crabgrass becomes a problem in turfs subjected to poor management practices, e.g. close mowing, frequent irrigation, excessive late spring -early summer fertilization. Crabgrass can be effectively controlled with preemergence herbicides. The success achieved is dependent upon proper timing of application, and non-disturbance of the herbicide barrier. The degree of crabgrass control provided by these herbicides may vary among products from year to year and from region to region.

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A Closer Look at Diseases and Pests

by Karl Danneberger, Karen K. Baker*and David L. Roberts

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Turf grass specialists often diagnose lawn and turfgrass insect and disease problems by examining symptoms in the field. However, diagnosis may require a device that will magnify the causal agent (insect, fungal fruiting structure, etc). For many specialists, a hand lens or a light microscope are used routinely. While the unaided human eye can resolve details as small as 1/125th of an inch, a hand lens can magnify 10-15 times and a light microscope can magnify an object from 2 to 1000 times allowing us to resolve even finer details. With the aid of two additional instruments, called electron microscopes, which can magnify up to 250,000 times, we can distinguish details as small as individual virus particles which are 0.0000000004th of an inch in diameter!

There are two types of electron microscopes; the transmission electron microscope (TEM) and the scanning electron microscope (SEM). Both operate much like a light microscope except that a beam of electrons is used instead of a beam of light. In a TEM, the beam of electrons is passed through a subject and a shadow picture is created. The SEM operates by passing the beam of electrons back and forth across the subject and collecting the signals which bounce off. These signals are transferred to a TV picture tube where they can be studied and photographed. All photographs from electron microscopes are in black and white, since color depends on the physical properties of visible light and both the TEM and SEM use no visible light, only electrons.

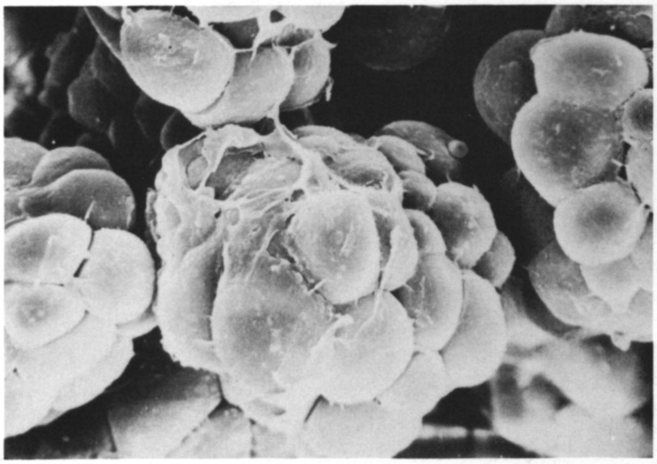
Insect pests and disease-causing fungi and bacteria make interesting subjects for electron microscopic studies. The great magnifying capability of the TEM and SEM allow us to see even the most minute details of the organisms which cause problems on plants. With the electron microscopes, scientists can study the insects and the injuries they inflict on plants, and the way in which fungi and bacteria infect and cause diseases in plants.

Acknowledgments: The authors thank Stan Flegler for taking the photographs of anthracnose.

Stripe smut (Ustilago striiformis)–SEM. Spore-filled pustule of the fungus breaking through the leaf surface of bentgrass. Magnified 150 times.

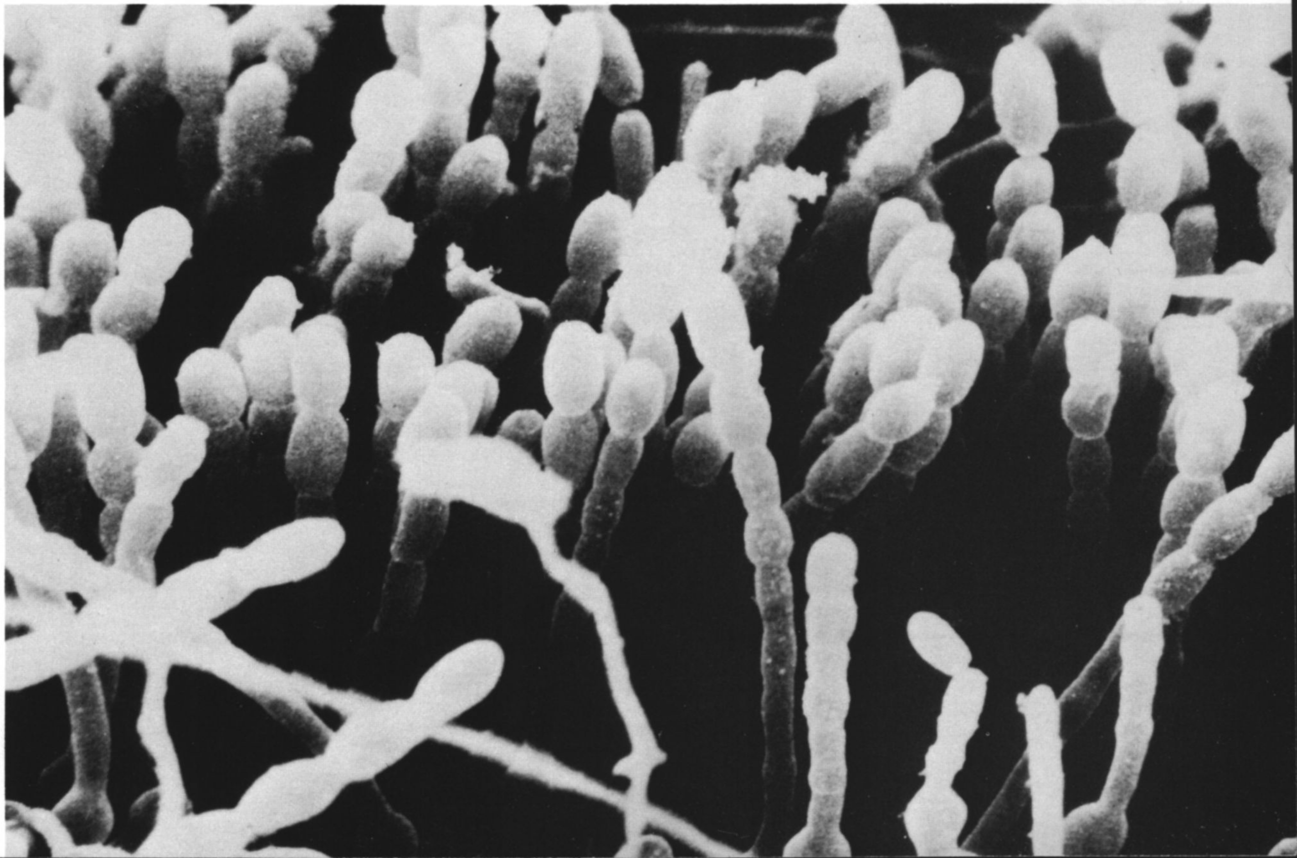
Stripe smut– SEM. Close-up view of the spiny fungus spores causing stripe smut. Magnified 940 times.

Flag smut (Urocystis agropyi)— SEM. Spore-filled pustule of the fungus breaking through the leaf blade of bentgrass. Magnified 110 times.



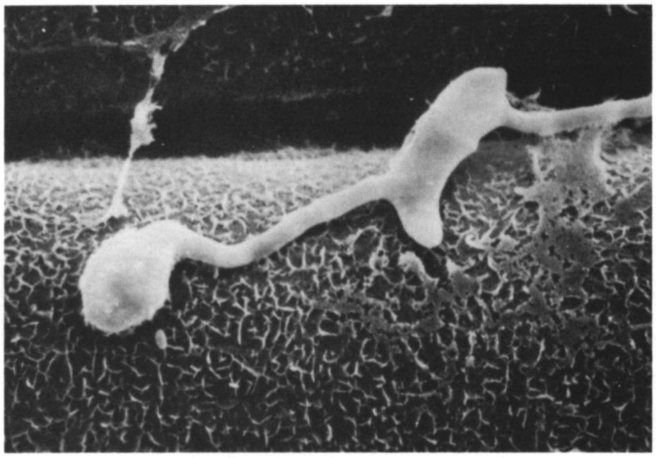
Flag smut— SEM. Close-up view of the spore balls of the fungus. Magnified 1200 times. The leaf symptom for both flag and stripe smut is purple striping of the leaf blade.

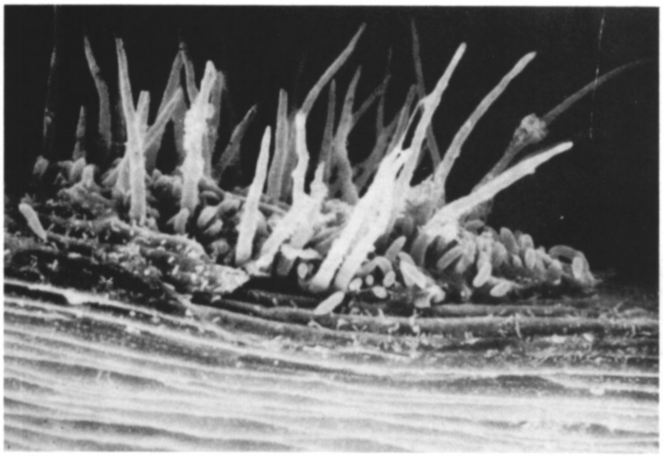
Powdery mildew (Erysiphe graminis)— SEM. Chains of fungus spores arising from infected surface cells of a grass leaf. Magnified 800 times. With this disease, leaves appear grayish-white due to the growth of the fungus and production of spores.



Diseases and Pests

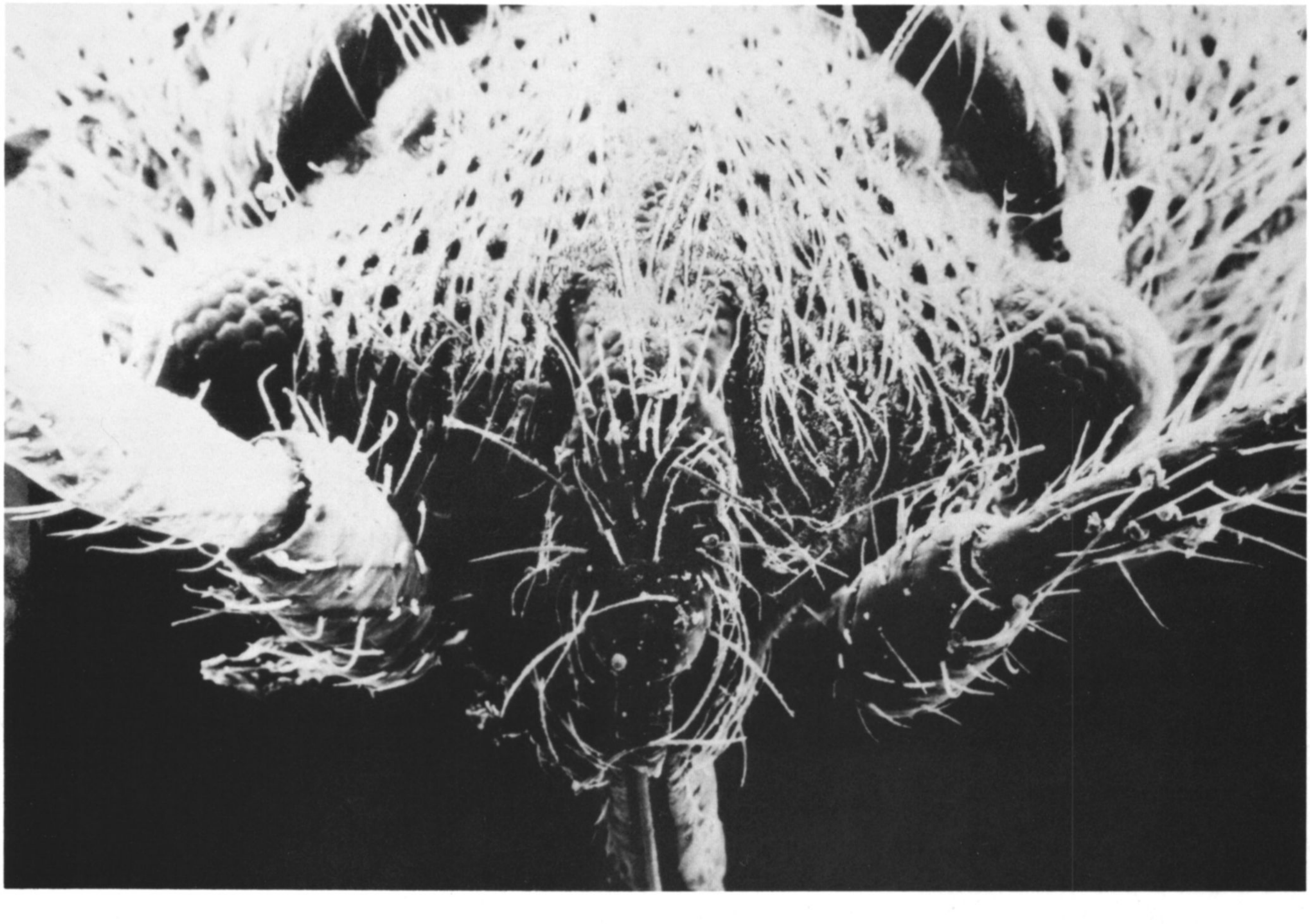
Fungus spore of Colletotrichum graminicola germinating on a leaf surface— SEM. Magnified 1000 times.

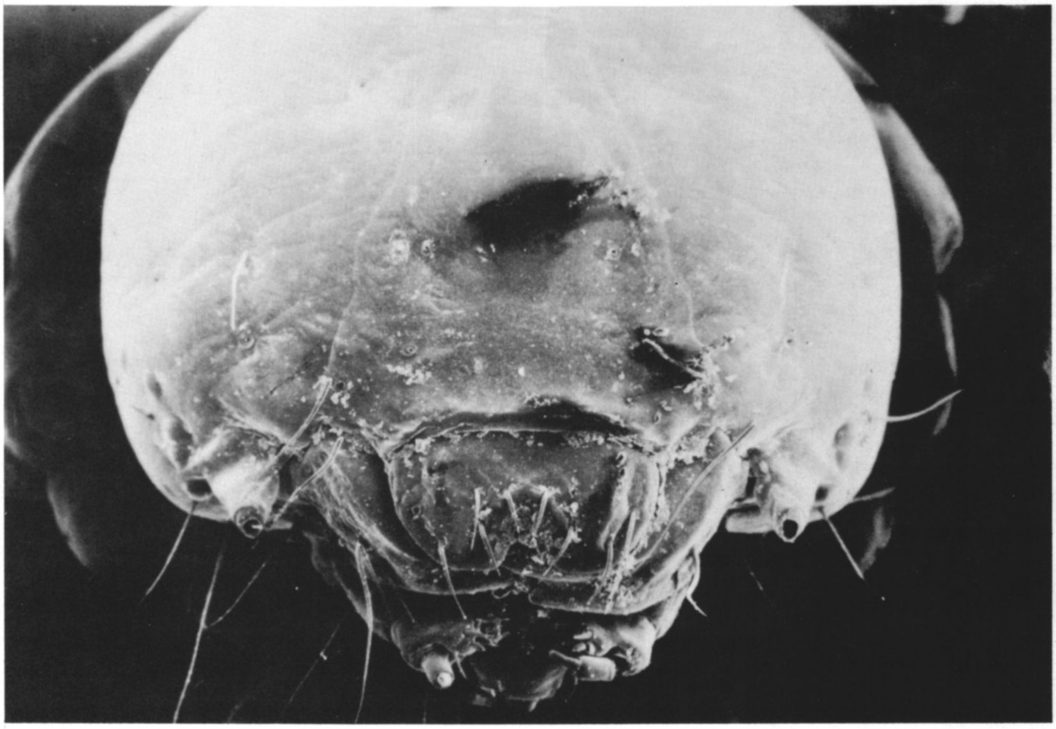




Anthracnose (Colletotrichum graminicola)— SEM. Fungus lesion of the surface of an annual bluegrass leaf blade showing spores in the fruiting structure. This fruiting structure, called an acervulus, is the main diagnostic characteristic of the disease. Magnified 200 times. The symptom for anthracnose is reddish-brown lesions on the leaves.

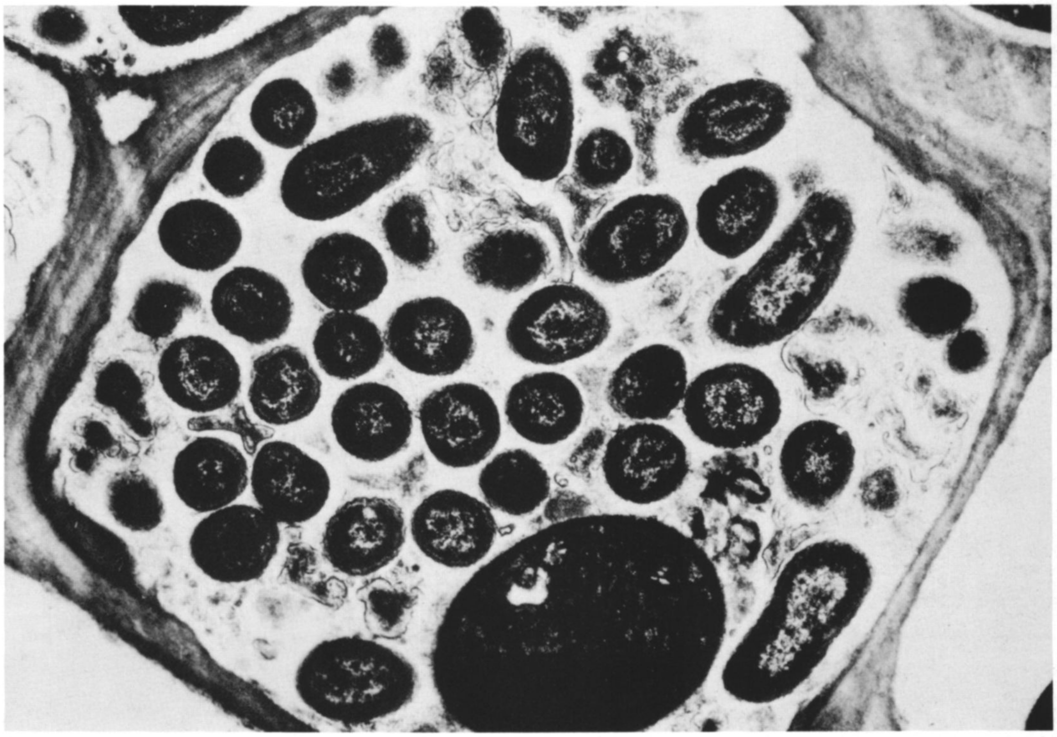
Chinch bug (Blissus sp)— SEM. Head of a chinch bug. Magnified 200 times. This is a sucking insect causing yellowing and eventual death of plants in affected areas. It is a problem most often encountered in bentgrass.





Sod webworm (Crambus sp.)– SEM. Head of a sod webworm. Magnified 34 times. This larval stage of moth feeds by chewing leaves off near the base of the plant. It is most commonly a problem in bluegrass lawns.

Cross section through bentgrass root cell filled with bacteria and a large fungus cell.– TEM. Magnified 17,000 times.



New Fusarium Blight Treatment

by Dr. Joseph M. Vargas, Jr.

Dr. Vargas received his Ph.D. degree from Oklahoma State University of Minnesota in 1968. He was assistant professor, botany and plant pathology, Michigan State University, 1968-74; assistant professor, Institute of Agricultural Technology, 1972-74; associate professor, 1974.

The debate among plant pathologists still goes on over the cause of the disease known as Fusarium blight. However, while the debate of the cause or causes of Fusarium blight goes on, a new chemical management tool has come on the market.

The fungicide is triadimefon which will be sold under the trade name of Bayleton. It has been one of the most effective fungicides for the management of Fusarium blight in research trials at several universities including Michigan State. Triadimefon is different from other Fusarium blight fungicides in that it is only effective when applied as a preventive treatment. Other Fusarium blight fungicides can be applied either preventively or curatively. This means if triadimefon is to be effective it must be applied to the turf before Fusarium blight symptoms appear or before the "frog eyes" from previous years become active again. This will vary from one location to another. One should check with the turfgrass experts in their area to determine the date when Fusarium blight normally occurs. Triadimefon should be applied 2-3 weeks prior to the time Fusarium blight symptoms normally occur.

Triadimefon must be applied before symptom appears

The exact rate for effective management of Fusarium blight with triadimefon are still being investigated. The test results range from 2 oz/1000 sq. ft. to 8 oz/1000 sq. ft. and from one to two applications/season. This should not be surprising considering the confusing nature of this disease. But even more important in explaining the rate difference may be the cultural regimes under which the Kentucky bluegrass was maintained. Kentucky bluegrass turfs maintained with good cultural practices should have milder outbreaks of Fusarium and, therefore, lower rates should be more effective in managing Fusarium blight. Fungicide treatments are far more effective for more diseases where good cultural practices for disease management are followed.

Good cultural practices for Fusarium blight management consist of nitrogen fertility in the summer months and light frequent irrigation during the warm weather. Kentucky bluegrass turf undergoing senescence (natural aging and dying) is more susceptible to Fusarium blight than those not undergoing senescence. Nitrogen fertility in

the summer helps prevent the Kentucky bluegrass from undergoing senescence. This goes against traditional beliefs of only applying nitrogen in the spring and the fall on Kentucky bluegrass and avoiding summer nitrogen application. However, these recommendations were based primarily on research demonstrating the times of year Kentucky bluegrass could best utilize the nitrogen coupled with data showing high rates of nitrogen makes Kentucky bluegrass more susceptible to heat and drought stress. This would all be relevant if your primary goal was "growing grass" but it isn't, or at least it shouldn't be. The primary goal of any turfgrass manager should be "maintaining turf". More explicitly maintain healthy, dense, pest-free turf. Whether the plant can better utilize the nitrogen in the spring and fall compared to the summer is not the point. The point is Kentucky bluegrass needs some nitrogen applications in the summer to avoid senescence and severe Fusarium blight outbreaks. While excess nitrogen, 2 to 3 lbs/mo. in the summer, may make Kentucky bluegrass more susceptible to heat and drought stress, 1/2 lb actual nitrogen in June, July, and August will not noticeably increase Kentucky bluegrass susceptibility to heat and drought stress and it will reduce its susceptibility to Fusarium blight.

Light frequent watering also goes against traditional beliefs of heavy infrequent irrigation to encourage deep root growth. The idea behind this is that the soil will dry from the top down and the turfgrass root will grow down in search of moisture. Heavy infrequent irrigation will encourage deep root penetration in the spring and fall when the soil temperatures are cool. However, regardless of how a turf is irrigated in the summer, the natural tendency of all turfgrass species is to have shorter roots in the summer when warm soil temperatures occur. Therefore, the argument for heavy, infrequent irrigation to encourage deep root growth in the summer is not valid.

Light, frequent irrigation does reduce the severity of Fusarium blight. Its action is probably three-fold. One, it supplies water to Fusarium blight infected plants that have only short root systems. Secondly, if applied at midday, helps cool the turf better enabling it to survive heat stress. The third effect may be the encouragement of microorganisms which are antagonistic to the Fusarium fungi or other precursors of Fusarium blight.

The lawn care industry now has a new fungicide for the management of Fusarium blight, triadimefon (Bayleton), to go along with the other fungicides Tersan 1991, Fungo 50 and Cleary's 3336. The main difference with triadimefon is that it must be applied preventively before Fusarium blight begins to develop. Regardless of which fungicide is used to manage Fusarium blight, it will be far more effective if it is incorporated with good cultural practices discussed above.

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Winter Grain Mite

by Herbert T. Streu

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The winter grain mite Penthaleus major (Duges) is a common and important pest of small grains and certain cool-season vegetables throughout the world. It is commonly reported damaging small grains in the western United States but has been only rarely recorded east of the Mississippi, even though the mite was first described in the U. S. in Washington D. C. by Banks in 1902 where he found it in early spring "on ground under stones and sticks".

Known by various common names, including the "red-legged earth mite" and the "blue oat mite", it has only recently been found damaging turfgrasses in the New Jersey (Streu and Gingrich 1972) and Ohio (Niemczyk 1978) even though bluegrass was listed as one of its hosts by Chada (1956) and 'Chewings' fescue was mentioned by Krantz (1957). The reason for its status as a "new" pest of turfgrasses lies in its unusual biology, differing in its life history and feeding habits from all other turf pests, that is, it feeds on the grass only during the cold winter season. Thus, the mites have not been noticed when populations are at their peak, and the damage inflicted has been ignored as some form of winter injury, or the work of early spring populations of the clover mite Bryobia praetiosa Koch.

Figure 1: Eggs of the winter grain mite attacted to a dead grass blade. Note the pinkish color and wrinkled egg surface.

In contrast to most insect and mite pests, the winter grain mite "oversummers" as an egg cemented or attached to dead grass blades, roots or other materials forming the components of the thatch. These oversummering eggs hatch in early October and develop through a series of juvenile stages into females by November. These first generation females, which reproduce without males, lay an average of one or two eggs a day for a total of 30 to 65 eggs during the egg-laying period, which lasts for 38 days.

Figure 2: Female winter grain mite. Note the red legs and dorsal anus on rear part of the mite's body.

The reddish-orange eggs are glued singly at the base of the grass plant, in the root systems, or in the thatch. Although newly deposited eggs are brightly colored with a smooth surface, within a day, the egg surface becomes wrinkled and opaque, perhaps the result of changes in the egg's adhesive coating.

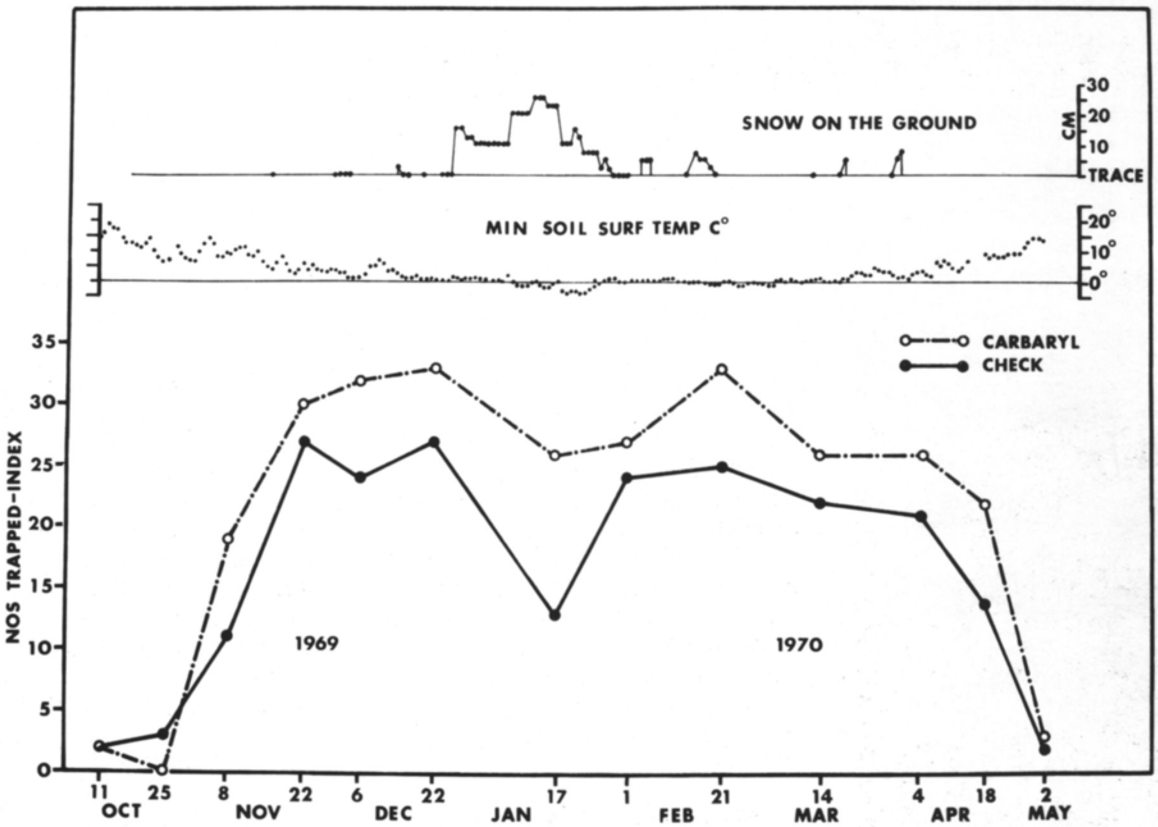

Figure 3: Seasonal activity of the winter grain mite recorded in New Jersey turfgrass plots during 1969-70. Note the higher populations recorded in plots summer-treated with carbaryl (Sevin). (From; Streu and Gingrich 1972).

As the eggs hatch, populations increase sharply during November, with all stages of mite present from early November until population decline in late April. Two generations a season have been reported, the spring generation of females depositing the oversummering eggs.

When first hatched, larvae are reddish-orange but as the mites develop through a series of nymphal stages the body darkens to dark brown or black with legs and mouthparts retaining the reddish-orange color. Adult mites are soft-bodied, black or dark greenish black with red-orange legs and mouthparts. There are two silvery eyes, one on each side of the front portion of the mites body. The most distinctive feature of the winter grain mite or "red legged earth mite" is the unique dorsal anus. Surrounded by a conspicuous reddish-orange spot, this cup-shaped structure is located on the top part of the rear portion of the mite's body and distinguishes the winter grain mite from all others found associated with cool season grasses. When the mite is disturbed, a droplet of amber colored liquid appears at the anal opening suggesting a form of defense mechanism.

Populations increase during November

Mite populations increase rapidly during November and early December to a peak of several thousands of individuals per square foot by late February or early March. During bright sunny days, the mites tend to cluster around the base of grass plants. The mites are most active at night or on dark cloudy days, or under a protective snow cover, feeding on grass blades and upper parts of the plants with rasping type mouthparts which remove plant cell contents. Severely damaged grass blades exhibit a typical silvered appearance caused by the loss of chlorophyll. Heavy mite feeding produces a scorched appearance from dessication of the plants. Heavily infested areas turn brown and appear

Winter Grain Mite

Figure 4: Winter grain mite injury on a blade of Kentucky bluegrass. White or silvered appearance due to loss of cell contents from mite feeding.

dead.

The most severe grass damage appears during mid-December through mid-March and corresponds with the highest mite populations. Thus, heavily damaged grass will appear "winter damaged" and will begin early spring growth considerably later than uninfested grass. As a result, heavy winter grain mite damage may contribute to increased grass susceptibility to diseases, insects and other stress factors.

Because mite populations are present and feed only during the winter months, and are not present when damage is most apparent, the pest status and damage caused has been largely overlooked until only recently. In 1978 Niemczyk reported that large populations of winter grain mites had produced what appeared to be winter dessication on Penncross bentgrass fairways in a golf course in Pennsylvania, and noted similar damage on bentgrass in a southern Ohio golf course. Since that time, Niemczyk has been working on pesticide efficacy and control of the mite at the Ohio Agricultural Research Center at Wooster, Ohio. As of this writing, however, no compounds are specifically labelled for winter grain mite control on turfgrass.

Streu and Gingrich (1972) reported that normal summer insecticide applications are ineffective in controlling mites. Rather, these authors found higher mite populations in plots summer-treated with carbaryl (Sevin) than in untreated or in diazinon, carbophenothion or ethion treated plots. They suggested that carbaryl may have reduced predator populations in the treated plots sufficiently to have resulted in the very high mite populations they found. Moreover, these data also suggest that winter grain mite over-

Mite populations are not present when damage is most apparent

summering eggs are not affected by summer applications of diazinon, carbophenothion or ethion, or perhaps other regularly used materials.

Niemczyk (1980, unpublished), however, has found that April applications of diazinon, Dursban or Proxol reduced winter grain mite populations by greater than 99 per cent five days after treatment (Table 1). However, no work has as yet been conducted to establish whether earlier (November) treatments might result in prevention of winter population buildup and thus prevent winter damage, or whether late (April) applications of pesticides were effective in killing the oversummering eggs produced by the spring generation of females.

Winter grain mites are apparently a serious pest of many of the cool season grasses grown in the North— bluegrasses and bentgrasses being the most susceptible to severe damage. Research data has shown that normal summer applications of many commonly-used insecticides registered for use on turf insect pests are ineffective in killing the oversummering eggs of this mite.

Nevertheless, work by Niemczyk over three years has shown that many of these materials, including diazinon, Dursban or Proxol, and perhaps others are effective in killing the active mite stages. Perhaps late November or early December applications of one of these materials will effectively control mite populations before they increase to the point of producing heavy spring damage— or the resistant oversummering eggs.

* * *

Figure 5: Winter grain mite injury on Ohio golf course fairway. (Courtesy H. Niemczyk)

Table 1. Application of various insecticides for control of the winter grain mite in turf. Cincinnati, Ohio– 1980. [a)]

INSECTICIDE[b)]	FORMULATION	RATE LB ai/A	W.G. MITES/FT^2 5 DAYS AFTER TREATMENT C)	% CONTROL
DIAZINON	4 EC	2.5	4.2 b	99.5
DURSBAN	4 EC	1.0	7.6 b	99.2
BENDIOCARB	76 WP	1.0	412.8 ab	53.9
SEVIN	80 S	8.8	351 ab	60.8
PROXOL	80 S	3.3	5.9 b	99.3
PROXOL	80 S	6.6	0 b	100
KELTHANE	35 W	0.67	347.6 ab	61.2
CHECK	-	-	895.7 a	-

a) From Niemczyk and Power (unpublished).

b) Treatments applied March 20, 1980. 10 ft. x 10 ft. plots replicated 4X. Volume of spray 1.23 gal/1000 ft^2.

c) Data taken March 25, 1980, based on 4, 4¼ in cup cutter samples from each plot. Means followed by the same letter are not significantly different according to Duncan's new multiple range test (5% level).

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Part 1

Postemergence Control of Summer Weeds[1]

by B. J. Johnson

B.J. Johnson is a professor in Agronomy and research project leader on management of herbicides for weed control in turfgrass at the Georgia Experiment Station, University of Georgia, at Experiment. He received his B.S. from Berry College, Rome, Georgia and M.S. in Agronomy from Texas A&M University. For the last 10 years he has conducted studies on management of herbicides for weed control in warm and cool-season turfgrasses. His major interest has been to evaluate herbicides using different management practices to determine the least amount of chemicals needed for effective control of summer and winter weeds. These results have been widely accepted. Mr. Johnson is a member of the Editorial Committee of Weed Science Society of America and member of Weed Science Society of America, American Society of Agronomy, Crop Science of America, The International Turfgrass Society and Gamma Sigma Delta.

No single management practice will automatically provide a good quality turf for home and business lawns. However, it is usually necessary to control weeds to have and maintain a good quality weed-free turf. It is just as important to select a herbicide that will not injure the turf as it is to select one that will kill weeds. Therefore, the selection of herbicides is important in the overall management program.

Summer weeds can emerge and grow during the spring and summer due to many reasons. Preemergence herbicide treatments may have failed to control weeds effectively from improper methods of application, unfavorable weather conditions, or turf area previously not treated. Regardless of the reasons, the emerged weeds should be controlled with herbicides to maintain an attractive turf.

CRABGRASS CONTROL

Crabgrass, a summer annual was effectively controlled with MSMA in bermudagrass turf (Table 1). The control was good (84 to 86%) from single treatment with 2.0 lb/A rate, but it was necessary to repeat treatments for excellent (94 to 99%) control. The response of crabgrass to MSMA is shown in Figure 1. In all instances, crabgrass control was lower as rates of MSMA were reduced from 2.0 lb/A to 0.5 lb/A. Thus, the importance of repeated treatments at lower rates becomes more apparent. It should be noted that MSMA at 2.0 lb/A did not control mature crabgrass effectively with a single application every year in our studies. Therefore, care should be taken to observe closely the performance of MSMA and be prepared to follow with an additional treatment when needed.

Figure 1. Crabgrass control with MSMA. Plot on right treated with two applications in July compared with untreated plot on the left. Picture was made 7 days after second application.

Select a herbicide that will not injure the turf

Combinations of MSMA with 2,4-D and applying the chemicals as a single tank-mixture did not significantly improve crabgrass control when compared with MSMA alone (Table 1). The combination treatment should only be used when broadleaf weeds are present in the turf areas. The MSMA + 2,4-D treatments will discolor bermudagrass slightly more within a few days after treatment than MSMA alone.

Highest crabgrass control was obtained when second MSMA treatment was made at 12-day intervals for the 1.0 lb/A rate and 12- to 19-day intervals for 1.5 and 2.0 lb/A rate (Table 2). The control was not acceptable from

1. Trade names are included for the benefit of the reader and do not imply any endorsement or preferential treatments. A herbicide may have more than one trade name and the one used is from the company furnishing the chemical. All herbicide rates are based on lb. material/A.

TABLE 1. Postemergence crabgrass control in bermudagrass with herbicide treatments. [a]

MSMA Treatments		Additional Herbicide Treatments		
			2,4-D lb ai/A	
Rates	Application	None	0.25	0.5
lb ai/A	No.	—	% Crabgrass control[b] —	
0.5	1	31	47	50
	2	71	84	86
1.0	1	65	77	76
	2	87	92	91
1.5	1	72	84	81
	2	91	98	95
2.0	1	84	86	86
	2	94	99	99

a. Treatments were applied to mature crabgrass and repeated applications were made at 7-day intervals. Ratings were made 4 to 5 weeks after first treatment.
b. Crabgrass control ratings are averages from 2 or 3 years and based on 0 = no control and 100 = complete control.

TABLE 2. Crabgrass control as affected by intervals between first and second MSMA treatments.[a]

Days between first and second application	MSMA rates lb ai/A			
	0.5	1.0	1.5	2.0
	----	% Crabgrass control[b]		----
4	51	67	73	79
8	56	68	78	83
12	56	91	99	99
16	45	76	93	99
19	40	82	98	99

a. Ratings are averages from 2 years and were made 3 weeks after the final treatment.
b. Crabgrass control ratings are based on 0 = no control and 100 = complete control.

0.5 lb/A rate regardless of second application. Repeated treatments closer than 12 days for 1.0, 1.5, or 2.0 lb/A resulted in lower crabgrass control when compared with repeated treatments made at 12 days. This probably occurred since crabgrass was in a severe yellowing stage during the first 8 days after the initial treatment and did not respond to the second treatment. By 12 days the chemical had reached its injury peak and crabgrass left in plots responded.

Goosegrass is one of the worst summer weed problems

These results indicate that MSMA can be used effectively for controlling crabgrass in bermudagrass turf. In general mature crabgrass was controlled better from 2.0 lb/A rate than when the chemical was applied at lower rates. Regardless of rate of application it was usually necessary to apply a second treatment approximately 12 days after the initial treatment. When MSMA is applied to immature crabgrass a single application may be all that is needed for effective control. It was observed in our studies that DSMA could be substituted for MSMA. However, it was necessary to increase the DSMA rate for effective control. For example, crabgrass control was generally equal from the 3.0 lb/A of DSMA when compared with MSMA at 2.0 lb/A.

GOOSEGRASS CONTROL

Goosegrass is one of the worst problem summer annual weeds that grow in bermudagrass turf. It readily competes with all turfgrasses since most

Summer Weeds

commonly used preemergence herbicides fail to provide adequate control.

The control of goosegrass was not satisfactory with MSMA treatments that normally controlled crabgrass. In order to obtain acceptable goosegrass control with MSMA, the rates had to be increased to 3.0 lb/A applied in each of two applications (Table 3). Even at this rate, goosegrass control was not consistent. Some years the control was better than others. When the weeds were not completely controlled, they would continue to grow and require repeated treatments.

In a later study we found that two applications of MSMA at 2.0 lb/A applied in combination with Sencor at 0.125 lb/A controlled 97% of mature goosegrass in common bermudagrass turf (Table 3). Similar control was obtained with two applications of Sencor applied alone at 0.5 lb/A. However, the advantage of combination treatments for goosegrass control is less initial turf injury and shorter recovery period than when treated with Sencor alone at higher rates. It was observed in our studies that goosegrass control was not as consistently good from MSMA + Sencor combinations when either (a) rate of Sencor was less than 0.125 lb/A or (b) when rate of MSMA was less than 2.0 lb/A. It should be noted that goosegrass was not effectively controlled from combinations of MSMA with Sencor when applied only as a single treatment.

TABLE 3. Goosegrass control and common bermudagrass injury as affected by herbicide treatments.

Treatments[a]			Goosegrass	Turf
Herbicide	Rate	Application	control[b]	Injury[c]
	lb ai/A	No.	%	%
MSMA	2.0	1	13	0
		2	58	0
	3.0	1	38	0
		2	86	0
Sencor	0.25	1	17	9
		2	63	30
	0.5	1	56	12
		2	98	31
MSMA		1	38	15
+ Sencor	2.0 + 1/8	2	97	19

a. Herbicides were applied to mature goosegrass in late July or early August and ratings were made 3 or 5 weeks after initial treatment.

b. Goosegrass control ratings are averages from 3 experiments over a 2-year period where 0 = no control and 100 = complete control.

c. Turf injury ratings were based on percentage of MSMA treatments where 0 equals MSMA treatments, 1 to 15 represents slight injury, 16 to 30 as moderate injury and above 30 as severe injury.

SEQUENTIAL TREATMENTS OF PREEMERGENCE AND POSTEMERGENCE HERBICIDES FOR GRASSY WEED CONTROL

It is often necessary to control summer weeds in the spring after they emerge. Since postemergence herbicides will not prevent germination of weeds, repeated postemergence treatments are usually necessary throughout spring and summer for effective control. To prevent repeated herbicide treatments, preemergence herbicides can be applied at the same time the postemergence treatments are made. Preemergence herbicides are those normally applied before emergence of weeds, but in this case, preemergence treatments prevent emergence of additional weeds after postemergence herbicide treatments control all emerged weeds. In most instances the preemergence and postemergence treatments can be applied as a single tank-mix application provided the chemicals are emulsifiable concentrates, flowables, or wettable powders.

Summer Weeds

MSMA at 2.0 lb/A and Sencor at 0.5 lb/A in each of two applications controlled 94% or more of the crabgrass (Table 4). There was no additional benefit in crabgrass control from sequential treatments of MSMA or Sencor at 0.5 lb/A with any of the preemergence treatments. Most preemergence herbicides do not have postemergence activity on crabgrass. However, the combination of Sencor at 1.0 lb/A with Betasan or Ronstar increased the overall control when compared with Sencor alone. There was no apparent emergence of additional crabgrass in any of the treated plots when ratings were made 10 weeks after treatment.

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"Postemergence Control of Summer Weeds" will be continued in the next issue.

TABLE 4. Effect of herbicide combination treatments on control of crabgrass and goosegrass.[a]

Herbicides for Postemergence control			Herbicides for preemergence control (lb ai/A			
Treatments	Rate	Application	Untreated check	Betasan 10.0	Ronstar 4.0	Balan 3.0
	lb ai/A	No.		% Control[b]		
				Crabgrass		
Untreated	–	–	0	0	0	0
MSMA	2.0	1	95	99	95	94
		2	99	99	100	99
Sencor	0.5	2	94	100	99	97
	1.0	1	84	94	93	86
				Goosegrass		
Untreated	–	–	0	0	0	0
MSMA	3.0	2	61	39	89	73
Sencor	0.5	2	98	96	100	96
	1.0	1	96	95	100	98

a. *Herbicides were applied in late spring as separate treatments.*
b. *Ratings were made in August and are averages from 2 years and based on 0 = no control and 100 = complete control.*

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Personnel Management in a Small Business

by Walter D. Wasilewski, Management Consultant

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RECRUITMENT AND SELECTION

Recruiting is a method of action taken by business management to attract candidates who have the abilities and attitudes needed to help the business achieve its objectives.

The labor market affects the employer's efforts to recruit. When there is a surplus of labor, as now, even poor methods of recruiting will probably attract more than enough applicants. However, service oriented businesses must always compete for the best candidates available.

The service enterprise must also consider Equal Employment Opportunities (EEO) guidelines in their selection process and advertisements. Ninety-six per cent of all businesses find that if federal laws don't apply, state laws do.

The recruiting process consists of matching the employer's needed qualifications with the candidate's abilities and attitudes. The candidate is hired only when sufficient overlap exists between these qualifications.

The small business person can easily have unrealistic expectations of potential employees. For example: they might expect applicants to have a BA in business, to be in the top of their class, to have the charm of Henry Kissinger, to have several years of experience (at $4.00 per hour), and be willing to work long hours.

In short, be realistic about what qualifications are needed by your business. Let's consider a few of the qualifications that could be considered for a lawn sprayer:

1. The ability to talk to people effectively.
2. A clean-cut, well-groomed appearance.
3. A good driving record.
4. A record of good attendance at prior employment.
5. A good attitude about oneself.

ADVERTISING FOR CANDIDATES

One of the most important points to remember when writing your advertisement is that you want to attract as many qualified candidates as possible. This will allow you to be selective when making your choice. At the same time, do not create false expectations in the minds of the applicants. For example:

Help Wanted— Male
EXECUTIVE CAREER OPPORTUNITY

Work at full salary while you learn with a national company large enough to provide wide open opportunity for unlimited growth and small enough to recognize and reward ambition and ability with increasing responsibility and salary. We have an effective training program so lack of experience is no problem. A high school education is enough but some college would be helpful.

If you have the ambition, we have the opportunity for you to prove it.

APPLY IN PERSON

A. Read the advertisement and indicate your reaction.
B. What type of job opportunity do you feel the advertisement entails?
C. What criticism do you have to make of this advertisement?
    1. Do you see the advertisement as a "come on" with little chance for meaningful advancement because of the lack of educational requirements?
    2. No applications would be received because no direction was given as to where to apply.
    3. The classification "Help Wanted— Male" could also become troublesome because sex discrimination could be alleged.

Now write your own advertisement and complete steps A-C. Again consider EEO guidelines in writing your advertisement.

SELECTION AND THE INTERVIEW

Many employers feel selection of employees will be an easy decision. Interview candidates, size them up, and

Personnel Management

then let your gut reaction guide your choice. Picking the candidate you like is an important step. Interview tools are designed to aid this gut reaction.

PRELIMINARY SCREENING INTERVIEW

This step is often handled well on the phone. The employer screens for minimum qualifications before inviting qualified applicants for a formal interview. During the phone conversation do not ask questions that can be answered with a simple yes or no. This screening should be short and to the point. The qualified candidates can then be scheduled to fill out a formal application and take part in an interview.

I prefer to conduct five formal interviews for each job opening. Your candidate selection should be based on as much information as possible. Do not ask questions that have been answered completely on the application unless there seems to be an error. Most questions should start with "Tell me about . . . . How did you . . . ? What went wrong . . . ?" Again, do not ask questions that can be answered yes or no. Many people feel that conversations must go on non-stop. If the applicant does not answer the question, it must be rephrased immediately. There is nothing wrong with silence in an interview. Give the candidate time to think. If the question needs clarification on a point, you will see it written all over the applicant's face!

Watch body language. Learn to read it. Many managers do this by habit. This skill can be practiced all the time with an applicant, a customer, an employee, and sales people. Often this language tells the professional more than words.

Next issue! We will explore effective orientation of new employees.

"WOW! Did you see that?"

Classified Ads

TRUCKS

'76 rack-body Ford 350; 10,000 lb gross vehicle weight, 27,400 miles; includes towing ball and switch for rewinding hose reel; $5,000. Also available– 500 and 250 gallon plastic tanks. Call 356-8484 or write to: 20 Milrose Lane (Lawn Genie Corp), Monsey, NY 10952.

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'78 Ford Truck F350. Approx. 20,000 miles, 2 fiberglass, 300 gal. tanks with motor, pump and 200 ft. of 5/8 hose with handy Electric Hose Reel. Customers in Farmington, Livonia and Dearborn Heights, Michigan. Sale priced at $9,500. Will sell Truck or customers separately. Call Jim Stevens (313) 474-1286.

'77 Chevrolet C-50 Truck with liquid delivery system– 800 gal. tank, Engine driven hydraulic pumping system with mechanical agitation, variable capacity to 6 GPM at 250 PSI, low mileage. $7,900. Phone (516) 454-6540 or (516) 234-4189.

EQUIPMENT

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A-1 Finn 900 gal. spray tank and flat bed, includes all hardware to fit on your own truck cab. Handles both granular and liquid. 2 Hahn electric reels with 325' of hose on each, with spray guns. Only used 2 seasons. PTO driven. $5,295 or best offer. Now sells for $11,000. Phone (216) 943-0990.

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Sta-Green Announces New Distributor

Sta-Green Plant Food Company, Inc. of Sylacauga, Alabama announces the naming of Lawn Aids Division of Lawn Aid, Inc. as distributor for their products in Ohio, Indiana, Illinois, Michigan and parts of Kentucky, Pennsylvania and W. Virginia.

Sta-Green is the specialty fertilizer manufacturing and marketing arm of Parker Fertilizer Company, Incorporated. Since its founding in 1904, Parker has pioneered and produced many varieties of fertilizer for ever-changing and expanding markets. Sta-Green now manufactures over 200 different products, including slow release fertilizer, herbicide-fertilizer compounds, insecticide-impregnated fertilizer, soluble fertilizers, and a "Custom Blending" service.

Lawn Aids is a partnership of Gary Weaver of TurfGard Co., Troy, Ohio and Ron Grove, of Lawn Aid, Inc., Tipp City, Ohio. The company will be marketing the Sta-Green products along with other chemicals and equipment for the lawn care industry, golf courses and grounds maintenance.

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