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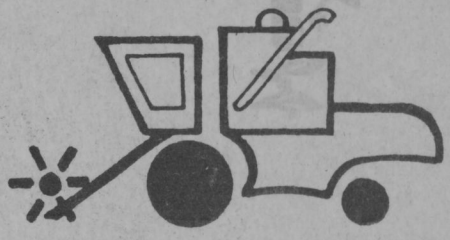


Harvests

Volume 37 Number 1

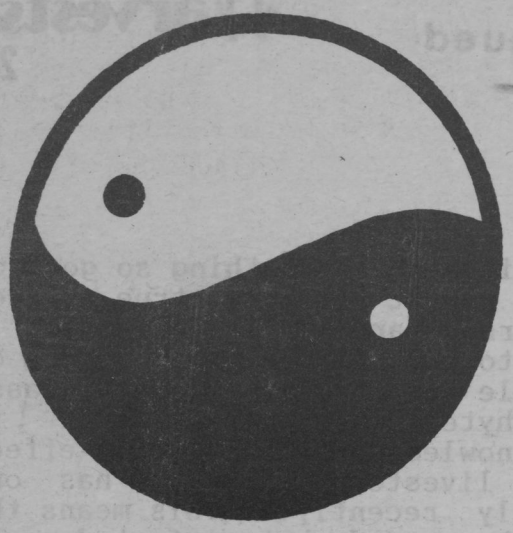
THE HARVEST MIX

The lead article, "Yin and Yang of Endophytes", is a review of the pros and cons of endophytes in turf and pasture grasses.

Threshing the Journals is under the following categories: tall fescues; plant selection screening and tissue culture; seed and sod; evapotranspiration and temperature; and other research reports.

A legislative update from the American Association of Nurserymen is titled "America the Beautiful: The Facts".

As in each issue, we have an update on the benefits of lawns and sports turf.



THE *Yin* AND *Yang* OF ENDOPHYTES

by William C Roberts

Most everyone is familiar with the symbolic oriental circle which is divided into white and black halves. The black half is symbolic of bad, whereas the white stands for good. It is exactly this type of symbol which might appear on bags of grass seed which contain endophytes. A quality sought after by turf growers, this fungus has now been proven to be very detrimental to farm animals. For this reason, some grasses are now being sold as "Endophyte Free". Not too long ago, this was considered poor quality. Why the big switch in attitude ? Why all of the excitement over a microscopic fungus which is admired by turf growers ?

To put it bluntly, endophytes kill ! It is for this reason that this tiny organism has made so many headlines in agricultural publications in the past few years. So, what is to be done about endophytes in grasses ? The turf seed users, who are represented by everyone who has a lawn, as well as all the country clubs and sports facilities around the world, benefit from the presence of endophytes; whereas the farmers who are already being financially stressed and who face even greater losses when posed with the problem of endophyte-infected pastures, loathe them. What to do is a question that is difficult to answer, unless one knows more about these fascinating organisms. So, let's go to school.

What Are Endophytes ?

What exactly are endophytes ? "An endophyte is a plant within a plant" [Roberts July 1985]. More accurately, it is a fungus which takes part in a mutualistic relationship with grass plants. The fungi are provided both structural support and food from its host. In return, the grass plant is provided much sought after insect resistance, as well as many other strengthening benefits. The relationship is, in this manner, very beneficial to both parties, except in one isolated case, choke disease.

Choke Disease

An endophyte enters a plant through the seed rather than infecting a grown plant through soil contact. As the young plant begins to develop, the fungi grow also. Never penetrating live cells, the endophyte lives in the intercellular areas of the sclerenchyma tissue. Endophytes are mostly based in the crown and the stem of the plant [Roberts July 1985]. Root and leaf concentrations are low, and for this reason, are less effective in fighting insects and diseases which attack these areas. The only problem with this cosy arrangement is when the fungus begins to flower during its sexual stage. This fruiting of the mycelia has adverse effects on seed production and in this manner is damaging to seed crops [Roberts April 1985]. In fine fescues, it can also cause blockage of the seed stem, thus causing the stem to die of dehydration [DeMoss 1984]. This one detriment to the grass is the choke or cattail disease.

Pest Control

Other than this problem, which does not damage the plant itself, only its productivity, endophytes are only advantageous. The major and most obvious benefit endophytes bestow upon their hosts is insect resistance. Scientists are not sure exactly how the fungus aids in this manner, yet it is thought that the endophyte either releases a toxin which is poisonous to its predators, or causes a reaction within the plant which does so [Hurley and Funk 1984]. The amount or type of toxin produced is not known, but in test after test, endophyte infected plants are more resistant to stem attaching bugs, which include: cutworms, army worms, stem weevils, billbugs, chinch bugs, and the sodwebworm [Hurley and Pompei 1984]. These bugs can have very visible damaging effects on grasses. Therefore, the deterred attacks of these bugs is an incredible help in maintaining a well kept stand of grass.

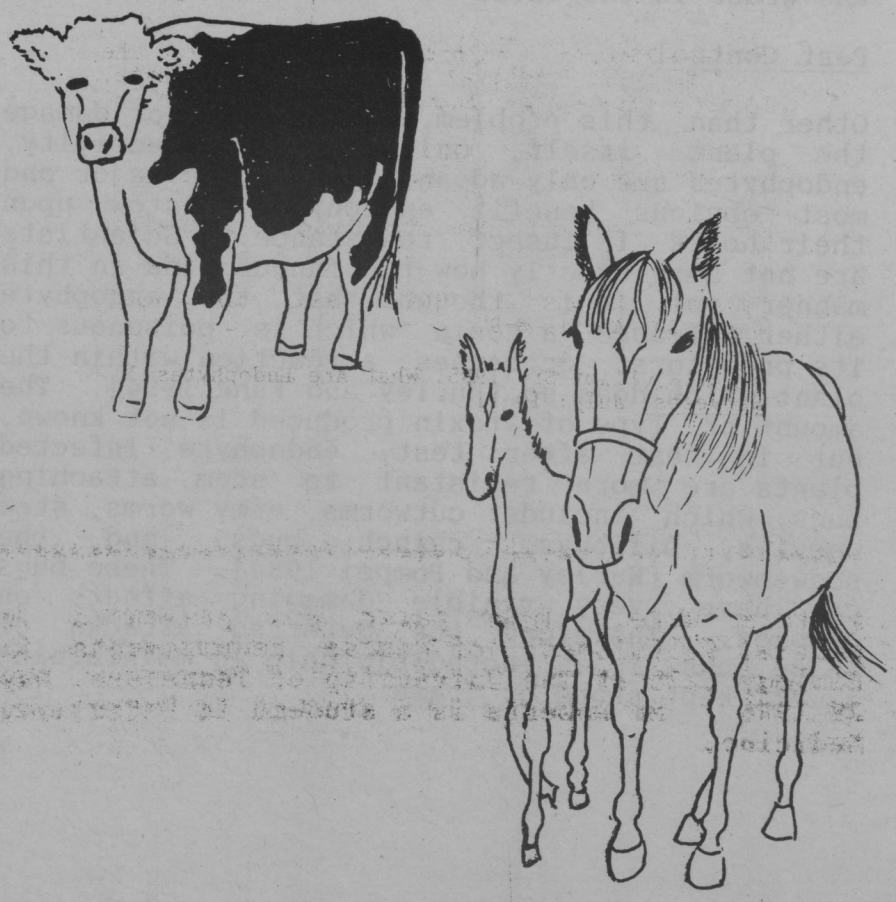
THE *Yin* AND *Yang* OF ENDOPHYTES Continued

Further Benefits

The amazing endophytes don't stop here, though. These plants also show a much increased resistance to many other detrimental environmental agents. These include resistance to many diseases, including certain ruts, an enhanced heat tolerance, enhanced drought tolerance, improved persistence, increased density, faster recovery from injury, more attractive appearance, greater vigor, and reduced crabgrass invasion [DeMoss 1984]. This is quite an impressive list of accomplishments, and although the plants are not totally invulnerable to any of these conditions, the effects are very much reduced upon comparison. We might wonder: "Why, if these endophytes are so powerful, does my lawn still look so bad ". The answer is simply that if the plant didn't form this relationship, it would probably look much worse.

Resistance to Fungicides

To top this off, endophytes are resistant to fungicides. This allows one to treat the plant for other pathogens without risking the loss of this beneficial little guest. Only abnormally high rate drenches of fungicides will have any effect at all [Roberts July 1984]. So, for all practical purposes, there is little that can be done to damage the presence of endophytes in a mature plant. Why would one want to drive off such a valuable little fungus ? The farmer's answer is very simple, "endophytes kill".



Costly to Farmers

It is hard to believe that something so good can also be so bad, but it is very true. Sheep, cattle, and horses are all affected by endophytes, and to the farmer, the effects can be both noticeable and costly. Today, grasses containing endophytes are not seeded for pastures. The knowledge of the adverse effects of endophytes on livestock, however, has only appeared relatively recently. This means that many pastures have endophyte-infested grass which dates back to the original seeding. Although endophytes are not likely to spread to other grasses, the tillers produced by grasses during asexual reproduction [the only method of reproduction in most all grass environments since rarely do people or animals allow the plant to reach the height necessary for seed production] will contain the fungus. In this manner, it spreads. Now that it has been realized that such grasses are unsatisfactory for farm use, the logical thing to do would be to get rid of it. Reseeding a pasture, however, is costly both in labor, replacement seed, and in the time which the pasture must be put out of use to allow the new grass to develop, thicken and strengthen. The natural strength of these grasses makes it difficult to simply overseed them, and as mentioned above, to kill the fungus takes incredibly high doses of fungicides, which may be harmful to the environment. So, now that we realize the difficulty one would have in alleviating the endophyte, let us look at exactly why one might want to.

Fescue Toxicosis

Cattle are affected by a condition, spawned by feeding on fescue containing Acremonium coenophialum, called "Fescue Summer Syndrome" [Roberts January 1984]. The same substance which is responsible for all of the strengths and resistances in the plants is thought to be the toxin which causes this condition in cows. Animals getting this syndrome experience poor weight gains, even from above average feeding. But, the effects are even more serious than this. Generally the cattle eat less, even with their already poor weight gain, milk production is decreased, the coat becomes rough, and an increased respiratory rate is noticed [Henton, Lothrup Jr, Dean and Waldrop 1983]. The seriousness of this condition was shown during a study at Auburn University where cattle raised on non-infected pastures were found to have a 50-100 % increase in productivity [Alabama Agricultural Experiment Station 1983]. Any sickness is costly to a farmer due to vet bills and time spent caring for the animal, but the results of a condition which can strike an entire herd through their food supply, especially one which causes decreased production, can be devastating.

Staggers in Sheep

Sheep are another species of farm animal which are affected by endophytes. In their case, known as "Ryegrass Staggers", the sheep get coat damage in the form of roughness [Roberts July 1985]. Being one of the major products from sheep, a poor coat can be costly to a farmer, especially if it is characteristic of all of his livestock due to its tie with feed. Sheep are generally weak animals that do not recover very well from any sickness, and are also plagued by muscle tremors due to the toxic substances stored in endophyte grasses [Roberts July 1985]. Such a weakness in a lamb can often cause these timid animals to simply give up. There is no profit in dead sheep.

Agalactia in Mares

The third major condition which is attributed to endophytes is Agalactia in horses. Agalactia is a condition characterized by a failure of a mare to lactate [Henton, Lothrop Jr, Dean and Waldrop 1983]. Although the mother horse is not really sickened, as in the case of cattle and sheep, the consumption of endophyte toxins causes a high death rate among the young of mothers pastured on this grass. It is obvious that decreased or absent milk production would be very dangerous to the colt, especially if colostrum [the milk produced during the first day or two after birth which is high in antibodies, thus aiding the young horse's weak immunity system until it strengthens on its own] is unavailable. Such cases almost always result in the death of the foal. Other equine problems arising from endophyte toxins include prolonged gestation, a thickened placenta, and the abortion or production of weak foals [Henton, Lothrup Jr, Dean and Waldrop 1983]. All of these damage either the productivity of horses or their continued population, and being such well loved and expensive animals, this can be termed as no less than a tragedy.

More Trouble

These are the three major ailments which torment animals raised on endophyte grasses. Other problems also arise, however, which are attributed to endophytes. Increased rectal temperature, the failure to shed winter fur, faulty thermostats resulting in attempts to cool off by standing in water or rolling in mud, low conception rates, and death have all been found to have ties to the type of grass that the animal feeds on [Roberts July 1985]. All around, to a farmer, endophyte spells "TROUBLE".

Conclusion

So, we see that what turf managers consider their "friendly fungus" is not much better than an assassin to a livestock producer. What to one producer means better grasses and bigger profits, means pain, heartache, and financial loss to the other. What is even harder on farmers is that until research found the link between the fungi and the syndromes, many of the best grasses contained endophytes. These grasses have all of the strength needed in a grass which must put up with the harsh grazing, stomping and ripping inflicted by grazing animals. In other words, many of them make perfect pasture grasses. Therefore, as turf growers and recreational grass users reap the benefits of this amazing symbiotic relationship, the farmers and our food supplies suffer. For this reason, it seems that our diverse nation with its sports arenas, golf courses and green pastures must become a two grass family, if grass users are to profit and survive.

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Editors Note: This paper was presented in partial fulfillment of course requirements in Biology 1235 at The University of Tennessee, May 28,1986. Mr Roberts is a student in Veterinary Medicine.

THREADING THE JOURNALS

Tall Fescues

ESTIMATION OF ACREMONIUM COENOPHIALUM MYCELIUM IN INFESTED TALL FESCUE

C A Roberts, F E Barton II and
K J Moore
Agronomy Journal
Volume 80 Number 5
Pages 737-740
1988

Animals grazing tall fescue often exhibit symptoms of a syndrome commonly referred to as "fescue toxicity". This syndrome has been associated with the presence of an endophytic fungus, Acremonium coenophialum.

Two current methods for estimating the extent of infection include microscopic tally of infected plants within a given field, and enzyme-linked immunosorbent assay. In the microscopic procedure, tillers are clipped generally near the base of the culms, and fungal hyphae are stained with aniline blue. Infection level is estimated as proportion of infected plants. The enzyme-linked immunosorbent assay procedures used in detection of the fungal endophyte involve colorimetric reactions of a specifically bound enzyme-antibody with an enzyme substrate. Neither procedure is a direct quantification of endophytic mycelium.

Fungal mycelium has also been estimated by the determination of chitin, a primary constituent in fungal cell walls that is not present in higher plants. Chitin determination has been reported to be more reliable than non-chemical estimations of mold in alfalfa hay. In addition to chemical procedures, chitin in alfalfa has been predicted also by rear infrared reflectance spectroscopy.

The objectives of a study conducted at the University of Missouri were the quantification of endophytic mycelium in tall fescue tissue by the chemical and spectral determination of chitin, and the comparison of chitin with the corresponding microscopic data.

Research results demonstrated that endophytic chitin in toxic tall fescue can be quantified both chemically and spectrally. Since chitin is a primary constituent of fungal cell walls, chitin determination can be used to estimate relative A. coenophialum mycelium in tall fescue tissue. However, potential sources of error, such as chitin from insects or fungi other than Acremonium species must be minimized.

Chitin was not correlated to percent infected plants, because the two procedures did not measure the same parameter; chitin is indicative of mycelium that can fluctuate even though the proportion of infected plants remains constant.

HERBICIDES FOR KILLING TALL FESCUE INFECTED WITH FESCUE ENDOPHYTE

A E Smith
Weed Technology
Volume 3 Number 3
Pages 485-489
1989

Tall fescues, grown on over 14 million hectare [12.5 million acres] is the most important and widely grown pasture, turf and conservation grass in the humid areas of the southeastern United States. Much of the fescue infected with an endophyte causes fescue toxicosis symptoms in grazing animals. The endophyte is seed transmitted and will die if the seed is stored 1 or 2 years. During a 4 year grazing trial in Alabama, steer average daily gain on tall fescue with a 5 percent level of endophyte infection was 0.83 kilograms [0.74 pound] but only 0.45 kilograms [0.40 pound] on grass that was 94 percent infected.

The availability of fungus-free seed has necessitated the development of systems to kill the infected sod before interseeding fungus-free seed. Field studies at the University of Georgia have been conducted to evaluate the response of fescue sod to foliar-applied herbicides as single and sequential applications during the fall and spring. Sequential applications of paraquat at 0.14, 0.28 and 0.56 kilograms active ingredient per hectare [0.13, 0.26 and 0.52 pounds active ingredient per acre] in September and October and glyphosate at 0.84 and 1.7 kilograms per hectare [0.75 and 1.6 pounds per acre] applied as single or sequential applications in September and October, resulted in more than 90 percent kill of the tall fescue sod. Spring treatments of paraquat and glyphosate were less effective than those applied in the fall.

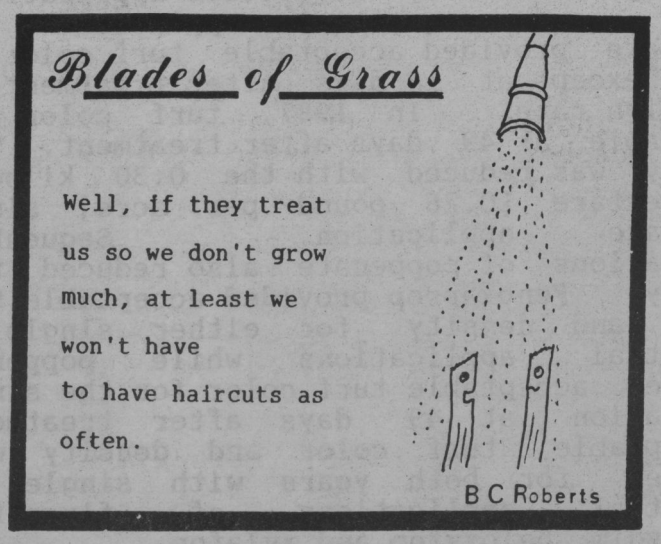
Dalapon, fluazifop-P, HOE-39866, sethoxydim and simazine did not effectively kill the sod.

RESPONSE OF TALL FESCUE TO PLANT GROWTH REGULATORS AND MOWING FREQUENCY

B J Johnson
Weed Technology
Volume 3 Number 1
Pages 54-59
1989

Plant growth regulators have been evaluated for vegetative growth and seedhead suppression on tall fescue and other cool-season turfgrasses in the northern region of the United States for several years. Results from these studies have shown that most plant growth regulators will injure and will discolor turfgrass while reducing vegetative growth and suppressing seedheads. When plant growth regulators are applied to fine turfgrasses, they either cause phytotoxicity to the grass or the chemicals will not perform consistently. However, the evaluation of these chemicals has been limited in the Southeast where grasses are grown under different environmental conditions.

Tall fescue is grown in the Piedmont region of Georgia, but it grows under stress conditions that can reduce turf quality. Because the Piedmont region extends into other southeastern states, determining the influence of plant growth regulators on tall fescue in this region is important. Experiments at the University of Georgia were initiated on tall fescue to determine the effects of plant growth regulators on injury, vertical growth and seedhead suppression of grass maintained at a high quality level and to determine the frequency of mowing needed to obtain effective seedhead suppression.



Mon-4620, paclobutrazol plus mefluidide and flurprimidol plus mefluidide temporarily injured and discolored tall fescue without reducing shoot density. Mefluidide applied at 0.43 kilogram active ingredient per hectare [0.38 pound per acre] and Mon-4620 at 2.8 kilogram active ingredient per hectare [2.5 pound per acre] suppressed vegetative growth of mowed grass 4 weeks while unmowed grass was suppressed for 8 weeks. Mefluidide at 0.14 kilogram per hectare [0.13 pound per acre] with either flurprimidol at 1.1 kilogram active ingredient per hectare [1.0 pound per acre] or paclobutrazol at 1.1 kilogram active ingredient per hectare [1.0 pound per acre] suppressed vegetative growth of mowed tall fescue for 5 and 6 weeks, respectively. Combination treatments also suppressed the growth of nonmowed tall fescue 8 to 10 weeks. Mowing effectively suppressed seedheads for 12 weeks when the grass was mowed at 3 and 6 weeks, while mowing only once at 4 weeks did not. Seedhead suppression was not improved with weekly mowing compared with two mowings. Mowing influenced the performance of plant growth regulators on vegetative growth and seedhead control but not plant injury, quality or shoot density.

RESPONSE OF TALL FESCUE TO PLANT GROWTH REGULATOR APPLICATION DATES

B J Johnson
Weed Technology
Volume 3 Number 2
Pages 408 - 413
1989

The most common uses of plant growth regulators in turfgrasses are to reduce mowing on hazardous slopes, to reduce vegetative growth during rapid growth cycle and to suppress seedheads. Plant growth regulators have been evaluated on cool-season grasses for several years, but the evaluation of these chemicals has not been as widespread in the Southeast where grass species and environmental conditions are different.

Optimum plant growth regulator treatment dates would depend on the climate when the chemicals will be used. Since the Piedmont region extends across Georgia and other Southeastern states, determining optimum plant growth regulator treatment dates in this region is important. An experiment was initiated at the University of Georgia on tall fescue to determine the effects of dates of plant growth regulator applications on injury, vegetative growth and seedhead suppression on tall fescue grass maintained at a high quality level.

Mon-4620 applied at 2.8 kilograms active ingredient per hectare [2.5 pounds per acre], paclobutrazol plus mefluidide at 1.1 plus 0.4 kilogram active ingredient per hectare [1.0 plus 0.35 pound per acre], and flurprimidol plus mefluidide at 1.1 plus 0.4 kilogram active ingredient per hectare [1.0 plus 0.35 pound per acre] were applied on four dates to determine their influence on highly maintained tall fescue turf.

Seedhead suppression was good to excellent by Mon-4620 applied March 1 or 18 and by paclobutrazol plus mefluidide, and flurprimidol plus mefluidide applied any time from March 1 until April 1. None of the plant growth regulators suppressed seedheads effectively when applied April 15 when the grass was near the end of the rapid growth cycle and just before seedhead emergence.

Vegetative growth of mowed tall fescue was suppressed for 8 weeks in 1987 when plant growth regulators were applied March 1, immediately after full green-up. Application dates were not as important in 1988 as in 1987. Tall fescue was injured the least by Mon-4620 applied in March and by flurprimidol plus mefluidide applied on March 18. Paclobutrazol plus mefluidide injured the turf severely regardless of application date.

TOLERANCE OF TALL FESCUE TO POSTEMERGENCE GRASS HERBICIDES

L B McCarty, J M Higgins, T Whitwell & L C Miller
HortScience
Volume 24 Number 2
Pages 309-311
1989

Tall fescue is a cool-season perennial grass used in the southeastern United States for limited-wear areas, such as lawns, industrial sites and roadsides. Tall fescue's desirable characteristics include low fertility requirements, rapid establishment from seed and adaptation to a wide range of soil types and pH ranges. Tall fescue's deep root system also provides a measure of drought resistance, especially drought avoidance.

Because of tall fescue's upright, bunch-type growth habit and slow summer growth rate, weeds often invade these areas. Control of established crabgrass, dallisgrass and goosegrass is difficult to achieve in tall fescue without turf injury. Traditionally the organic arsenical herbicides have been used for grass weed control in tall fescue; however, due to the need for repeat applications, a certain degree of turf injury accompanies this control.

Research with several postemergence grass herbicides has demonstrated inconsistent performance or poor turfgrass tolerance. The recent introduction of several grass specific herbicides and lack of information on tall fescue's tolerance to these herbicides has led to this study at Clemson University. The objective was to determine the response of tall fescue to various rates of single and sequential applications of 6 postemergence grass herbicides.

Field experiments were conducted to determine the effect on Clemfine tall fescue of the following herbicides: sethoxydim and fluazifop applied at 0.10, 0.20, or 0.30 kilograms per hectare [0.09, 0.18 or 0.27 pounds per acre] and xylafop, haloxyfop, fenoxaprop and poppenate applied at 0.07, 0.15 or 0.30 kilograms per hectare [0.06, 0.13, or 0.26 pounds per acre]. These herbicides are known to control grass weeds such as crabgrass and goosegrass. Turf color was acceptable following single and sequential fenoxaprop applications through 49 days after treatment. Turf density was not affected by single applications, but was slightly reduced by sequential applications. Single and sequential applications of poppenate provided acceptable turf color in 1985, except at 14 days after treatment at the high rate. In 1987, turf color was acceptable at 49 days after treatment. Turf density was reduced with the 0.30 kilogram per hectare [0.26 pound per acre] single poppenate application. Sequential applications of poppenate also reduced turf density. Fenoxaprop provided acceptable turf color and density for either single or sequential applications while poppenate provided acceptable turf color for the single application at 49 days after treatment. Unacceptable turf color and density were observed for both years with single and sequential applications of fluazifop, sethoxydim, haloxyfop and xylafop.

WATER MANAGEMENT DURING TALL FESCUE ESTABLISHMENT

J D Fry and J D Butler
HortScience
Volume 24 Number 1
Pages 79-81
1989

Irrigation is often required to achieve satisfactory turfgrass seed germination and stand establishment in arid and semi-arid regions of the United States. Although extensive work has been done to determine water use rates of mature warm and cool-season turfgrass species, little information is available on water requirements of turfgrasses as they develop from seed to maturity. Too much or too little water is often applied after seeding; either may result in poor stand development.

Tall fescue has been recognized for its drought-resistant characteristics as a mature plant. Information on water requirements during tall fescue establishment, however, is limited, and would be valuable for improving seedling growth and conserving water.

Generally, it has been recommended that seedbeds remain moist during establishment. In low-maintenance turf areas, where irrigation is not readily available, this is often difficult. Furthermore, water restrictions during dry periods can limit water availability. Deficit irrigation, application of water in amounts less than that used by turf when soil moisture is not limiting, has been evaluated on mature turfgrasses; however, effects of deficit irrigation on turfgrass establishment have not been determined.

There has been some interest in the use of hydrophilic polymers as soil amendments and seed coatings to increase plant water availability. Most of the work using hydrophilic polymers has been done with species other than turfgrass. However, hydrophilic polymers used as seed coatings for Russian wildrye grown in a vermiculite medium did not aid germination when employed over a wide range of soil matric potentials.

Research conducted at Colorado State University has evaluated the effect of deficit irrigation on tall fescue establishment and studied the effectiveness of amending soil with a hydrophilic polymer to enhance tall fescue germination and seedling survival during drought.

In the field, lysimeters containing a sandy clay loam soil were seeded with Rebel tall fescue and irrigated with equivalents of 50 to 100 percent of the potential evapotranspiration [water used when soil moisture was not limiting] of a mature turf. The low irrigation level resulted in poor germination and stand establishment.

Pre-plant incorporation of a hydrophilic polymer at 98 kilograms per hectare [87 pounds per acre] was ineffective in enhancing seedling survival under dry conditions. Greenhouse studies evaluating higher levels of polymer application on tall fescue establishment during drought revealed that the polymer did not reduce plant stress until occupying at least 1.0 percent of the soil volume to a depth of 12.5 centimeters [5 inches]. Excessive polymer amounts would be required to achieve this proportion in the field. However, the polymer may be more effective on coarser textured soils, where a more dramatic effect on soil water holding capacity might be observed.

PEACH ROOT DEVELOPMENT AND TREE HYDRAULIC RESISTANCE UNDER TALL FESCUE SOD

D M Glenn and W V Welker
HortScience
Volume 24 Number 1
Pages 117-119
1989

Peach tree growth is sensitive to environmental factors and responds to cultural practices, such as weed control, proximity of sod, irrigation strategies, fertilization and tree density. Little is known, however, of environmental and cultural effects on the peach root system.

The purpose of this greenhouse study conducted at the Appalachian Fruit Research Station, Kearneysville, West Virginia was to determine how the presence of tall fescue grass affects peach root growth, morphology and tree hydraulic resistance in comparison to growth in bare soil.

The entire soil surface was kept bare in one treatment, while a fescue sod was established in one-third of the box for the second treatment. Trees were planted 17 centimeters [6.8 inches] from one edge of the box in bare soil in both treatments. Sod reduced tree growth. The length of roots greater than 1 millimeter [one twenty fifth of an inch] in diameter was unaffected by the sod at any position in the box. The length of roots smaller than 1 millimeter in diameter was reduced beneath the sod and in the area between the sod and tree compared to the bare soil treatment. The presence of grass under both stressed and nonstressed conditions did not affect plant resistance to water flow per centimeter root.

Plant Selection Screening & Tissue Culture

A WHOLE PLANT MICROCULTURE SELECTION SYSTEM FOR KENTUCKY BLUEGRASS

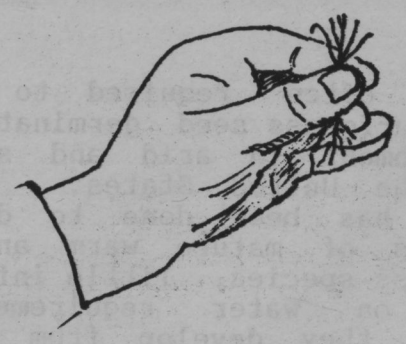
M A Pieper and M A L Smith
Crop Science
Volume 28 Number 4
Pages 611-614
1988

A whole plant microculture system for turf would expedite selection and indepth study, since many critical research problems for these plants are difficult to resolve on the whole plant level in nature. The ability of leaf cells to undergo osmotic adjustment, for example, has been linked to tolerance of desiccation and high saline soils, yet this property is extremely difficult to measure, much less control in field research plots, as native osmolarity varies with the environment.

A simplified whole plant microculture selection system would eliminate many of the ungoverned variables that currently hinder research and permit greater control over leaf cell osmotic changes, pathogen/grass interactions, and other physiological properties that impact on adaptation to stress.

Research at the University of Illinois has helped to develop a continuous whole plant microculture system for Kentucky bluegrass. Stable, fully differentiated grass plant microcultures have been readily produced on hormone-free medium and maintained indefinitely by nodal subculture with greater efficiency than those produced by seed. Two different experimental applications have been demonstrated.

Osmotic potential adjustments in response to environmental stress have been found under strictly regulated conditions using bluegrass leaves from microculture. Also, evaluations of root rot pathogen symptoms have allowed quantitative assessment of disease progression. The methodology is especially valuable because it results in continuous maintenance of stable, uniform, differentiated plants, and their direct use in research. This experimental system has potential as a vehicle for directed research on turfgrasses.



ATTRIBUTES OF TALL FESCUE GERMPLASM OF DIVERSE GEOGRAPHIC ORIGIN

D M Burner, J A Balasko and P M O'Brien
Crop Science
Volume 28 Number 3
Pages 459-462
1988

Foreign plant introductions of tall fescue have not been adequately evaluated in the United States. Research at West Virginia University has had the objective of determining whether variability in important agronomic characteristics existed among and within tall fescue accessions of different geographic origin.

Twenty-six foreign and three United States cultivars were compared in each of two space-planted field experiments in different years and locations in West Virginia. Water soluble carbohydrate concentration of summer forage, yield, disease resistance, relative maturity and winter injury were determined. Three accessions were from the United States, 15 from Europe, 6 from Central Asia and 5 from the Mediterranean area.

The United States and European cultivars yielded more first-cut herbage than the Mediterranean cultivars. They also yielded more regrowth herbage than the Central Asian and Mediterranean cultivars. The European cultivars were less diseased than the Central Asian and Mediterranean cultivars. Geographic groups did not differ significantly in mean water soluble carbohydrates, relative maturity or winter injury.

It was concluded that breeding strategies for rapid development of tall fescue cultivars adapted to the temperate United States should concentrate on domestic cultivars and European introductions as sources of superior germplasm.

GREENHOUSE SCREENING OF TURFGRASS SPECIES AND CULTIVARS GROWN IN ALKALINE SOIL

D T Lindgren, P M Schaaf and R C Shearman
HortScience
Volume 23 Number 5
Page 911
1988

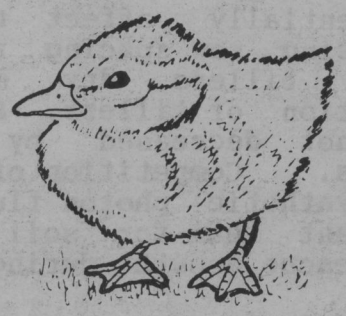
Alkaline soils can reduce crop yields and lower aesthetic values of ornamentals and turf. Chlorosis associated with alkaline soils occurs in many plants and influences plant growth and development by reducing photosynthetic efficiency.

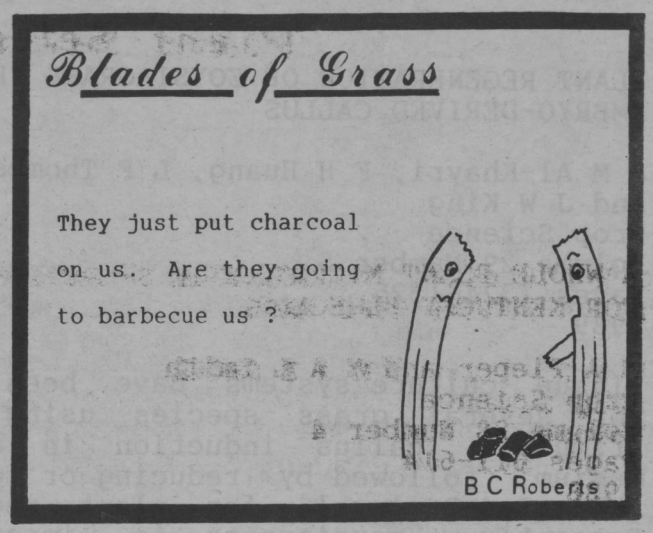
Research at the University of Nebraska has involved 6 Kentucky bluegrasses, 6 perennial ryegrasses, and 1 weeping alkaligrass. A Lawet silt loam soil of pH 8.3 was modified so that a pH of 6.6 was obtained. Grasses were planted and verdure, root dry weight, and shoot/root ratio were recorded.

Cultivars differed in verdure, root dry weight and shoot/root ratio when averaged over soils. Verdure and shoot/root ratio differed for soil pH when averaged over species and cultivars. The soil effect had a strong influence on the amount of verdure and on shoot/root ratio.

Weeping alkaligrass produced less verdure and root dry weight than Kentucky bluegrass and perennial ryegrass. On the whole, grasses grown at pH 8.3 had more verdure and a higher shoot/root ratio than grasses grown on a soil with pH 6.6. However, individual ryegrass cultivars produced higher verdure weights on pH 6.3 soil while only 3 of the 6 Kentucky bluegrass cultivars produced more verdure on the pH 8.3 soil.

For Kentucky bluegrass, Arboretum, had low verdure and root dry weight on the pH 6.6 soil, while Ram I had low verdure and root dry weight on the pH 8.3 soil. Game perennial ryegrass had low values for verdure on both soils, while Manhattan perennial ryegrass had low values for root dry weight on both soils.





ENHANCED REGENERATION IN LONG-TERM CALLUS CULTURES OF RED FESCUE BY PRETREATMENT WITH ACTIVATED CHARCOAL

O M F Zaghmout and W A Torello
HortScience
Volume 23 Number 3
Pages 615-616
1988

Addition of activated charcoal to culture media has been shown to either enhance or inhibit in vitro growth and morphological development of various tissues in culture. The beneficial effects of activated charcoal on embryogenesis and plant regeneration have been found due to the adsorption of inhibiting substances, such as various phenolic compounds that accumulate during culture. Activated charcoal may also bind toxic compounds derived from sucrose dehydration during autoclaving.

Inhibitory responses of activated charcoal have been found due to the adsorption of various auxin sources, cytokinins, vitamins and other media constituents. As such, higher levels of these media components must be added to overcome inhibition by activated charcoal.

Research at the University of Massachusetts has involved additions of activated charcoal to maintenance media before regeneration. These were evaluated for possible enhancement of plant regeneration from long-term embryogenic callus cultures of red fescue. Pretreatment with activated charcoal increased the level of precocious germination during culture and significantly increased shoot and root formation after transfer to regeneration media. Activated charcoal adsorbed and reduced the activity of toxic levels of 2,4-D. Adsorption of 2,4-D, along with other inhibitors of morphogenesis, by activated charcoal is implicated in the enhancement of regeneration.

Seed and Sod

PLANT REGENERATION OF ZOYSIAGRASS FROM EMBRYO-DERIVED CALLUS

J M Al-Khayri, F H Huang, L F Thompson and J W King
Crop Science
Volume 29 Number 5
Pages 1324-1325
1989

Tissue culture systems have been developed for several grass species using 2,4-D to stimulate callus induction in a nutrient medium, followed by reducing or eliminating the 2,4-D level for plant regeneration. Presently, zoysiagrass is important for ornamental turf purposes in the transition zone [zones 5 and 6] in the United States and in the Orient. Few improved cultivars exist, and tissue culture methods that could enhance development of improved cultivars have not been reported for zoysiagrass. The objective of this study at the University of Arkansas was to establish a tissue culture system for the regeneration of zoysiagrass.

Embryos were aseptically excised from seeds and over 90 percent produced callus. Embryogenic callus was produced on Murashige-Skoog agar medium supplemented with 2,4-D, but not on N6 medium. A 2,4-D concentration of 1.0 milligram per liter [1 part per million] resulted in greater callus production than higher concentrations. A 16 hour photoperiod of fluorescent light increased callus production over dark conditions. Direct elimination of 2,4-D and dark callus induction resulted in greater regeneration frequency and a higher number of plantlets per callus than gradual elimination and light callus induction. Normal plantlets were transplanted to soil and grown to maturity in the field, where overwinter survival was exhibited. This tissue culture system can be used for agronomic improvement of zoysiagrass.

ESTABLISHMENT OF RED FESCUE SEED CROPS WITH CEREAL COMPANION CROPS.
I. MORPHOLOGICAL RESPONSES

T G Chastain and D F Grabe
Crop Science
Volume 28 Number 2
Pages 308-312
1988

A number of perennial grasses, including red fescue, do not produce a marketable seed crop during the year a new seed field is established. When red fescue is spring-planted in Oregon, the first seed crop is not harvested until 95 weeks later. This lack of income in the year of planting, coupled with increasing costs of production, requires the identification of a more cost-effective establishment method. Planting red fescue with cereal companion crops would enable the grower to obtain an income from the grain crop during the year of establishment.

Research at Oregon State University has had the objectives to determine the feasibility of establishing red fescue seed crops with cereal companion crops in Oregon's Willamette Valley and to examine the influence of cereal companion crops, cultivars and row spacing on the growth environment and plant development of red fescue. Pennlawn red fescue was charcoal-seeded in 30 centimeter [12 inch] rows in October 1982 and 1983 on a Woodburn silt loam soil near Corvallis, Oregon.

Yamhill and Hill 81 winter wheat and Hesk and Scio winter barley were drilled in 15, 30, 45 and 60 centimeter [6, 12, 18 and 24 inch] rows perpendicular to the red fescue rows. The effect of wheat and barley on photosynthetic photon flux density, soil moisture available to red fescue plants and red fescue growth characteristics were monitored until cereals were harvested.

Companion crops reduced photosynthetic photon flux density on red fescue plants by as much as 90 percent at peak cereal leaf area. This greatly decreased red fescue tiller numbers, and dry matter production and increased tiller height. The two cereals did not differentially affect red fescue growth. Increasing row spacing resulted in more red fescue tillers, dry matter and reduced etiolation of tillers. Soil moisture content was not decreased by establishment of cereals. Competition of companion crops for photosynthetic photon flux density was more important than for soil moisture in reducing red fescue growth during the establishment year.

ESTABLISHMENT OF RED FESCUE SEED CROPS WITH CEREAL COMPANION CROPS.
II. SEED PRODUCTION AND ECONOMIC IMPLICATIONS

T G Chastain and D F Grabe
Crop Science
Volume 28 Number 2
Pages 313-316
1988

Some perennial grass seed crops, such as red fescue, do not produce a marketable seed yield during the establishment year. Planting red fescue with cereal companion crops could provide a cash income during the establishment year, thereby increasing the profitability of the venture for the grower. Few studies have examined the factors governing the success of this method. The majority of these have been conducted in Europe, where this system is commonly employed.

Research at Oregon State University has been concerned with the influence of companion crops on red fescue seed production and net income over a 3 year period. Pennlawn red fescue was interplanted in 1982 and 1983 with cereal companion crops near Corvallis, Oregon on a Woodburn silt loam soil. Yamhill and Hill 81 winter wheat and Hesk and Scio winter barley were planted in 15, 30, 45 and 60 centimeter [6, 12, 18 and 24 inch] rows at right angles to red fescue rows. Although companion crops adversely affected red fescue growth during establishment, first-year seed yield in the first experiment was not significantly reduced. Red fescue seed yields ranged from 490 kilograms per hectare [438 pounds per acre] when planted with Hill 81 wheat, to 654 kilograms per hectare [583 pounds per acre] with Scio barley. Where as yield without a companion crop was 589 kilograms per hectare [528 pounds per acre].

First-year seed yield was somewhat depressed in the second experiment by the wheat cultivars and Hesk barley but not by Scio barley. Yields ranged from 908 kilograms per hectare [811 pounds per acre] for red fescue planted with Hill 81 to 1008 kilograms per hectare [900 pounds per acre] with Scio; where as 1177 kilograms per hectare [1051 pounds per acre were obtained with no companion crop.

Second-year seed yield was not affected by companion crops in either experiment.

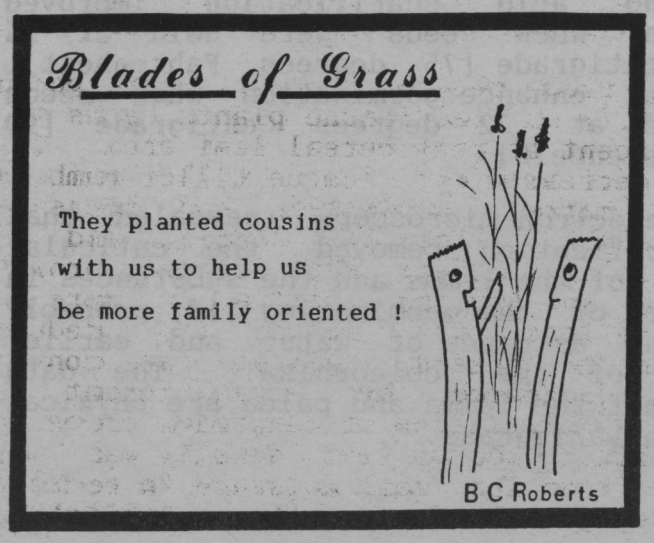
Establishment with Yamhill wheat increased net income over a 3-year period by 508 dollars per hectare [454 dollars per acre] over red fescue establishment alone. Planting with Hesk barley produced the lowest increase in net economic returns, 211 dollars per hectare [188 dollars per acre]. Red fescue seed production was most profitable when wheat companion crops were planted in 15 centimeter [6 inch] rows. This study demonstrates the potential for profitable and reliable establishment of red fescue seed crops with cereal companion crops in Oregon.

POTENTIAL FOR JUVENILE SOD PRODUCTION

L Wu
HortScience
Volume 23 Number 1
Pages 162-164
1988

The term "juvenile sod" refers to an immature sod produced in pans in a greenhouse, with only 5 to 6 weeks from seeding to harvest. The reason for producing juvenile sod is to increase the turnover rate in sod production. It also offers an advantage over the traditional field sod culture by using a soil-free sod culture medium. A juvenile sod free of weeds and with low transport weight may be widely accepted by both sod industries and consumers.

In addition, soils of a field-produced sod may be incompatible with the soil of the site to be sodded. For instance, sod for a sand football field usually has to be washed free of its parent soil before sodding.

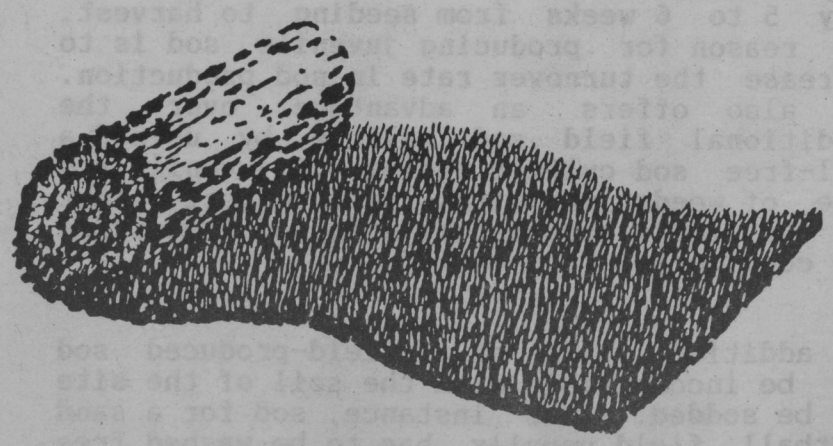


Sod farms have attempted to produce juvenile sod, but have been unsuccessful because the young sod does not provide sufficient sod strength for handling. Sod has been cultivated on flax fibers for football field use; however, no research has been conducted evaluating the culture condition that may affect the quality of juvenile sod, especially the tensile strength.

Research at the University of California has concerned cultural conditions that may affect tensile strength of a juvenile sod. The factors studied included: turfgrass species, seeding rates, seed mixture, seed germination, and texture of the underlying support of cultured sod.

Seeds were planted in peatmoss after adjusting pH to 7 and were watered with nutrient solution. Tensile strength produced in plastic pans having molded ribbed bottoms and drainage holes was compared with flat-bottomed pans. Covering the pans with thin plastic sheets was compared with pans left uncovered during the first 4 days of germination. Olympic tall fescue, Manhattan perennial ryegrass and Baron Kentucky bluegrass, seeded at 60 and 30 grams per square meter [12 and 6 pounds per 1000 square feet], 60 and 30 grams per square meter [12 and 6 pounds per 1000 square feet], and 30 and 15 grams per square meter [6 and 3 pounds per 1000 square feet], respectively, were evaluated.

Ribbon-bottom, covered pans and increased seeding rates resulted in greater tensile strength, which was sufficient for marketable handling.



GERMINATION OF BAHIAGRASS IN RESPONSE TO TEMPERATURE AND SCARIFICATION

F J Marousky and S H West
Journal American Society Horticultural Science
Volume 113 Number 6
Pages 845-849
1988

Bahiagrass is an important grass grown in the southeastern United States. It is widely used for golf courses, lawns, recreational areas, roadsides and pastures. The plant is grown from seed that characteristically germinate slowly and erratically. The caryopsis is enclosed by the lemma and palea. Acid scarification increases bahiagrass germination and removal of the lemma and palea promote rapid germination of various Paspalum spp. Dormancy of tropical grasses during long dry seasons may be an adaptation brought about by protective lemma and palea.

The influence of temperature and various scarification treatments on the physical changes of the lemma and germination of bahiagrass have been studied at the University of Florida. Mechanically scarified seeds readily germinated on an agar medium. Acid scarified seeds germinated better than untreated seeds, but not as readily as mechanically scarified seeds. All caryopses excised from nongerminated acid-scarified seeds readily germinated on an agar medium after 17 days. Excised caryopses were placed on a temperature gradient bar corresponding to positions at 15.5, 21, 26.5, 32 and 37.5 degrees Centigrade [60, 70, 80, 90 and 100 degrees Fahrenheit]. All caryopses germinated at 21 to 37.5 degrees Centigrade [70 to 100 degrees Fahrenheit], but germination and seedling growth were best at 32 to 37.5 degrees Centigrade [90 to 100 degrees Fahrenheit].

Lipase and acid scarification improved germination when seeds were held at 24 degrees Centigrade [75 degrees Fahrenheit], but did not enhance germination when seeds were held at 32 degrees Centigrade [90 degrees Fahrenheit].

Scanning electron microscopy revealed that acid scarification removed the cuticular substances of the lemma and the substances in the fissure of the germinating lid, probably facilitating entrance of water and earlier emergence of the coleorhiza. The data suggest that the lemma and palea are physical barriers in bahiagrass.

Evapotranspiration and Temperature

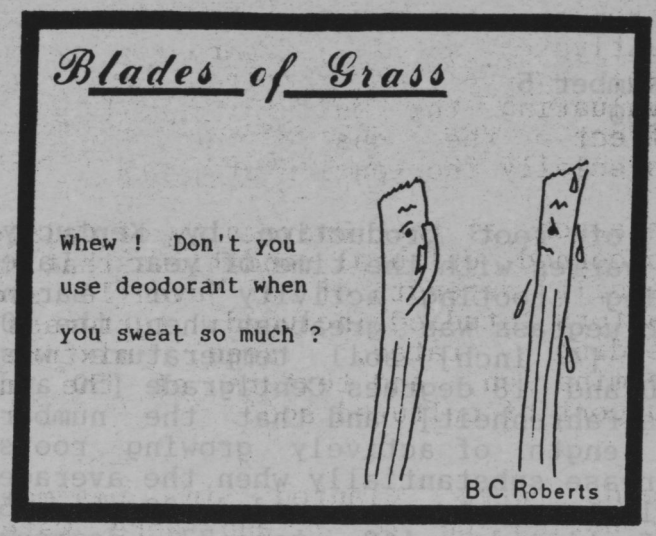
COMPARATIVE TURFGRASS EVAPOTRANSPIRATION RATES AND ASSOCIATED PLANT MORPHOLOGICAL CHARACTERISTICS

K S Kim and J B Beard
Crop Science
Volume 28 Number 2
Pages 328-331
1988

More than 50 percent of water used in Texas in 1980 was for irrigation. In 1980, 116.5 billion cubic feet [33 billion cubic meters] of water were used by municipalities and rural communities of Texas. This consumption is expected to double by the year 2000. Since water costs are projected to increase substantially, and water availability for turfgrass culture will become more limited, research is needed to delineate the comparative water use rates of turfgrass species.

Interspecies evapotranspiration differences have been reported among tall fescue, St Augustinegrass [both the common species and a dwarf cultivar], bermudagrass [Santa Ana and Suwannee], Emerald zoysiagrass, matrella zoysiagrass, kikuyugrass, seashore paspalum, centipedegrass, perennial ryegrass [Pennfine] and Kentucky bluegrass. In these instances, the cutting height, nitrogen level or both were varied among species. Reports indicate that cool-season grasses use 45 percent more water than warm-season grasses. Among warm-season species, the sparse, tall-growing grasses tend to have high evapotranspiration rates, whereas the dense, low-growing grasses have low evapotranspiration rates.

Evapotranspiration is a function of plant, soil and meteorological factors. Relationships exist between evapotranspiration rates and net radiation, soil moisture content, air temperature, soil temperature, pan evaporation, wind velocity, relative humidity and the temperature gradient between air and leaf surface.



Research at Texas A & M University has been conducted: to determine the comparative evapotranspiration rates of 12 turfgrasses under non-limiting soil moisture conditions; to assess the relationships between evapotranspiration rates and specific plant morphological characteristics and to determine the relationships between environmental parameters and evapotranspiration rates for each species. Results have been reported as follows:

- Differences in evapotranspiration rates were observed both among and within genera.

- Texas common buffalograss, Georgia common centipedegrass, Arizona common bermudagrass, Tifgreen and Tifway bermudagrasses, and Adalayd seashore paspalum had low evapotranspiration rates.

- Emerald zoysiagrass was characterized as having a medium evapotranspiration rate.

- Texas common St Augustinegrass and Meyer zoysiagrass possessed medium low evapotranspiration rates.

- Kentucky 31 tall fescue and Argentine bahiagrass had medium evapotranspiration rates and common blue grama possessed a medium low evapotranspiration rate.

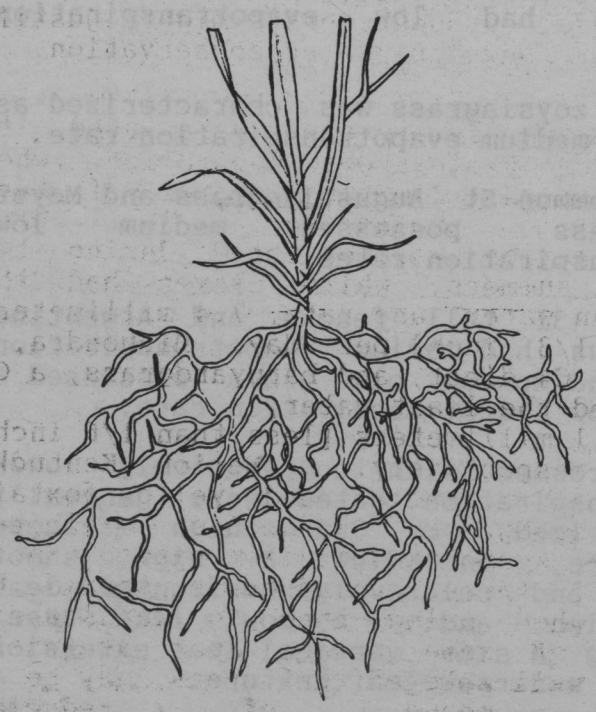
- Those grasses with comparatively lower evapotranspiration rates were generally characterized by a high canopy resistance, including a high shoot density and relatively horizontal leaf orientation and a low leaf area, including a slow vertical leaf extension rate and a narrow leaf texture.

PREDICTION OF KENTUCKY BLUEGRASS ROOT GROWTH USING DEGREE DAY ACCUMULATION

A J Koski, J R Street & T K Danneberger
Crop Science
Volume 28 Number 5
Pages 848-850
1988

The rate of root production by Kentucky bluegrass varies with the time of year. Late winter/spring rooting activity of Baron Kentucky bluegrass was greatest when the 10 centimeter [4 inch] soil temperature was between 10 and 18 degrees Centigrade [50 and 64 degrees Fahrenheit] and that the number and total length of actively growing roots could decrease substantially when the average daily soil temperature exceeded 20 to 25 degrees Centigrade [68 to 77 degrees Fahrenheit]. Thus, root growth of Kentucky bluegrass is highly responsive to seasonal changes in soil temperature.

Turfgrass management practices, such as mowing, fertilization, cultivation and pesticide application have traditionally been evaluated in terms of how they affect the appearance and growth of the shoot portion of the plant. Turf researchers now recognize that the health of the turfgrass root system can also be influenced by management practices. The ability to predict periods of maximum root activity in the field could allow researchers and turfgrass practitioners to better evaluate management techniques that influence root growth.



The majority [60 to 70 percent] of the season's total root production occurs during the months January through June. Because the degree of root activity [formation of new roots and elongation rate] during these months increases in conjunction with rising soil temperatures, a logical initial step in understanding these relationships would be to relate root activity to heat unit accumulation. The degree-day concept is appropriate because of its relative simplicity and wide acceptance and use for the prediction of plant growth and development, classification of crop species, cultivars and hybrids and for evaluating climates and geographic regions for specific crop/management combinations.

The purpose of this study conducted at Ohio State University was to develop a model utilizing degree-days calculated from soil temperature data, that could predict cumulative root production for Baron Kentucky bluegrass during the January through June period in Ohio. Temperature at the 10 centimeter [4 inch] depth in fine quartz sand and cumulative root length data were collected in the rhizotron facility at the Ohio State University during 1981, 1982, and 1985. Within the confined cultural and environmental conditions of this study, the model accounted for 95 percent of the observed variation in cumulative root length. The following equation was developed:

CRL = 5.269 + 0.032[ADD] + 0.0000138 [ADD2]

CRL = cumulative root length
ADD = accumulated degree days

Under field conditions, other factors besides temperature and heat unit accumulation would be expected to display strong and independent effects on turfgrass root growth. The development of a widely usable model would include provisions for variations in edaphic conditions and for the great diversity of management practices and maintenance intensity levels which are utilized today. This could aid researchers and field practitioners in investigations of management practices in their attempts to optimize root production. The ability to predict root production might also be useful to those conducting fertilizer efficiency or water use studies. The development of similar predictive models for other turfgrass species should also be possible.

PERENNIAL RYEGRASS CULTIVAR EVAPOTRANSPIRATION RATES

R C Shearman
HortScience
Volume 24 Number 5
Pages 767-769
1989

Turfgrass evapotranspiration rates have been compared on an interspecific basis, but only limited research has been conducted on intraspecific differences. There is a growing interest in water conservation in turfgrass management. Species and cultivars with reduced evapotranspiration could play a role in water conservation programs.

This study conducted at the University of Nebraska was initiated to investigate perennial ryegrass cultivar evapotranspiration rates and to determine the effects of vertical elongation rate, verdure and root density on evapotranspiration.

Twelve perennial ryegrass cultivars, including:

Prelude	Pennant
Blazer	Pennfine
Citation	Yorktown II
Manhattan II	Fiesta
Manhattan	Derby
Palmer	Linn

have been evaluated for evapotranspiration rates in a field study using mini-lysimeters. Cultivars differed in evapotranspiration, verdure, vertical elongation rate and root density. Evapotranspiration ranged from a low of 4.39 millimeters [1/5 inch] per day for Prelude on 3 September 1987 to a high of 9.98 millimeters [2/5 inch per day] for Linn on 13 May 1988. Linn had a mean vertical elongation rate that was twice that of Prelude. Vertical elongation rate was positively correlated and verdure was negatively correlated with evapotranspiration. Crop coefficients ranged from 0.81 to 1.03.

Turfs in this study never wilted or showed visual drought stress symptoms. Under these conditions, vertical elongation rate and verdure were important factors in influencing potential canopy resistance and turfgrass evapotranspiration rate. Turfgrass managers could use these characteristics to select cultivars with low evapotranspiration rates. In addition, these results indicate a strong potential for selection and breeding of perennial ryegrass cultivars with enhanced water conservation characteristics. Turfgrass breeders interested in low evapotranspiration rates could use vertical elongation rate and verdure as selection criteria.

EVAPOTRANSPIRATION RATES OF TURF WEEDS AND GROUNDCOVERS

J D Fry and J D Butler
HortScience
Volume 24 Number 1
Pages 73-75
1989

Irrigation is essential to maintain vigorous turfgrass and other landscape plants in arid and semi-arid regions. Research over the past decade has provided valuable information concerning evapotranspiration rates of warm and cool-season turfgrass species. Little is known, however, about the water use of weeds that encroach into and occupy large portions of turf areas. Furthermore, planting of ground covers other than turfgrass, such as dichondra and white clover, has sometimes been done without knowledge of their water requirements.

The germination of crabgrass, goosegrass, yellow woodsorrel, and other weeds can be favored by excessive water. However, once mature, some weeds, such as goosegrass, often exhibit greater drought resistance than the cultivated grasses with which they compete. Consequently, drought, as it often occurs later in the season, can favor growth of undesirable weed species.

Research at Colorado State University has been conducted to compare the evapotranspiration rates of several groundcovers, frequently planted as desired species and weeds that often encroach into home lawns. This information may help better assess water requirements of low-quality turf areas inhabited by weeds. Furthermore, knowledge of the evapotranspiration rates of commonly used groundcovers might justify their use for landscape water conservation.

Small weighing lysimeters were used to determine potential evapotranspiration [when soil water is not limiting] rates of turf weeds and groundcovers. When evapotranspiration was monitored during two consecutive summers, white clover had the highest mean water use rate, 7.4 millimeters [less than 1/3 inch] per day. Dichondra, a low-growing C4 dicot, and barnyardgrass, a C4 monocot, used the least water,

3.9 and 4.1 millimeters [less than 1/6 inch] per day, respectively. Merion Kentucky bluegrass, a C3 species, and yellow foxtail and smooth crabgrass, C4 species, exhibited intermediate evapotranspiration rates. Water use rates of these groundcovers should be considered when using them in landscapes. Eradication of some weeds, such as white clover, in well-watered turf areas, may be an effective means of reducing evapotranspiration.

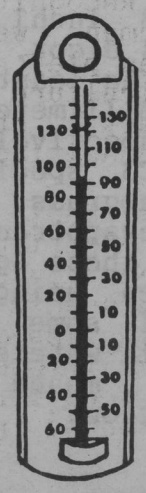
PRE-AND POSTSTRESS TEMPERATURE INFLUENCE PERENNIAL RYEGRASS IN VITRO HEAT TOLERANCE

R H White, P Stefany and M Comeau
HortScience
Volume 23 Number 6
Pages 1047-1050
1988

Rapid assessment of heat tolerance in field tests is complicated by the difficulty in separating the effects of temperature from other environmental and pest factors. Thus, progress in breeding efforts to improve high-temperature tolerance in turfgrasses is often slow. Such efforts are also inhibited by the variability in yearly weather patterns. Rapid economical screening procedures for high temperature tolerance in turfgrasses are needed to support turfgrass breeding programs.

Electrolyte leakage following in vitro stress to compare the heat tolerance ranking of various turfgrass species to a drought-tolerance ranking has shown that the heat-tolerance ranking showed a good relationship to observed differences in drought tolerance. Differences in high-temperature tolerance among species were more evident when stress time, rather than stress temperature, response curves were compared.

Research at Rutgers University has had the objective of evaluating the effects of temperature before and after heat stress and time after stress on Prelude and Manhattan II perennial ryegrass heat injury in vitro. This research primarily represents an attempt to standardize techniques prior to evaluation of cultivars and selections representing a much broader genetic base. Although the plant material used in these studies was collected from the field over a relatively short period of time, the data provide meaningful information that has not previously been reported regarding the use of electrolyte leakage as a means for determining turfgrass heat tolerance.



The temperature required to cause 50 percent cell solute afflux was 59.5 degrees Centigrade [139 degrees Fahrenheit] for Prelude and 56.5 degrees Centigrade [134 degrees Fahrenheit] for Manhattan II, when measured immediately after stress treatment. However, electrolyte leakage increased with time after termination of stress. When measured 24 hours after termination of stress, 52 degrees Centigrade [125 degrees Fahrenheit] caused 50 percent cell solute efflux from leaf segments of both cultivars. Injury levels 44 hours after 30 minutes at 50 degrees Centigrade [122 degrees Fahrenheit] were equivalent to 12 percent and 89 percent when incubated at poststress temperatures of 7 degrees Centigrade [45 degrees Fahrenheit] and 35 degrees Centigrade [95 degrees Fahrenheit], respectively. Incubation temperature following a 55 degrees Centigrade [131 degree Fahrenheit] treatment did not affect electrolyte leakage rate in either cultivar. Greater injury occurred in both cultivars when grown at 25 degrees Centigrade [77 degrees Fahrenheit] than at 41 degrees Centigrade [106 degrees Fahrenheit].

ANCIENT INDIANS MASTERED MULCHING

"In an aerial photographic survey of ancient Indian croplands, anthropologists at the University of Colorado have found evidence that 550 years ago the Anasazi had already developed surprisingly advanced agricultural practices, including the widespread use of small pebbles as mulch to retain soil moisture.

"Remains of at least 87 pebble-mulched fields were found south of the Pueblo San Maracos ruins, the site of a major Anasazi settlement near Santa Fe, New Mexico.

"The surviving mulch caused native shortgrass growing there to be healthier than surrounding grass".

Turf & Recreation
September 1989

Research Reports

PSYCHOLOGICAL AND SOCIOLOGICAL RESPONSE TO PLANTS: IMPLICATIONS FOR HORTICULTURE

Paula D Relf
Hort Science
Volume 25 Number 1
Pages 11-13
1990

Society may soon benefit from scientific discoveries that could allow us to alter and produce plants adapted to specific needs. As human beings become increasingly committed to urbanized, high-tech, bio-tech life styles, we need to understand the influence of plants on life quality, human well-being and social developments. We as researchers, educators, and industry members, need to focus on the consumer to develop an understanding of the psychological, social, intellectual and economic factors that motivate people to participate in horticultural pursuits. We need to identify and quantify the benefits that individuals and communities gain from the proximity to and interaction with plants. Using this information to enhance the quality of life is the ultimate goal behind conducting research in this area. However, there are also several pragmatic and immediate reasons for pursuing such research.

From an industry perspective, such research can be valuable in maintaining and expanding the market to keep pace with increased pressure brought on by the influx of agricultural businesses and mass-marketing chains into horticulture.

From the educator's perspective, research on people-centered horticulture can provide the data for designing educational opportunities and settings, from computer-based interactive video design programs to space station simulation, from low-income housing to geriatric centers, that will meet needs of a diverse clientele.

From the perspective of a horticulture department in a land-grant university, research in this area offers the potential for addressing several major concerns. It would increase the visibility of horticulture and the positive role it plays in people's lives in a documented and quantified way. This greater prominence, in turn, could increase recognition and support among administration and government officials as well as taxpayers. New careers that combine horticultural skills with "people skills" could potentially attract new students, particularly from the social sciences. In addition, a focus on the socio-economic aspects of horticulture could attract entirely new sources of funding for horticultural research.

Consider:

Market Expansion. Although floriculture and ornamental horticulture are among the fastest growing section of agriculture, there is still a need for market development, diversification and expansion to compensate for consumer shifts and changing market pressures.

Motivations for Buying and Using Plants. What motivates people to buy and cultivate plants ? The Garden Council is urging the industry to work together to expand business by creating more interest among consumers: "We need to... give the consumer the message that gardening is fun".

Behavioral Changes and Plants. Identifying and understanding the factors that motivate individuals to participate in gardening activities would provide the horticultural industry with tremendous planning, product development and marketing tools. However, this is but one of many areas that would be of value. Another area of equal interest and value is how plants can be used to change human behavior.

Impact on Educational Programs. Providing answers to the questions posed above could not only influence how plants are used and increase sales of horticultural products, but also influence the kinds of jobs horticulturists perform and how they are trained for these jobs.

Role of the Horticulturist in People/Plant Research. In encouraging people/plant research, two major questions that arise are: "Why should horticulturists at land-grant universities be involved ?", and "Given their limited training in the social sciences, how can horticulturists contribute to such research ?" Recognition of horticulture's role in human well-being and social development can play an important part in bringing horticulture to the forefront of the interdisciplinary studies in technical sciences and humanities.

[Editor's note: Paula D Relf is an Associate Professor of Horticulture and Extension Specialist in Consumer Horticulture at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. These few excerpts from Professor Relf's article provide great food for productive thought for all of us interested in the Green Industry.]

A NEW METHOD FOR ESTIMATING SEED NUMBERS IN THE SOIL

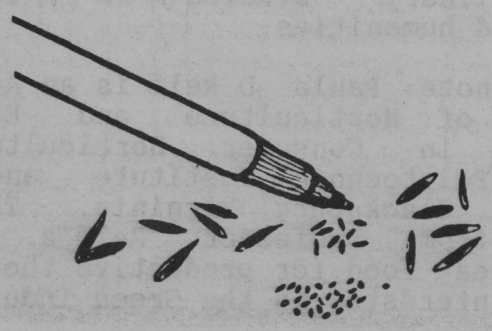
Katherine L Gross & Karen A Renner
Weed Science
Volume 37 Number 6
Pages 836-839
1989

Quantifying the diversity and density of seeds in soil is of interest to agronomists, ecologists and evolutionary biologists. A number of methods for estimating the soil seed bank by germination or washing of soil samples have been described. Generally, these methods are time consuming and effective in estimating the densities of only some of the species in the soil.

Weed seed densities are known to be highly variable in soil. Thus, to estimate seed densities in soil accurately requires that a large number of relatively small soil samples be taken. Community-level surveys of seed diversity in soil also require that a large number of samples be taken across a field [or plant community] to estimate species diversity accurately.

Research at Michigan State University has developed a method of washing soil samples using a modified hydropneumatic root elutriator that effectively separates seeds of a wide range of plant species from soil samples. The hydroelute system is very efficient in separating fine roots and organic matter from a wide range of soil types.

The system has provided reliable estimates of seed densities for weed species with a broad range of seed weights [0.06 to 9.80 milligrams] and had no effect on seed viability of three weed species tested. Elutriation of soil samples [up to 60 grams] taken from a cultivated field took approximately 15 minutes. Separating, classifying and counting seeds is time consuming [20 to 30 minutes per sample], but provides an accurate estimate of seed densities for weeds with a diameter of 0.5 millimeter or more.



TURFGRASS WEAR AS AFFECTED BY GOLF CAR TIRE DESIGN AND TRAFFIC PATTERNS

R N Carrow and B J Johnson
Journal American Society of Horticultural Science
Volume 114 Number 2
Pages 240-246
1989

Traffic on recreational sites causes significant injury to turfgrasses, including wear-damage caused by pressure on shoot tissues as well as tearing, scuffing, and abrasion and as soil compaction, which causes injury indirectly as soil physical properties that influence root activities are altered. While both injuries often occur on the same site, they are distinctly different in nature.

Considerable expense and management skill is required to reduce wear damage on high-use recreational sites. One factor that influences degree of injury is tire design. More wear and compaction of the soil result from use of narrow tires. More wear occurs from sharp turns and from repeated passes over an area. In a 1982 survey, there were an average of 52 golf cars per 18 hole golf course.

The purpose of these studies conducted at the University of Georgia was to determine the effects on turfgrass wear of several golf car tire designs, golf cars and tire locations relative to the turn [inside or outside]. Several driving patterns were used to cause various components of wear [pressure, tearing, etc] to be expressed. In 1985 and 1986, wear tests were conducted on Tifway bermudagrass. Wear damage to turf in all studies was assessed by visual turf quality, color, verdure and leaf bruising.

Golf car traffic caused significant wear damage regardless of golf car, tire design or traffic pattern. Damage increased with frequency of trips over the site and with moderately sharp turns. Differences in wear injury between the tire designs did occur, but were minor in most instances. These differences could not be explained by tread pattern alone, since similar designs gave different degrees of wear. Whether the tire was radial or not did not influence turfgrass wear. Golf car type exhibited a minor effect on bermudagrass wear. Management alternatives to minimize turfgrass wear should concentrate on distributing traffic and avoiding sharp turns, while selection of pneumatic tire design or golf car is of minor relative importance.

SELENIUM ACCUMULATION AND SELENIUM-SALT COTOLERANCE IN FIVE GRASS SPECIES

L Wu, Z Z Huang and R G Burau
Crop Science
Volume 28 Number 3
Pages 517-522
1988

Since the discovery that trace amounts, 0.01 milligrams per kilogram, of selenium in the forage have important nutritional and metabolic functions in animals, considerable attention has been give to selenium deficiency in livestock and selenium uptake by forage plants. The minimal dietary level required to prevent white muscle disease in livestock ranged from 0.03 to 0.10 milligram per kilogram of selenium in dry weight of forage, depending upon the dietary level of vitamin E and possibly other substances.

Research conducted at the University of California-Davis has had the objective of determining the pattern of selenium accumulation and selenium-salt cotolerance in five forage and turfgrass species. The potential of using these grass species for land and water quality improvement, as well as for crop production on land contaminated with selenium and/or salt. Five grass species tall fescue, crested wheatgrass, buffalograss, seaside bentgrass and bermudagrass were studied. Selenium uptake and selenium and salt tolerance were examined under nutrient solution culture conditions.

Both selenium and salt tolerance tests indicated that distinct differences in both selenium and salt tolerances exist among the 5 grass species, but there has been no direct association between selenium and salt tolerance. At moderate selenium toxicity levels, the amount of selenium uptake by the grass species is inversely related to selenium tolerance, in which the species with greater tolerance accumulates less selenium than less tolerant species.

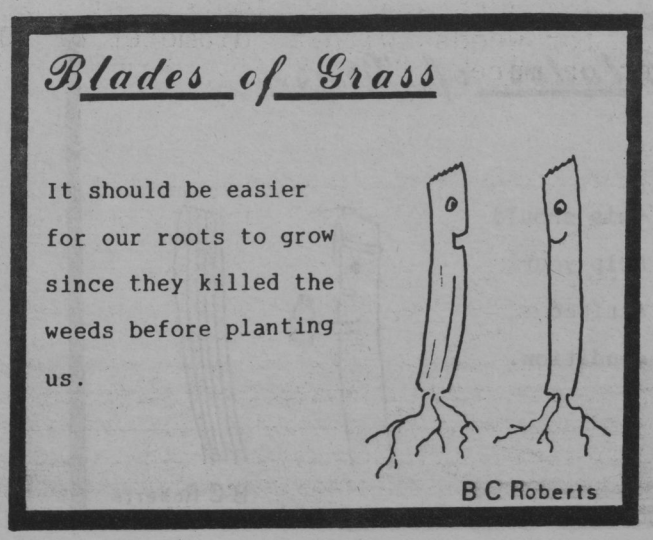
Tall fescue presents a promising potential for use on soils with relatively high levels of salinity and selenium. It has an extensive, deep root system and high transpiration rate. Land planted with such a grass may have reduced water table level and drainage problems. As a result of repeated harvesting of the grass, much of the selenium may be removed from the soil. The plant materials may be used as a supplement for livestock feeds deficient in selenium. This tolerant grass may also be used for seed production. Seed production for forage or turf should minimize the risk of food chain contamination.

ESTABLISHMENT OF KENTUCKY BLUEGRASS SOD FOLLOWING APPLICATION OF HERBICIDES.

Z J Reicher and N E Christians
HortScience
Volume 24 Number 5
Pages 799-801
1989

Preemergence and postemergence herbicides commonly are used to control annual weeds during production and after establishment of grass sod. These materials have the potential of delaying establishment by inhibiting rooting.

Research at Iowa State University has had the objective to determine the effect of several preemergence herbicides and of fenoxaprop, a postemergence herbicides, on establishment of Kentucky bluegrass sod. Fenoxaprop was applied at 0.20 and 0.40 kilogram per hectare [0.17 and 0.34 pound per acre] 28 and 14 days before sod harvest and 14 and 28 days after sod laying. Three preemergence herbicides, bensulide at 8.43 kilogram per hectare [7.53 pound per acre], DCPA at 11.80 kilogram per hectare [10.53 pound per acre], and pendimethalin at 1.69 kilogram per hectare [1.5 pound per acre] were applied over the top of the freshly laid sod. All applications of fenoxaprop at 0.40 kilogram per hectare [0.34 pound per acre] were phytotoxic by 14 days after application in 1986. No treatments had inhibited rooting at 4 weeks after sod transplant. Only fenoxaprop applied at 0.40 kilogram per hectare [0.34 pound per acre] 14 and 28 days after sod laying inhibited rooting 8 weeks after sod laying in 1986. Fenoxaprop at 0.20 kilogram per hectare [0.17 pound per acre] discolored the turf when applied 14 days before sod harvest. None of the treatments affected rooting 4 or 8 weeks after sod laying in 1987.



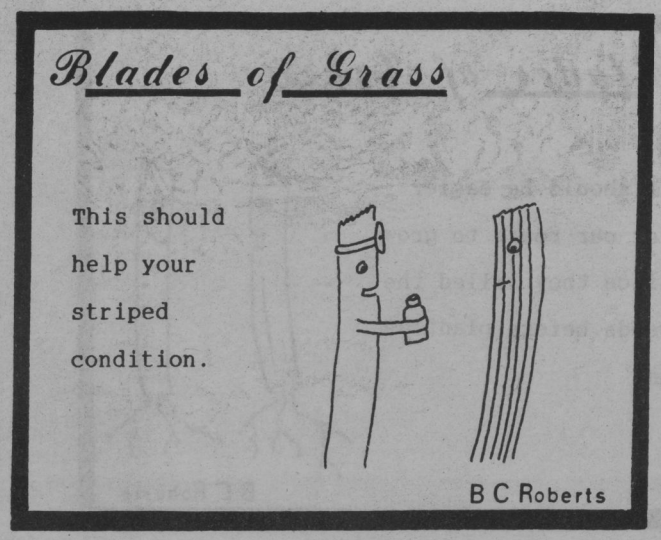
RESIDUAL STRIPE SMUT CONTROL IN KENTUCKY BLUEGRASS WITH REDUCED FUNGICIDE LEVELS

P H Dernoeden
HortScience
Volume 24 Number 5
Pages 796-798
1989

Stripe smut is a destructive disease of Merion and several other cultivars of Kentucky bluegrass. Stripe smut infection can result in severe injury when turf is subjected to drought stress and may be enhanced under high nitrogen alone or high nitrogen plus low phosphorus and potassium fertility.

Commercial lawn care companies frequently apply nitrogen fertilizer in spring, which may overstimulate turf and enhance stripe smut severity. Furthermore, lawn care companies have little control over irrigation of lawns or the existing species and cultivars that comprise the turf. Hence, where lawns are severely injured by stripe smut, the commercial applicator may use a fungicide to control the disease.

Research at the University of Maryland had the objective to evaluate lower fungicide amounts for efficacy, identify other fungicides that effectively control stripe smut and assess the residual effectiveness of fungicides over 2 years. A secondary objective was to monitor the spring and fall recovery of severely smutted Kentucky bluegrass that had been subjected to heat and drought stress during summer. Fungicides were foliar-applied to a diseased stand of Merion bluegrass in spring while disease symptoms were evident.



THE LAWN INSTITUTE

In the initial study, sequentially applied [14-day interval] triadimefon at 3.0 plus 3.0 kilogram per hectare [2.6 plus 2.6 pound per acre] and terbuconazole at 1.6 plus 1.6 kilogram per hectare [1.4 plus 1.4 pound per acre] provided excellent control and commercially acceptable turfgrass quality 2 years after fungicide application. Propiconazole at 1.7 plus 1.7 kilogram per hectare [1.5 plus 1.5 pound per acre] provided good disease control; however, benomyl at 6.1 plus 6.1 kilogram per hectare [5.4 plus 5.4 pound per acre], fenarimol at 3.0 plus 3.0 kilogram per hectare [2.6 plus 2.6 pound per acre], iprodione at 6.1 plus 6.1 kilogram per hectare [5.4 plus 5.4 pound per acre], and prochloraz at 7.6 plus 7.6 kilogram per hectare [6.7 plus 6.7 pound per acre] provided poor disease control when plots were rated 2 years following application.

In the second study, a single application of terbuconazole at 1.6 kilogram per hectare [1.4 pound per acre] and diniconazole at 1.5 or 3.0 kilogram per hectare [1.3 or 2.6 pound per acre] provided excellent stripe smut control and turf exhibited commercially acceptable quality 2 years following fungicide application. Triadimefon at 1.5 or 3.0 kilogram per hectare [1.3 or 2.6 pound per acre], terbuconazole at 0.8 kilogram per hectare [0.7 pound per acre], and propiconazole at 1.7 kilogram per hectare [1.5 pound per acre] treated turf exhibited reduced disease injury after 2 years; however, turf quality was not as good as that provided by other fungicide treatments.

Observations and data collected over 3 years do not support the view that stripe smut infected plants die during summer stress periods, thereby controlling the disease by reducing large populations of perennially infected plants.

Warvests
21

'America the Beautiful'

THE FACTS

LEGISLATIVE UPDATE
AMERICAN ASSOCIATION OF NURSERYMEN

President Bush has proposed a massive national tree planting initiative. Included in the president's FY 1991 budget proposal to Congress, this initiative calls, in part, for the planting of one billion trees per year in urban and rural areas.

Here is some background on the president's proposal, titled 'America the Beautiful'.

Q. Why is so much emphasis being placed on planting trees ?

A. Trees provide tangible economic, social, and environmental benefits to society. Planting trees offers every individual the opportunity to make a direct contribution to the betterment of the environment.

Q. What benefits do trees provide ?

A. They enhance wildlife habitat, air and water quality; they also reduce soil erosion, increase property values, and provide wood products and jobs to strengthen local economies.

Tree planting also provides an interim approach to reducing atmospheric carbon dioxide until more is understood about the relationships between atmospheric gases and the global climate.

Q. Why emphasize the planting in cities and towns ?

A. Trees are especially effective in cleaning the air and conserving energy in communities. Trees provide cooling shade that can significantly reduce energy demands [cities are often much hotter than rural areas due to the vast expanses of concrete and asphalt], and can also act as buffers against cold winter winds.

Q. How do trees and plants help address concerns about global climate change ?

A. Scientists have documented increases in certain atmospheric gases since the mid-1800's. These gases are known to help retain heat in the atmosphere. One of these gases is carbon dioxide. Research is now striving to accurately predict what effect the accumulation of these gases may have on the global climate. Some scientists have speculated that a significant rise in the earth's temperature may result.

Meanwhile, we know for a fact that trees and plants remove carbon dioxide from the atmosphere and release oxygen as a by-product. They are nature's "air cleaners". Planting trees and plants improves air quality, along with the many other benefits, and makes economic and environmental sense, whatever the findings about global climate change.

Q. What is the cost of "America the Beautiful?"

A. The proposal calls for a total of $175 million in 1991. This includes $110 million for rural tree planting and improvement, and $65 million for urban and community planting and improvement.

Q. How many trees would be planted under "America the Beautiful ?"

A. The initiative calls for planting, maintaining, and improving one billion trees per year over the next several years. 30 million would be planted in some 40,000 communities across the nation. The balance would be devoted to rural areas.

Q. Where will the trees come from ?

A. The initiative provides an opportunity for significant private sector involvement. Private sector nurseries are seen as the primary supplier for the landscape-sized material needed for the urban and community component of the initiative. The rural component will draw on many sources, including state, forest industry, and private nurseries.

AAN will be working closely with the White House, USDA Forest Service, and Congress to refine and advance the initiative.

Q. How will people be encouraged to plant trees ?

A. A strong cooperative public information campaign will be an important element. Messages should focus on the tangible economic and environmental benefits of trees and how every individual's efforts can help make a difference.

Q. Will government-run nurseries be expanded to implement the initiative ?

A. While modest increases in federal personnel would be necessary to coordinate the program, the initiative, as proposed, does not provide funding for the expansion of federal or state nursery production.

Q. How many trees will be planted in each state/community ?

A. Because the program is voluntary, it is not possible to predict the number to be planted in any one area. As the opportunity to double the number of trees in cities and towns across the country exists, virtually every person in the country has the opportunity to get involved.

Q. What can garden centers, growers, landscape specialists, and other industry firms and organizations do to help advance this presidential initiative ?

A. Write to your US Senators and Representatives today, expressing your support for the president's "America the Beautiful" initiative. The nursery industry can help transform this proposal into a bona-fide, properly-funded program.

Note: The benefits of trees noted in this release also apply to lawngrasses. The Lawn Institute's Lawn and Sports Turf Benefits is a documented booklet that shows the many benefits that the little grass plant provides humankind and our environment. [Available from The Lawn Institute, P O Box 108, Pleasant Hill TN 38578 for $5.00.]

Update
Some Benefits of Lawns

DR THOMAS L WATSCHKE, PENNSYLVANIA STATE UNIVERSITY SAYS "DON'T FORGET TURF"

"Turfgrasses, which cover more urban and suburban acres than trees, not only can provide a complimentary carbon dioxide reduction capacity, they can be established instantly through sodding. Furthermore, sodding can be accomplished on almost any site for a cost comparable to - or, in most cases, less than - that of planting trees.

"The opportunity to utilize both turfgrasses and trees to reduce the greenhouse effect, particularly in urban settings, must not be overlooked...

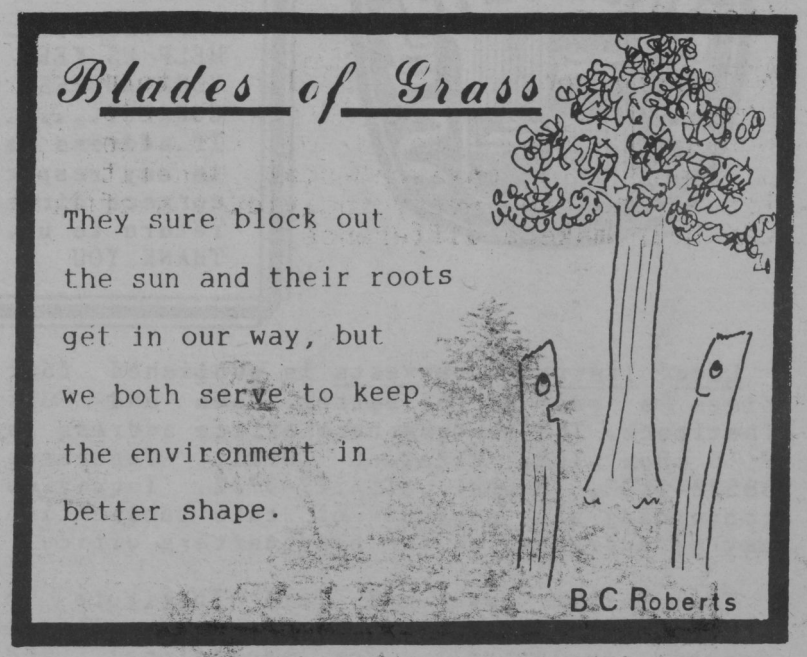
"The versatility and safety that turfgrasses offer to urban settings is natural. It is entirely conceivable that turfgrasses will become commonplace in the architecture of rooftops in the future. By utilizing synthetic support materials and recirculating captured rainfall for irrigation, sodded rooftops will significantly modify temperature, reduce carbon dioxide and other gases and help reduce urban storm water runoff volume. In addition, the use of 'grasscrete' for parking lots and roadways will modify environmental extremes and significantly reduce urban runoff.

"The strategic use of turfgrasses, particularly in the form of sod, is the most sensible and economically feasible approach to countering the environmental impact of the heat produced by carbon dioxide generation, construction methodology and the preponderance of impervious surfaces found throughout the urban areas of the United States.

"The specific environmental enhancements and associated benefits that are the direct result of the presence of turfgrasses are significant and merit individual consideration. Absorption of pollutants from the air...; oxygen generation...; particulate matter entrapment...; temperature modification...; water quality and quantity...; noise abatement...; allergy control...; fire retardation...; and glare reduction...

"Turfgrasses should be included in any legislative solution to the greenhouse effect... Growth of turfgrasses [and their roots], unlike trees, is very unlikely to threaten or damage surrounding structures, sidewalks, paths or streets. And turfgrass itself usually can be easily replaced..."

-From Golf Course Management February 1990
"The Environmental Benefits of Turfgrass and Their Impact on the Greenhouse Effect"
Pages 150,151,152,154



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The Better Lawn and Turf Institute is incorporated as a nonprofit business league formed exclusively for educational and research purposes concerned with agronomic, horticultural and landscape concepts.

Lawn Institute Harvests is dedicated to improved communications among turfgrass seed and allied turf industries and other firms, businesses, organizations and individuals with lawngrass research and educational interest and concerns.

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