January 1991

LAWN INSTITUTE

Harvests

Volume 37 Number 4

THE HARVEST MIX

This issue contains Threshing the Journals under the topics of:

- tall fescue;
- herbicides;
- computer based systems;
- turfgrass nutrition;
- soil science;
- creeping bentgrass/annual bluegrass;
- Kentucky bluegrass;
- soils and soil water;
- evapotranspiration;
- plant competition.

It was with a great deal of sadness that we learned of the death of Dr Fred V Grau, a pioneer in the turfgrass science field.

The editors want to extend best wishes for 1991 to each of you.

Tall Fescue

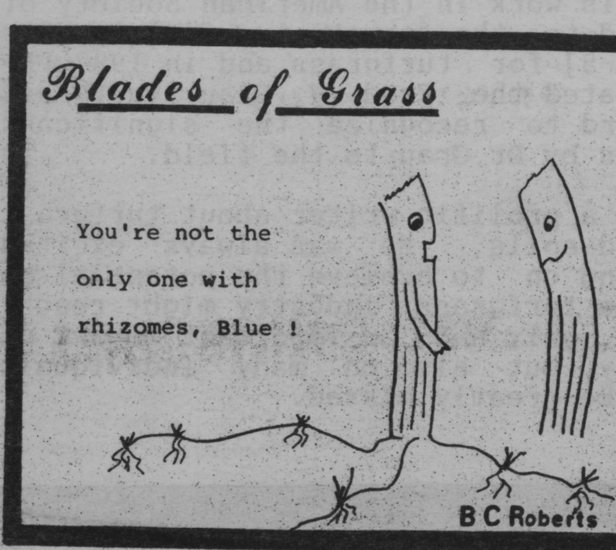
TALL FESCUE RHIZOME PRODUCTION AS INFLUENCED BY BERMUDAGRASS COMPETITION AND CUTTING FREQUENCY

J H Bouton, F C Whitehead and J P De Battista
Agronomy Journal
Volume 81 Number 2
Pages 220-223
1989

Although earlier taxonomic descriptions of tall fescue described it without rhizomes, a more recent account describes the plant with and without rhizomes. Some plants show aggressive rhizomatous behavior, spreading up to 0.3 meters [1.1 feet] per year.

The usefulness of the rhizome trait should be related to its ability to confer better persistence and competitive ability to tall fescue. This is especially true in the southern range of its adaptation where tall fescue-bermudagrass pastures predominate.

Research at the University of Georgia has determined the effects of bermudagrass competition and cutting frequency on rhizome production and growth among different tall fescue genotypes. Bermudagrass competition depressed rhizome production, tillering and plant size across all genotypes. Little effect was recorded for these same characters with frequent cutting unless done weekly. There were significant differences among genotypes for rhizome production. Highly rhizomatous genotypes survived better and grew larger in bermudagrass than non- or weakly-rhizomatous genotypes, indicating the rhizome trait may impart better performance in tall fescues grown in bermudagrass mixtures.



GROWTH, MORPHOLOGICAL, AND CHEMICAL COMPONENT RESPONSES OF TALL FESCUE TO ACREMONIUM COENOPHIALUM

N S Hill, W C Stringer, G E Rottinghaus, D P Belesky, W A Parrott and D D Pope
Crop Science
Volume 30 Number 1
Pages 156-161
1990

The legume-rhizobium association is probably the best known plant-microbial symbiotic relationship. Recently, another mutualistic symbiotic relationship between the plant and mycological kingdoms has been recognized. This symbiosis involves a group of endophytic clavicipitaceous fungi. These were thought to be simple parasites of grasses. Recent surveys suggest 95 percent of all tall fescue pastures are infected with an endophytic fungus A. coenophialum, a member of the Balanseae tribe of the ascomycetes.

The fungus grows intercellurlarly in the leaf sheath of the plant and confers stress and pest tolerance to the host. As the endophyte is totally dependent upon the plant for energy, the tall fescue-A. coenophialum association is a true example of a symbiotic relationship.

Research at the University of Georgia had the objective of determining variability in responses of tall fescue genotypes to endophyte infection for select growth characteristics, plant morphology and chemical components.

Responses of tall fescue plants to endophyte infection were not consistent for tiller production, crown weight, dry matter production, total nonstructural carbohydrate concentration or quantity, specific leaf weight or ergovaline production. Therefore, the endophyte lends increased phenotypic variability among endophyte infected and non-infected tall fescue without changing the genetic variability of the plants in this study. Development of systems to study interactions between genotypes of endophyte and tall fescue are necessary in order to manipulate and exploit low ergopeptine alkaloid-producing endophytes within tall fescue populations. Low ergovaline production by Genotype 7, regardless of leaf area or clipping length, suggests that variability exists, which may be manipulated to enable development of a highly infected/low ergopeptine alkaloid-producing tall fescue for grazing purposes. Endophytes increased phenotypic variation in this study and thus may increase the ability of mixed endophyte infected and non-infected populations to adapt to diverse environments.

CLASSIFICATION AND PEDIGREE VERIFICATION OF TALL FESCUE CULTIVARS UTILIZING THE PROLAMIN SEED PROTEIN FRACTION

R H Abernethy, J J Steiner, D S Wofford and D S Thiel
Crop Science
Volume 29 Number 3
Pages 791-797
1989

Techniques that provide rapid, reproducible, and uncomplicated verification of plant cultivar identity are sought by seed technologists, plant breeders, and certification agencies. The past decade has produced significant advance in the technology available for this purpose; however, not all the above criteria are satisfied by many of the available procedures. Polyacrylamide gel electrophoresis has been widely used to successfully distinguish differences in seed storage proteins among cultivars. The alcohol-soluble prolamin protein fraction has been used successfully to characterize cereal crop cultivars.

Prolamin fractions show a high degree of polymorphism. Most, if not all, of the polypeptides are the products of separate genes. Heterogeneity has resulted from duplication and non-deleterious mutations, which are allowed by lack of strong functional constraints on storage protein packing. Prolamin composition must be unaltered by the seed production environment if protein composition is to be useful for cultivar identification. Seed storage proteins used for cultivar identification should be stable under normal seed production environments.

Research at the University of Wyoming has distinguished between 16 cultivars of tall fescue. This has been based on qualitative and/or quantitative differences in alcohol-soluble prolamin seed protein banding patterns. An acidic polyacrylamide gel electrophoresis system was used. A series of cluster Q-analyses were performed on the data as a statistical approach to definitively show relationships among cultivars. Use of cluster analyses of the prolamin polypeptides should be applicable to the development of databases for plant cultivar identification and variety protection.

The sixteen tall fescues included in this study were:

- Alta
- BK-2
- Brookston
- Clemfine
- Fawn
- Forager
- Houndog
- Johnstone
- Kenky
- Kentucky 31
- Kenwell
- Missouri-96
- Olympic
- Rebel
- Triumph
- Willamette

IN MEMORIAL

DR FRED V GRAU
1903-1990

Fred V Grau started with his avid interest in turfgrass while a student at The University of Nebraska, and continued for a Master's degree in pathology at The University of Rhode Island and a PhD at The University of Maryland in weed control.

Dr Grau became the first Extension Turf Specialist in the United States, working with Dr Burton Musser at Pennsylvania State University in 1935. He found that crown vetch was a solution to highway roadside erosion control and helped develop the first hydraulic seeder. Penngift crown vetch was later developed.

In 1945 Dr Grau became the first director of the U S Golf Association Green Section. In 1953 he joined the Nitroform Agricultural Chemical Corp promoting Nitroform. In 1959, Dr Grau became executive secretary of the Pennsylvania Turfgrass Council. He helped create the Musser International Turfgrass Foundation and the National Sports Turf Council. His work in the American Society of Agronomy led to the formation of a separate division [C-5] for turfgrass and in 1987 the society created the Fred V Grau Turfgrass Science Award to recognize the significant contributions by Dr Grau to the field.

Dr Grau was a prolific writer about turfgrass subjects and soils. He was always excited about pushing on to achieve the potential he believed the turfgrass industry might reach. Dr Grau not only had an important impact on the industry, but also on many individuals and he will be greatly missed.

EFFECT OF THE TALL FESCUE ENDOPHYTE ON PLANT RESPONSE TO ENVIRONMENTAL STRESS

M Arachevaleta, C W Bacon, C S Hoveland and D E Radcliffe
Agronomy Journal
Volume 81 Number 1
Pages 83-90
1989

Tall fescue is one of the most important pasture grasses in the eastern United States. The popularity of tall fescue is a result of its wide adaptation, ease of establishment, long productive season and tolerance to abuse, drought, poor drainage and adaptation to a wide range of soil pH. The vastly improved animal performance of low-endophyte tall fescue has stimulated production of endophyte-free seed and replanting of infected pastures.

Most endophytic fungus-grass associations are mutualistic. This suggests that these fungi co-evolved with their grass host, are non-parasitic, and the endophyte-plant relationship of tall fescue is a mutualistic symbiosis. This raises the question of whether tall fescue in stressful environments, when free of the endophyte, continues to have the same productivity and persistence as infected grass.

The fungus benefits from the association by receiving nutrients, protection, reproduction and dissemination. In return, the plant may be aided by toxin production which deters ruminant grazing and pest attack. Genetically similar endophyte-infected perennial ryegrass plants, when compared with endophyte-free plants, produced more herbage, leaf area, tillers and roots.

Research at the University of Georgia has evaluated cloned endophyte-free and endophyte-infected tall fescue plants for differences in morphological, anatomical and physiological responses to flooding, nitrogen fertilizer rates and drought stress. The effects of these environmental variables were studied in respect to herbage dry matter production, tillering, leaf size, anatomy and in vitro dry matter disappearance.

Leaf blades of endophyte-infected as compared to endophyte-free plants were thicker and narrower regardless of flooding, nitrogen rate or drought stress. Plant ultrastructure was not appreciably altered by the endophyte. Herbage growth was 50 percent greater on endophyte-infected than endophyte-free plants, especially at higher nitrogen levels. Tillering increased on endophyte-infected plants but only at the highest nitrogen rate. The endophyte-infected plants were more productive than endophyte-free plants at mild soil moisture stress. At more severe stress, 75 percent of endophyte-free plants died and all endophyte-infected plants survived. Leaf rolling under drought stress was much more common in endophyte-infected than endophyte-free plants. Regrowth after harvest with abundant watering of previously drought-stressed plants was much greater on endophyte-infected than endophyte-free plants. These results indicate that there are positive benefits derived from association of an endophyte with tall fescue resulting in growth stimulation, improved survival and drought tolerance to the host plant that could be important in plant competition.

It should be emphasized that the behavior described here occurred with a single clone.

Within a pasture situation, it is expected that the diversity of expression shown by each seed and its companion endophyte will reflect the entire genotypic range of each member within the cultivar complex. This suggests that the genetic plasticity within a particularly diverse cultivar, such as Kentucky-31 tall fescue, must include individuals which, when studied separately, may not behave as the cloned materials used in this study. It is likely that the endophyte alters the basic phenotypic [morphology and physiology] expression of individual plants. These results demonstrate that it is important to measure the performance of cloned endophyte-infested and endophyte-free plants under stress, and suggests that the performance of several clones of a cultivar be tested before we can determine the overall effect of the endophyte on the value of a particular seed-sown cultivar.

Herbicides

ACCELERATED BIODEGRADATION OF HERBICIDES

D D Kaufman, R G Harvey and H D Skipper
Weed Technology
Volume 1 Number 4
Pages 332 and 333
1987

Since the late 1970's, the reasons for the performance of certain pesticides to fail after several years of continuous use has been studied. These pesticides include representatives from the herbicide, insecticide and fungicide groups, encompassing several classes of chemistry - carbamates, carbamothioates [thiocarbamates] and organophosphates.

Although "enriched" soils - capable of rapid biodegradation - had been generated after several applications of phenoxys to soils in the late 1940's, no widespread occurrence of "enriched" soils for preemergence herbicides had been reported.

Stauffer Chemical Company initiated research into the problem of accelerated or enhanced biodegradation of carbamothioates. Its weed scientists compared several techniques to investigate the phenomenon and introduced a microbial-enzymatic inhibitor for commercial use with selected carbamothioates.

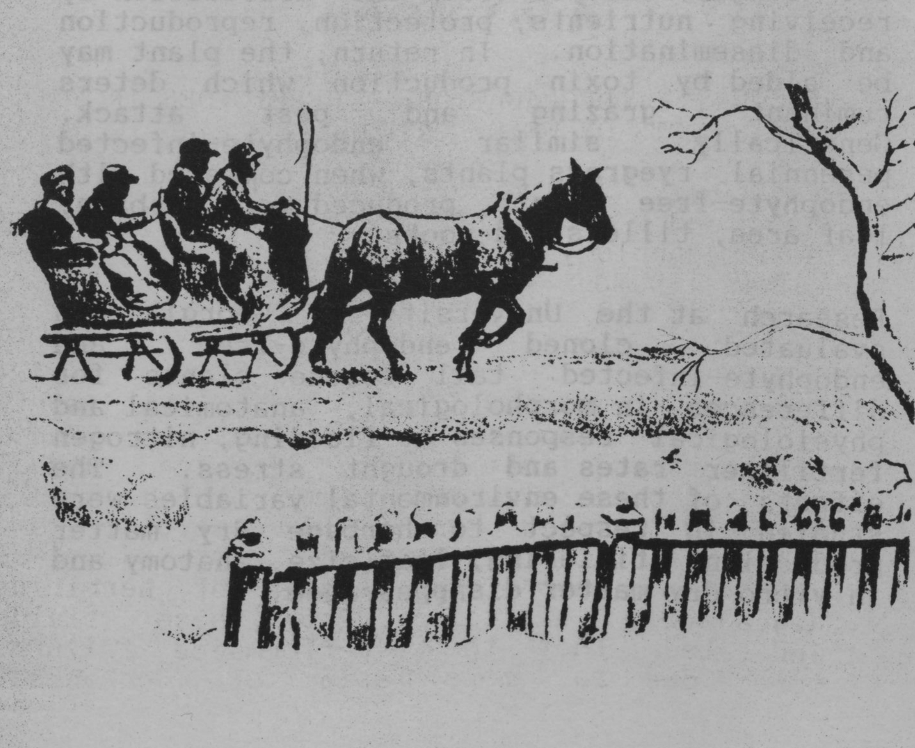
Another possibility with accelerated biodegradation is cross adaptation by soil microorganisms. If microbes become adapted to and could degrade Herbicide A, after repeated applications, would they also degrade Herbicide B and/or Insecticide Z ? Answers to these questions would assist the grower in his management program for pesticides subject to accelerated biodegradation.

The following papers were included as part of a symposium presented by the Weed Science Society of America to provide state-of-the-art information on accelerated biodegradation of herbicides.

HERBICIDES FROM NATURAL COMPOUNDS

S O Duke and J Lydon
Weed Technology
Volume 1 Number 4
Pages 122-128
1987

In the search for more cost-effective, efficacious, selective and environmentally safe herbicides, new strategies for discovery are being utilized. This trend is due, in part, to diminishing returns with traditional herbicide syntheses and screening methodologies and also to the promise of more rational methods to find new herbicide chemistries. Using natural product chemistries as the basis for new pesticides has been successful with insecticides [pyrethroids]. Industry is becoming aware that many natural compounds have a high potential to form the basis for commercially successful herbicides. Natural compound chemistries offer several potential advantages as herbicides. Although several natural products of higher plants have been patented as herbicides, none have been developed commercially. Many microbial products have been patented as herbicides and several have been or are being developed. The new tools of molecular biology and biotechnology are making natural products more attractive alternatives in herbicide discovery programs.

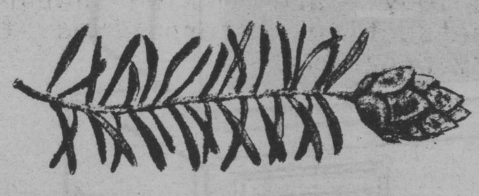


METHODOLOGY IN ACCELERATED BIODEGRADATION OF HERBICIDES

R V Subba-Rao, T H Cromartie and R A Gray
Weed Technology
Volume 1 Number 4
Pages 333-340
1987

Accelerated biodegradation of herbicides in soils can be demonstrated in the laboratory either by treating soil samples with an herbicide under conditions favorable for microbial growth or by sampling field soils soon after herbicidal treatment. Quantitative measurement of accelerated degradation in field soils is complicated by the difficulty both of obtaining a proper untreated soil and of obtaining a representative sample by proper mixing of treated soil. Both bacteria and fungi degrade herbicides and examples of either class of organisms can be isolated by suitable selection and enrichment conditions.

The enzymes involved in the initial steps of thiocarbamate biodegradation seem labile and have not been characterized. Studies of accelerated biodegradation of pesticides should measure the disappearance of the parent or active herbicide using chemical analyses or bioassays. Measuring accelerated biodegradation by determining metabolites [including carbon dioxide] is complicated by potential formation of other products, by incorporation of radioactivity into soil microflora, and by complex kinetics partly due to co-metabolism of the herbicide.



ENHANCED BIODEGRADATION OF HERBICIDES IN SOIL AND EFFECTS ON WEED CONTROL

R G Harvey, J H Dekker, R S Fawcett, F W Roeth and R G Wilson
Weed Technology
Volume 1 Number 4
Pages 344-349
1987

Research conducted since 1979 in the north central United States and southern Canada demonstrated that after repeated annual applications of the same thiocarbamate herbicide to the same field, control of some difficult-to-control weed species was reduced. Laboratory studies of herbicide degradation in soils from these fields indicated that these performance failures were due to more rapid or "enhanced" biodegradation of the thiocarbamate herbicides after repeated use with a shorter period during which effective herbicide levels remained in the soils. Weeds which germinate over long time periods were most likely to escape these herbicides after repeated use.

Adding dietholate reduced problems caused by enhanced biodegradation in soils treated previously with EPTC alone but not in soils previously treated with EPTC plus dietholate.

ACCELERATED DEGRADATION POTENTIAL OF SELECTED HERBICIDES IN THE SOUTHEASTERN UNITED STATES

C C Dowler, L R Marti, C S Kvien, H D Skipper, D T Gooden and J P Zublena
Weed Technology
Volume 1 Number 4
Pages 350-358
1987

The performance of pesticides depends on many environmental and edaphic factors, including soil type, clay and organic matter content, soil water potential, pH and temperature. Repeated applications of the same or similar herbicides decreased their effectiveness by accelerating microbial degradation.

The potential for repeated applications of the same or similar herbicides increases in irrigated fields where two or more crops are grown per year. This increases the potential for accelerated herbicide degradation and inadequate weed control.

Accelerated biodegradation of butylate and EPTC occurred in Southeastern Coastal Plain soils after as little as one previous application. This accelerated degradation was related to soil microbial activity. Although the rates of accelerated degradation were not the same for all soils, the same degradation trend occurred in all soils. EPTC degradation was accelerated in soils previously treated with butylate. Dietholate reduced but did not prevent accelerated degradation of butylate and EPTC. Up to six previous applications of alachlor or metalachlor did not accelerate degradation of these herbicides.

Computer Based Systems

TRAINED AND UNTRAINED INDIVIDUAL'S ABILITY TO IDENTIFY MORPHOLOGICAL CHARACTERS OF IMMATURE GRASSES

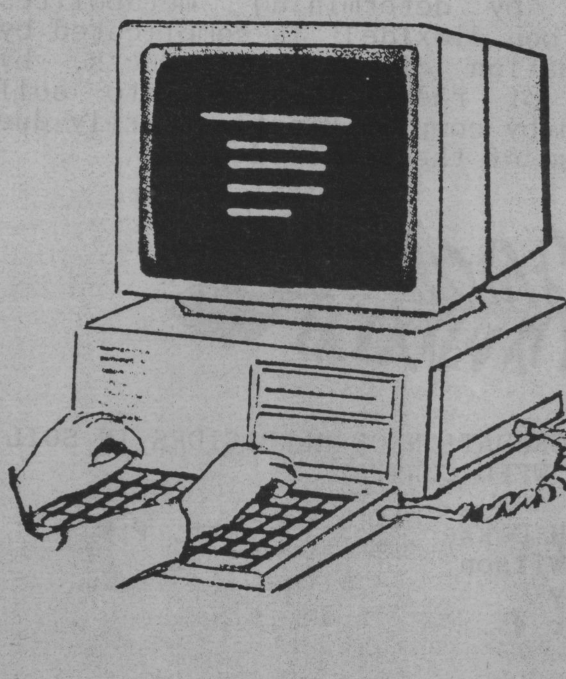
T W Fermanian, M Barkworth and H Liu
Agronomy Journal
Volume 81 Number 6
Pages 918-922
1989

Controlling weeds is a major operation in the maintenance of fine turf. The initial step in any control program is the correct identification of weed species and an assessment of their abundance. Grass weeds are particularly difficult to identify because of their similarity to turf species. In addition, frequent mowing removes the reproductive structures on which identification is usually based. Identification of juvenile grasses must, therefore, be based on the characteristics of vegetative structures. This is difficult because these characteristics are greatly affected by growing conditions.

One problem that affects both computer-based identification systems and written identification keys, is the inability of users to select the correct alternatives for some morphological characteristics or structures. Research at the University of Illinois has been designed to determine for each selected character whether individuals without training in plant identification could identify each character state correctly as often as trained individuals, and to determine if combining poorly distinguished character states would increase the value of a character for identification of the selected species.

Considered across all characters, the trained participants selected the correct alternative for a character 59 percent of the time, the untrained participants 53 percent. There was no significant association between training group and selection ability for: ligule size, sheath, blade width, collar and pubescence when all species were considered jointly.

The frequency with which ligule type was correctly identified was reanalyzed after combining the states of truncate or round and acute or acuminate. This modification increased the frequency of correctly identified ligule-type states from 47 to 62 percent and 31 to 49 percent for the trained and untrained groups respectively. On this basis, it is recommended that anyone attempting to construct an identification tool examine both the ability of characters to discriminate among the included species and the ability of expected users to select the correct state or condition of each character.



AGASSISTANT: AN ARTIFICIAL INTELLIGENCE SYSTEM FOR DISCOVERING PATTERNS IN AGRICULTURAL KNOWLEDGE AND CREATING DIAGNOSTIC ADVISORY SYSTEMS

T W Fermanian, R S Michalski, B Katz and J Kelly
Agronomy Journal
Volume 81 Number 2
Pages 306-312
1989

Agricultural scientists often provide advice to agricultural managers based on incomplete knowledge supplemented with their experience. Due to the variability of biological systems, agricultural knowledge is often unstable and may require periodic modification to reflect evolving conditions.

Research at the University of Illinois has produced Agassistant, a non-specialist artificial intelligence system for automatically determining, refining and evaluating diagnostic rules and patterns for agricultural decision problems. It has the ability to create general decision rules from examples of expert decisions. It can provide advice using these self-created rules or rules supplied by a system creator, and can also serve as a tool for developing expert or advisory systems.

Agassistant was first applied to build Weeder, a system for identifying 37 grass weed or turf species commonly found in turfs in the United States. To evaluate Weeder's potential for exclusive identifications, a program was developed to produce all possible combinations of variable values which lead to an exclusive identification of any grass represented in the system.

For most grasses, there were multiple ways of identifying each grass exclusively among all other grasses. Each identification required the selection of a value for an average of five variables. Weeder was found to be as efficient in the number of decisions required for an identification as the theoretical maximum efficiency for a dichotomous key covering the same species. Weeder represents an improvement over current methods of plant identification due to its ability to identify specimens through multiple sets of plant variables, use uncertain knowledge, allow the user to answer questions in any order, and be easily modified to reflect local differences in plant populations.

WEEDER: AN ADVISORY SYSTEM FOR THE IDENTIFICATION OF GRASSES IN TURF

T W Fermanian and R S Michalski
Agronomy Journal
Volume 81 Number 2
Pages 312-316
1989

In order to effectively control weeds found in turf, it is first necessary to correctly identify them.

Research at the University of Illinois has resulted in the building of a computer program, Weeder, using the artificial intelligence system Agassistant to provide a means for effectively identifying grass weed and turf species through the recognition of selected variables.

In order to measure the value of Weeder for identifying unknown grasses in comparison to a dichotomous identification key, 41 volunteers were assigned to one of two groups: first - those with any previous experience in plant diagnosis or any formal training in plant science; and second - those with no experience or training. Each individual identified 4 unknown grasses: creeping bentgrass, perennial ryegrass, zoysiagrass and large crabgrass using Weeder or a printed identification key.

The maximum mean of either group to identify a grass species was 55 percent of the specimens. This was achieved by participants with plant science training using Weeder. Participants with some plant science training had a higher mean identification of each species [23 percent identified] than participants with no training [18 percent] when using the identification key. Little difference in their ability to identify the unknown species was found between the two groups when they were using Weeder.

There was a significant increase in the mean ability of all participants to identify an unknown grass using Weeder [50 percent] rather than the identification key [20 percent] after rules for the 4 species were modified.

A demonstrated advantage of Weeder over the printed key was its ability to be easily modified to increase its usefulness. The mean percentage of correctly identified grasses by all participants increased from 11 to 50 percent after rules pertaining to the unknown grasses were modified to reflect variable values most consistently selected.

Turfgrass Nutrition

NITRATE AND AMMONIUM UPTAKE BY NITROGEN-DEFICIENT PERENNIAL RYEGRASS AND KENTUCKY BLUEGRASS TURF

D C Bowman, J L Paul and W B Davis
Journal American Society of Horticultural Science
Volume 114 Number 3
Pages 421-426
1989

Turfgrass management is fundamentally different from that of agricultural crops because the primary goal is to maintain appearance and vigor rather than high yields. This goal may be achieved, at least in part, through the judicious use of nitrogen fertilizers. Nitrogen is applied to turf every 1 to 4 months in amounts ranging from 25 to 50 kilograms nitrogen per hectare [22 to 44 pounds nitrogen per acre].

Research at the University of California-Davis has involved nitrogen uptake of two nitrogen-deficient turfgrass species. Nitrogen depletion was measured from a complete nutrient solution. The uptake rate of both nitrate and ammonium ions was enhanced 6-fold in nitrogen-deficient perennial ryegrass compared to nitrogen-sufficient controls, reaching a maximum of about 0.3 and 0.4 grams nitrogen per square meter per hour for nitrate and ammonium, respectively [0.06 and 0.08 pounds nitrogen per 1000 square feet]. Deficiency-enhanced uptake exceeded uptake by controls for about 72 hours following resupply of nitrogen. Nitrogen uptake was enhanced to a similar degree by nitrogen deprivation in Kentucky bluegrass.

Mowing had no effect on nitrate uptake by nitrogen-deficient perennial ryegrass turf, whereas mowing inhibited uptake by nitrogen-sufficient turf by about 60 percent. Deficiency-enhanced uptake was found to be the result of an increased capacity for nitrogen absorption rather than an increased affinity for nitrogen.

The results of this investigation support the interpretation that the rapid disappearance of nitrate and ammonium nitrogen fertilizers applied to turf in the field is due largely to plant absorption.

ALUMINUM EFFECTS ON GROWTH AND MACRONUTRIENT UPTAKE BY ANNUAL RYEGRASS

Z Rengel and D L Robinson
Agronomy Journal
Volume 81 Number 2
Pages 208-215
1989

Annual ryegrass is an important cool-season grass used for forage and turfgrass overseeding in the southeastern United States. Many soils used for ryegrass production in this region are acidic and contain potentially hazardous levels of soluble aluminum. However, the effects of aluminum on annual ryegrass have not been investigated in proportion to the importance of this grass. Genetic heterogeneity has hindered attempts to characterize many ryegrass cultivars according to aluminum tolerance.

Research at Louisiana State University has been concerned with four ryegrass cultivars. Based on the root and shoot tolerance indexes, the decreasing order of resistance to aluminum stress was Marshall > Gulf > Urbana > Wilo. The most sensitive indicator of aluminum tolerance was the root tolerance index.

The percentage inhibition of total calcium uptake may also be a useful indicator of aluminum-related plant damage. The more tolerant Marshall and Gulf maintained higher root zone solution pH values in the presence of aluminum than did Urbana and Wilo. It is believed that these pH differences were effects rather than causes of differential aluminum tolerance among the ryegrass cultivars.

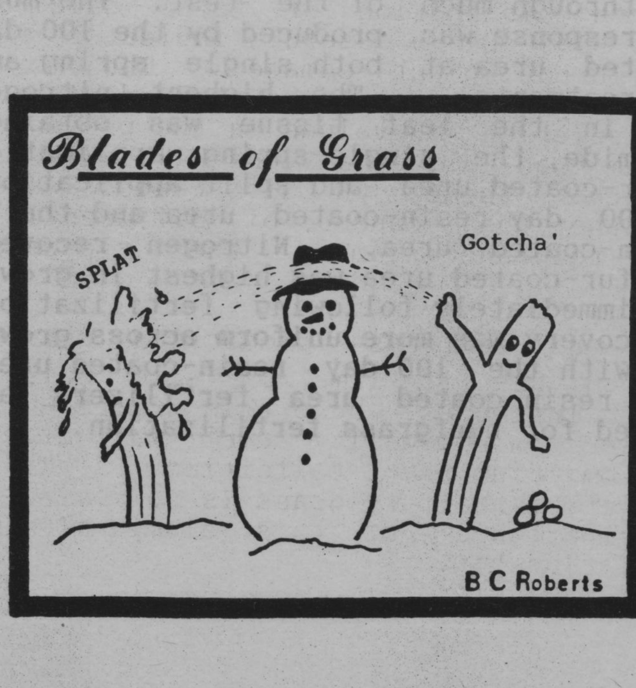
Editors Note: Turfgrass production places emphasis on use of lime on acid soils. However, in instances where this practice is not followed, poor quality turf may often result from aluminum toxicities. This research with annual ryegrass is a reminder of the importance of this aluminum-soil acidity relationship.

RAPID DEPLETION OF NITROGEN APPLIED TO KENTUCKY BLUEGRASS TURF

D C Bowman, J L Paul, W B Davis and S H Nelson
Journal American Society of Horticultural Science
Volume 114 Number 2
Pages 229-233
1989

Turfgrasses are often fertilized with soluble nitrogen fertilizers, such as ammonium nitrate, ammonium sulfate or urea, with typical amounts of 2.5 to 5 grams nitrogen per square meter [0.5 to 1.0 pounds nitrogen per 1000 square feet] applied as infrequently as once per year on low maintenance turf to as frequently as 12 times per year on high maintenance turf. Although nitrogen fertilization represents one of the most common turf management practices, only a few studies have examined the fate of nitrogen applied to turf. It has been reported that nitrate leaches below the turf root zone in sandy soils with high nitrogen application or with heavy irrigation or rainfall. Several investigators have shown that nitrogen may be lost as ammonia gas through volatilization following application of ammonium or urea fertilizers. Fertilizer nitrogen may also be lost from turfgrass soil or thatch by denitrification.

The process that has received the least attention is biological immobilization of the applied nitrogen. Rapid incorporation of the nitrogen by the plant and microorganisms would minimize losses caused by leaching or volatilization.



Research conducted at the University of California-Davis has measured the rate of depletion of nitrogen applied to turf under field conditions. The depletion of nitrogen applied to moderately nitrogen-deficient Kentucky bluegrass turf was measured using a soil sampling procedure. Nitrogen as either calcium nitrate or ammonium sulfate was applied in solution at 5 grams nitrogen per square meter [1 pound of nitrogen per 1000 square feet] and washed into the thatch and soil with an additional 0.3 centimeters of water. Both nitrogen forms were located primarily in the thatch and upper 1 centimeter of soil. The nitrate was present in the soil solution, while the ammonium was mainly exchangeable [86 percent]. The concentrations of nitrate and ammonium ions in the soil solution were 452 and 56 micrograms per milliliter, respectively [452 and 56 parts per million] in the upper 1 centimeter of soil. Depletion of both nitrate and ammonium from the turf was very rapid, with 70 to 80 percent of the applied nitrogen disappearing during the first 24 hours. Essentially all of the applied nitrogen was depleted by 48 hours. Results using labeled ammonium sulfate indicate that about 75 percent of the ammonium depletion is attributable to absorption by the turf. Similar results were obtained following fertilization of perennial ryegrass, tall fescue and creeping bentgrass.

It was concluded that, following a normal application of fertilizer nitrogen to turfgrass, inorganic nitrogen is depleted in 2 to 4 days and that the depletion is primarily the result of biological immobilization. Absorption by the turf is largely responsible for the disappearance, although the role of microorganisms in the rapid immobilization of nitrogen may be significant. Rapid deletion is likely facilitated by positioning the fertilizer in soil layers of high root length density or in the thatch. As a result of this rapid immobilization, very little of the applied nitrogen should be lost, at least in the short term, to leaching. This observation may also explain why turfgrass response to normal applications of nitrate or ammonium fertilizers is typically of short duration.

RESIN-COATED UREA EVALUATION FOR TURFGRASS FERTILIZATION

N W Hummel, Jr
Agronomy Journal
Volume 81 Number 2
Pages 290-294
1989

Slow-release fertilizers produced by coating technologies have provided the turfgrass industry with several alternatives to synthetic organic and inorganic sources. Sulfur-coated ureas, in particular, have compared favorably to other slow-release nitrogen sources and are now widely used in the turfgrass industry.

Several resin-coated materials have been marketed, but used primarily in the production of nursery and greenhouse crops. A creeping bentgrass turf fertilized with a resin-coated urea every 13 to 17 weeks was similar to that produced from monthly applications of soluble sources. In another test, 34 weeks of acceptable quality turf was produced from a single application of a resin-coated urea. In still another test, 3 applications of a resin-coated ammonium nitrate were necessary to maintain an acceptable level of quality on bentgrass throughout the season.

In the late 1970's, a new polyolefin resin coating was developed in Japan. When granular urea is coated with this resin, water moves through the resin film by osmosis into the capsule. Nitrogen release occurs when the urea solution diffuses back out. Nitrogen release can be controlled by using a surfactant that has a high affinity to water and the resin, and by controlling the added amounts of this surfactant. It is technically possible to produce products with release rates that range from 4 weeks to more than 1 year.

Research at Cornell University has had the objective of evaluating several experimental resin-coated ureas for fertilization of Merion bluegrass turf and to compare their effects on turf quality and growth with those of currently available nitrogen fertilizers. The resin-coated ureas tested had an analysis of 41 percent nitrogen and laboratory release rates of 270, 100 and 70 days, respectively. A mixture of resin-coated ureas, sulfur coated urea, urea, a 22-1.8-6.6 with 10 percent by weight dicyandiamide and oxamide were included for comparison. The fertilizers were applied at an annual rate of 196 kilogram nitrogen per hectare [165 pounds nitrogen per acre] as single spring or split spring and fall applications.

The most rapid response to fertilization, as measured by fresh weight yields and color ratings, was produced by urea followed in order by: sulfur-coated urea, 70 day resin-coated urea, and 100 day resin-coated urea. The release rate of the 270 day resin-coated urea was too slow to produce acceptable color ratings through much of the test. The most uniform response was produced by the 100 day resin-coated urea at both single spring and split treatments. The highest nitrogen recovery in the leaf tissue was obtained from oxamide, the single-spring application of sulfur-coated urea and split applications of the 100 day resin-coated urea and the 70 day resin-coated urea. Nitrogen recovery from sulfur-coated urea was highest in growth periods immediately following fertilization, while recovery was more uniform across growth periods with the 100 day resin-coated urea. Certain resin-coated urea fertilizers are well suited for turfgrass fertilization.

Soil Science

SOILS, SOIL SCIENTISTS AND CIVILIZATION
R J McCracken
Soil Science Society of America Journal
Volume 51 Number 6
Pages 1395 - 1400
1987

Several past civilizations have suffered and gone into eclipse or extinction due in greater part to lack of stewardship and/or knowledge of their soil resources. Since the middle of the 19th century, U S soil scientists have provided major findings, technological advances and intellectual leadership for the development of a highly productive agriculture sector that has contributed to a vigorous, dynamic civilization.

Our present civilization is being threatened by locally excessive soil erosion and other degradation of our natural resources, currently aggravated by rural economic problems. However, recent and current famines appear to be more closely related to economic and political factors than to deficiencies in soil resources. The quantity and quality of our global soil resources seem capable of supporting our civilization at least well into the 21st century, but local areas of hunger will continue due to local and regional economic conditions and various forms of political disruptions and repressions.

Humans now have the capability of degrading and polluting soil, water and air resources on a global scale - much too quickly. But, technologies for monitoring and controlling these degradations and for increasing our productivity are now becoming available or soon will be. We need to consider the immediate impact soil scientists can and should have in solving some of the pressing problems now plaguing our society, for as Charles Dickens wrote in the opening lines of his classic A Tale of Two Cities, "It was the best of times; it was the worst of times." It is now the best of times for soil science because never before have we had so much information about soils and their uses and so much interest and concern about the quantity and quality of our sol resources and their continued productivity.

SOME PERSONAL REFLECTIONS ON SOIL SCIENCE

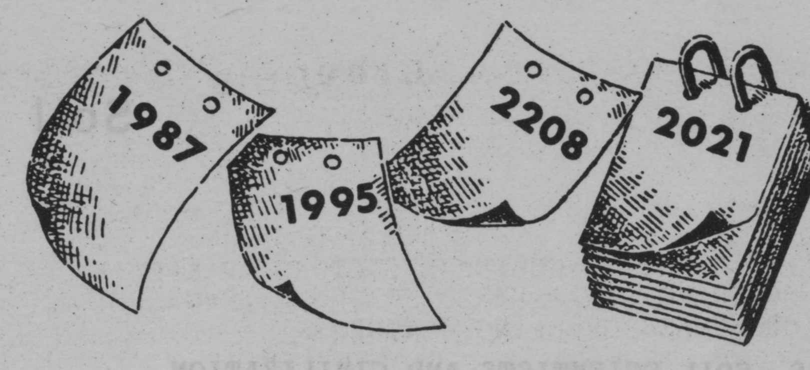
D G Aldrich, Jr
Soil Science Society of America Journal
Volume 51 Number 6
Pages 1401 - 1405
1987

The forces that drive the changes in soil science relate directly to funds supporting soil and plant research. Such funding is crucial in furthering our understanding of the fundamental chemistry, physics and biology of soils and our ability to relate and utilize this knowledge in solving soil-plant-water problems of agriculture however and wherever it is practiced today.

Over the past half century, U S agriculture has changed dramatically, moving more and more from an independent, production-oriented sector of the economy toward a technologically advanced, inter-dependent system that distributes food and fiber worldwide. As these changes in American agriculture continue to take place, the agricultural education and research system is being called upon to broaden the traditional context within which it has functioned in order to address significant societal concerns.

These legitimate societal issues include concerns about preserving the viability of our agricultural infrastructure, increasing the agricultural literacy among the general population, maintaining the quality of our environment and improving the health and nutrition of our citizens.

Thus, as the case is made for obtaining support for research in soil science and agriculture, it must contain evidence of how fundamental knowledge generated by research expands the foundation of applied or problem-solving research and development that is vital to society.

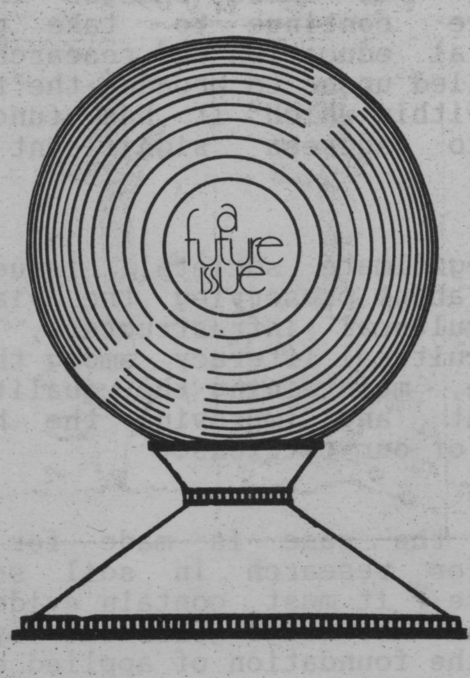


SOIL SCIENCE IN THE NEXT TWENTY-FIVE YEARS: DOES BIOTECHNOLOGY PLAY A ROLE ?

A Lauchli
Soil Science Society of America Journal
Volume 51 Number 6
Pages 1405 - 1409
1987

There is ample opportunity for biotechnology applications in future soil science research. In principle, all organisms are amenable to genetic engineering, including soil organisms and plants. Obviously, the research needs to have molecular biology and genetics skills to tackle genetic improvement of organisms. But, for the geneticist to succeed in this endeavor, the input by soil and plant scientists is crucial, because geneticists usually do not have the basic understanding of the issues of soil science that are involved, nor do they know how to assess the relative merits of the genetically engineered organism in its specific environment.

Not withstanding the complex legal aspects of releasing genetically engineered organisms, biotechnology opens exciting new possibilities in soil science. Close cooperation between geneticists on the one side and soil scientists and plant scientists on the other must be fostered if biotechnology is to be utilized for the benefit of maintaining the quality of our natural agricultural and urban environments.



SOIL BIOLOGY: ACCOMPLISHMENTS AND POTENTIAL

J M Lynch
Soil Science Society of American Journal
Volume 51 Number 6
Pages 1409 - 1412
1987

In the past decade, the development of techniques to measure the total soil biomass has enabled the demands and functions of the biota to be quantified, and has facilitated the identity of stresses and environments that limit microbial populations. Today we have the opportunity to investigate specific components of that biomass by using modern techniques, such as DNA fingerprinting and immunocytochemical techniques. Such investigations are an important prelude to providing an optimal biological environment in soil.

Traditionally, biological activity has been controlled by farming practices, such as liming and fumigation, and, although these are just as relevant today, there are new opportunities for inoculation with beneficial organisms. Attempts at inoculation in the field, with the exception of rhizobia, have not proved very reliable in the past because the complexity of the natural soil biological populations has not been unraveled.

Biotechnology has been defined in many different ways, but specifically, I have defined soil biotechnology as "The study and manipulation of soil micro-organisms and their metabolic processes to optimize crop productivity". Implicit in most definitions is the multi-disciplinary approach to biological problems and their solutions. Biotechnology should not be the preserve of the "gene jugglers" and its exploitation in soil management and crop production will only proceed satisfactorily if there is maximal communication between chemists, physicists, mineralogists, plant physiologists, geneticists, agronomists, ecologists, and biochemists/microbiologists.

Creeping Bentgrass & Annual Bluegrass

INFLUENCE OF CULTURAL FACTORS ON SPECIES DOMINANCE IN A MIXED STAND OF ANNUAL BLUEGRASS/CREEPING BENTGRASS

R E Gaussoin and B E Branham
Crop Science
Volume 29 Number 2
Pages 480 - 484
1989

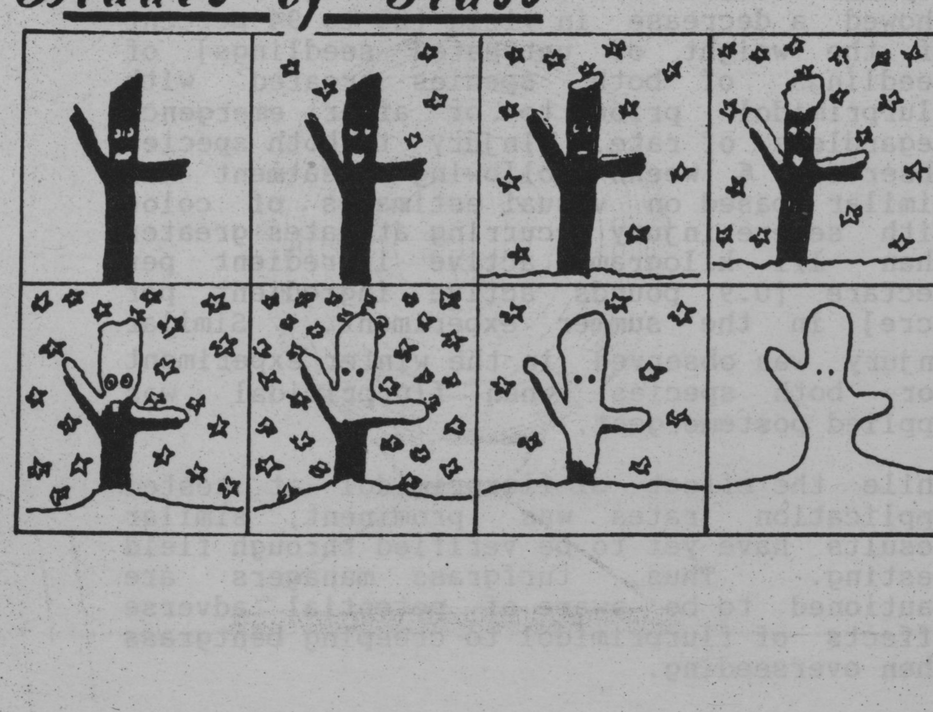
Annual bluegrass is a major grass component in most irrigated, close-cut, golf course fairways north of the transition zone. This is especially true in creeping bentgrass fairways that are maintained at clipping heights favorable for annual bluegrass.

Annual bluegrass is normally not desirable but is present as an invasive species. Invasion by annual bluegrass can occur via seed present in the soil or carried in by foot traffic or machinery. Once introduced, annual bluegrass can, over time, become the dominant component of the turf stand.

Research at Michigan State University has been conducted to determine the effect of five management factors and their interactions on the species composition of a mixed stand of annual bluegrass and creeping bentgrass maintained at 13 millimeters [1/2 inch]. The management factors investigated for 3 years were irrigation [daily at 75 percent open pan evaporation, triweekly at 11- percent open pan evaporation and at wilt]; clipping treatments [returned or removed]; nitrogen fertility at 98 or 293 kilograms nitrogen per hectare per year [88 or 264 pounds nitrogen per acre per year]; plant growth regulator treatments - mefluidide at 0.14 kilogram per hectare [0.125 pound per acre], EL-500 at 1.12 kilogram per hectare [1.0 pound per acre] and a control; and Penncross creeping bentgrass overseeded at 49 kilogram per hectare per year [44 pounds per acre per year] or not overseeded.

Returning clippings increased annual bluegrass 12 percent over plots in which clippings were removed. Overseeding with creeping bentgrass increased bentgrass populations 8 percent compared to plots irrigated daily at 75 percent open pan evaporation and not overseeded. Mefluidide in combination with high nitrogen fertility resulted in annual bluegrass populations 8 percent higher than control or EL-500 plots at the same fertility level. Mefluidide also increased annual bluegrass populations relative to control or EL-500 treatments when clippings were removed. The greatest decrease in annual bluegrass [28 percent] occurred with the treatment combination of clippings removed, overseeded and no plant growth regulator. Removal of clippings reduced the number of viable annual bluegrasss seeds in the soil by 60 percent.

Blades of Grass



FLURPRIMIDOL EFFECT ON THE EMERGENCE AND GROWTH OF ANNUAL BLUEGRASS AND CREEPING BENTGRASS

J E Haley and T W Fermanian
Agronomy Journal
Volume 81 Number 2
Pages 198 - 202
1989

Annual bluegrass is often a major component of golf course fairways, tees and greens. It generally produces abundant seed-producing inflorescences, even when mowed at heights of 6 millimeters [1/4 inch] or less. Large quantities of annual bluegrass seed in the soil present a problem during fairway, tee and green renovation. These seeds germinate quickly, compete strongly with creeping bentgrass, and thus, result in a mixed stand. Due to a lack of heat and drought resistance, annual bluegrass is generally considered a weed in turfs.

The application of the growth regulating compound flurprimidol can interfere with the emergence and early growth of creeping bentgrass used in overseeding programs, or cause sudden reductions in either species population. Research at the University of Illinois has determined the effects of flurprimidol on germinating seeds and young seedlings of annual bluegrass and Penneagle creeping bentgrass in greenhouse trials. Flurprimidol at 0.6, 0.8, 1.1 and 2.3 kilogram active ingredient per hectare [0.5, 0.7, 0.9 and 2.0 pounds active ingredient per acre] was applied preemergence or postemergence to plants 3 to 6 centimeters [1 to 2 inches] in height.

Verdure collected 6 weeks following treatment showed a decrease in yield [25 to 94 percent of the weight of untreated seedlings] of seedlings of both species treated with flurprimidol prior to or after emergence regardless of rate. Injury to both species observed 6 weeks following treatment was similar based on visual estimates of color with severe injury occurring at rates greater than 1/1 kilogram active ingredient per hectare [0.9 pounds active ingredient per acre] in the summer experiment. Similar injury was observed in the winter experiment for both species when flurprimidal was applied postemergent.

While the effect of flurprimidol at tested application rates was prominent, similar results have yet to be verified through field testing. Thus, turfgrass managers are cautioned to be aware of potential adverse effects of flurprimidol to creeping bentgrass when overseeding.

BERMUDAGRASS ENCROACHMENT INTO CREEPING BENTGRASS AS AFFECTED BY HERBICIDES AND PLANT GROWTH REGULATORS

B J Johnson and R N Carrow
Crop Science
Volume 29 Number 5
Pages 1220 - 1227
1989

Creeping bentgrass use on golf greens is expanding rapidly into the southern regions of the transition zone. Improved cultivars and the ability of turf growers to manage bentgrass where high temperature, high humidity and intensive disease stress occur have permitted its use in the Southeast.

Creeping bentgrass used for greens in the Southeast usually is surrounded by bermudagrass collars and aprons. Since bermudagrass grows well during the summer months when bentgrass is under stress, encroachment of bermudagrass into bentgrass creates a severe contamination problem. The mixture of the two grasses results in a poor-quality putting surface. Effective control of bermudagrass without concurrent bentgrass injury is a desirable management practice.

Research at the University of Georgia has been initiated to determine the effects of dates and frequency of herbicide-plant growth regulator treatments on tolerance of creeping bentgrass and encroachment of three bermudagrass cultivars under golf green conditions.

Creeping bentgrass was injured more when treated with various herbicide-plant growth regulator combinations in September than in April. However, creeping bentgrass injury was unacceptable [greater than 30 percent] with mefluidide applied in sequence with siduron or ethofumesate at either date. In general, herbicide-plant growth regulator treatments applied in April suppressed foliage and stolon growth of bermudagrass equal to or better than treatments applied in September and April. Bermudagrass growth was effectively suppressed until late May or early June when treated with siduron, siduron with flurprimidol or ethofumesate with flurprimidol. There generally was no difference in foliar growth suppression from treatments applied to Tifway, Tifgreen and common bermudagrass. When chemicals were applied only in April, the length and number of bermudagrass stolons were effectively suppressed for several weeks but stolon growth recovered and increased rapidly from mid-May until June. The suppression of stolon growth of all bermudagrass cultivars in June was as good or better when treated with ethofumesate plus flurprimidol than with other treatments.

NITRATE AND AMMONIUM LEACHING LOSSES FROM NITROGEN FERTILIZERS APPLIED TO PENNCROSS CREEPING BENTGRASS

C F Mancino and J Troll
HortScience
Volume 25 Number 2
Pages 194 - 196
1990

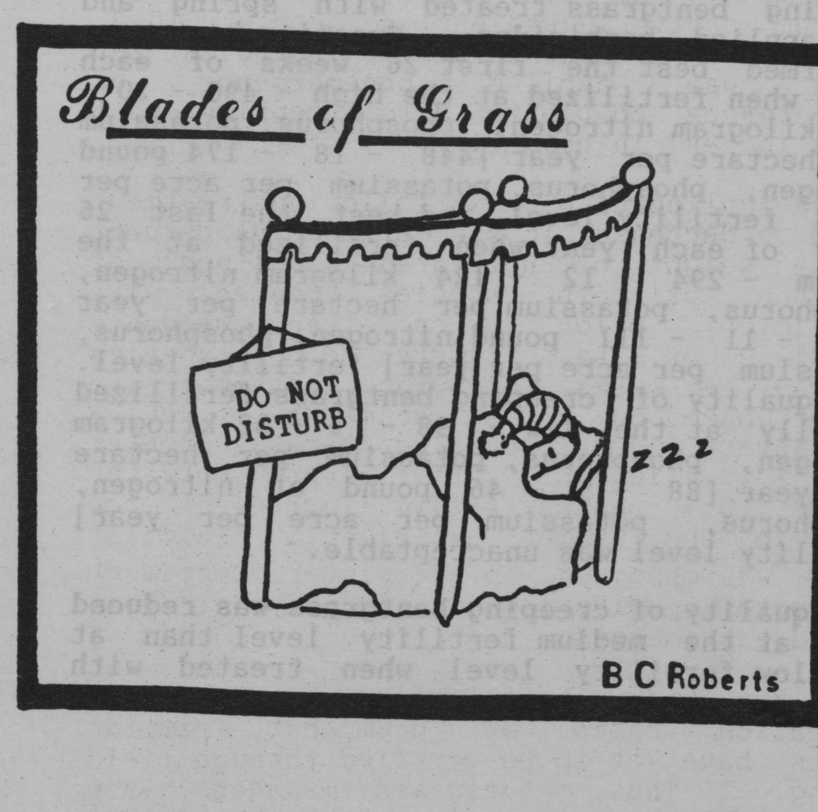
Sand, sand:peat, and sand:peat:soil mixtures make excellent root-zone mediums for golf course putting greens because they are well-aerated, increase rooting depth, and, to a degree, resist compaction. However, because of a lack of an adequate soil moisture reserve, low nutrient retention, and innate infertility, there is a need to frequently irrigate and fertilize turf growing on these artificial soil mixtures. As a result, the potential for leaching losses of nutrients, particularly nitrogen, is high. High nitrate levels in surface and groundwater make it unfit for human consumption and serve as a nutrient for undesirable microorganisms and aquatic higher plants.

Nutrient leaching losses can be low from fertilizers applied to turfgrass or pasture grasses on native soils. This appears to be true even when quick-release [highly water soluble] nitrogen sources are applied at excessive rates. The low leaching losses from these grass swards can be partially attributed to the efficiency of the grass root system in exploiting nutrients.

General findings indicate that nitrogen leaching losses, occurring primarily as nitrate, are higher from quick-release nitrogen sources and are enhanced by well-drained sandy soils. Research at the University of Massachusets has involved a greenhouse study conducted to determine leaching losses of nitrate and ammonium nitrogen from Penncross creeping bentgrass growing on an 80 sand:20 peat soil mixture following frequent, moderately heavy irrigations and light or moderate nitrogen fertilizer applications. Nitrogen sources included calcium nitrate, ammonium nitrate, ammonium sulfate, urea, urea formaldehyde and isobutylediene diurea. Application levels were 9.76 kilograms nitrogen per hectare [8.72 pounds nitrogen per acre] per 7 days and 19.52 kilograms nitrogen per hectare [17.43 pounds nitrogen per acre] per 14 days for 10 weeks. Irrigation equivalent to 38 millimeters [1 1/2 inches] per week was applied in 3 equal applications.

Overall, 46 percent of the applied water leached. Total leaching losses were less than 0.5 percent of the applied nitrogen. Nitrate represented the major portion of the leached nitrogen, with ammonium losses being negligible. There were no differences between sources when applied at these levels.

In a second study, a single 48.8 kilogram nitrogen per hectare [44 pound nitrogen per acre] application resulted in higher leaching losses of nitrogen, but only calcium nitrate and ammonium nitrate had total losses greater than 2 percent [2.8 percent and 4.13 percent respectively over an 11-day period]. Nitrate concentrations were found to exceed 45 milligrams per liter [45 parts per million] for ammonium nitrate,



HERBICIDE X ANNUAL FERTILITY PROGRAMS INFLUENCE ON CREEPING BENTGRASS PERFORMANCE

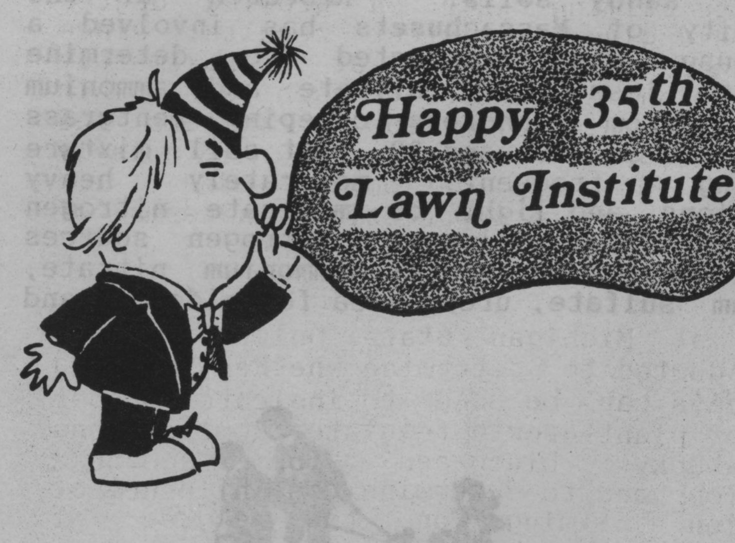
B J Johnson
Agronomy Journal
Volume 82 Number 1
Pages 27 - 33
1990

Performance of creeping bentgrass used for high quality golf greens in the transition zone and upper South depends on several factors. Improved cultivars and the ability of turf growers to manage the grass under environments of high temperature, high humidity and with intensive disease pressure have resulted in increased bentgrass use.

To maintain good quality putting green creeping bentgrass turf, it is often necessary to apply herbicides for summer and winter weed control. Most herbicides will cause some degree of bentgrass injury while growing in stress conditions; thereby, it is important that good fertilization programs be used for necessary grass recovery.

Research at the University of Georgia has been initiated to determine the effects of annual fertilizer programs on performance of creeping bentgrass treated with spring and fall-applied herbicides. Creeping bentgrass performed best the first 26 weeks of each year when fertilized at the high - 490 - 20 - 195 kilogram nitrogen, phosphorus, potassium per hectare per year [448 - 18 - 174 pound nitrogen, phosphorus, potassium per acre per year] fertility level and best the last 26 weeks of each year when fertilized at the medium - 294 - 12 - 124 kilogram nitrogen, phosphorus, potassium per hectare per year [263 - 11 - 111 pound nitrogen, phosphorus, potassium per acre per year] fertility level. The quality of creeping bentgrass fertilized annually at the low - 98 - 6 - 52 kilogram nitrogen, phosphorus, potassium per hectare per year [88 - 5 - 46 pound of nitrogen, phosphorus, potassium per acre per year] fertility level was unacceptable.

The quality of creeping bentgrass was reduced less at the medium fertility level than at the low fertility level when treated with oxadiazon and bensulide plus oxadiazon. Ethofumesate applied in the fall 1986 maintained the highest quality ratings at the high fertility level until mid-April when the quality was the same whether fertilized at the medium or high level. In most instances in 1987, the quality of creeping bentgrass treated with ethofumesate at the medium fertility level was equally as good as when treated with the same herbicide but at the high fertility level. When fertilizer by herbicide interaction occurred, creeping bentgrass maintained a higher quality at the medium to high fertility level than at the low fertility level.



Kentucky Bluegrass

GROWTH SUPPRESSION OF KENBLUE KENTUCKY BLUEGRASS USING PLANT GROWTH REGULATORS AND DEGREE DAY APPLICATION TIMING

B E Branham and T K Danneberger
Agronomy Journal
Volume 81 Number 5
Pages 749 - 752
1989

Plant growth regulators are commonly used to suppress vegetative and reproductive growth of grasses. The regulators have been successfully incorporated into highway roadside vegetation management programs to eliminate seedhead production and reduce mowing requirements. In addition, mefluidide has been shown to increase first harvest forage quality of several cool season forage species. The improvement in forage quality is thought to arise from the suppression of seedhead development. Unfortunately, the improvement in forage quality is offset by the decline in dry matter yield.

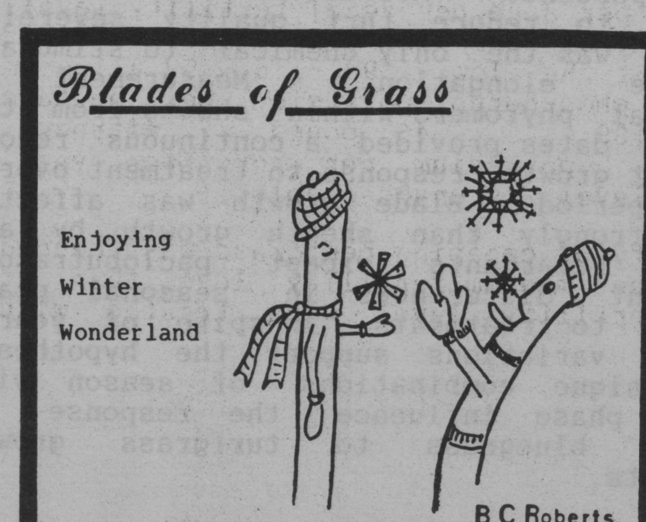
A difficulty encountered in the use of plant growth regulators for both forage and turfgrass management is the variable results observed from year to year when application timing is based on calendar days. Application timing based on growing degree days should give consistent results, since applications would be made at approximately the same plant growth stage each year. This would benefit highway roadside managers and other turfgrass managers by precisely defining the application window for reproductive growth suppression in terms of plant growth stage.

Research at Michigan State University has been conducted to determine whether growing degree days can be used to indicate proper timing of plant growth regulator applications on Kentucky bluegrass for seedhead suppression and to determine the influence of application timing on the degree of vegetative growth suppression.

Mefluidide at 0.28 kilogram per hectare [0.25 pound per acre] and amidochlor at 2.8 kilogram per hectare [2.5 pound per acre] were applied to a uniform stand of Kenblue Kentucky bluegrass at 25, 50, 75, 100, 125 and 150 growing degree days. Trials were conducted in East Lansing, Michigan in 1985 and 1986 and in Columbus, Ohio in 1986.

Application of plant growth regulator between 25 and 125 growing degree days provided excellent [greater than 86 percent] seedhead control. Mefluidide and amidochlor applications at 150 growing degree days gave 31 and 24 percent seedhead control, respectively, indicating that seedhead control was lost with this application timing.

Clipping weights at East Lansing varied between years with only the 150 growing degree day application in 1985 and the 75 growing degree day in 1986 differing significantly from the other application timings. However, the 75 growing degree day treatment in 1986 had reduced plant growth regulator activity because of rainfall 5 hours after application. Application timing of plant growth regulator appeared to have no significant effect on the degree of vegetative growth suppression. However, growing degree day timed plant growth regulator applications are a valid technique for seedhead control in Kentucky bluegrass.



SEASONAL APPLICATION OF ETHEPHON, FLURPRIMIDOL, MEFLUIDIDE, PACLOBUTRAZOL, AND AMIDOCHLOR AS THEY AFFECT KENTUCKY BLUEGRASSS SHOOT MORPHOGENESIS

K L Diesburg and N E Christians
Crop Science
Volume 29 Number 4
Pages 841 - 847
1989

The use of turfgrass growth retardants from the 1950's to the early 1970's was restricted to areas of low use and visibility because of phytotoxicity. Retardants released in the late 1970's and early 1980's cause less discoloration and thinning of turf, but their activity has been inconsistent. Plant receptivity to growth regulation has also been shown to vary among and within species. Plant response to growth regulation may vary with seasonal plant growth phase or even with daily fluctuations in weather.

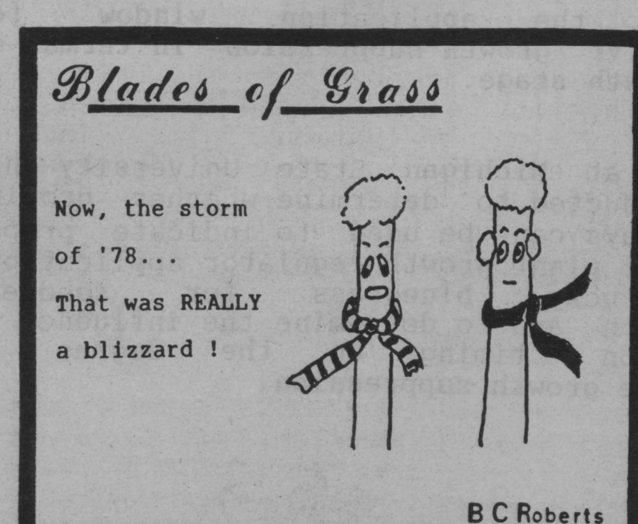
Research at Iowa State University has involved use of five growth regulators during three growth phases of Kentucky bluegrass: Spring reproductive, Summer vegetative and Fall reproduction -inductive. The objectives were to investigate the effect of application timing through the season and to compare the major effects of each chemical on growth, quality and leaf morphogenesis. Amidochlor and mefuidide were fast acting and most effective in Spring with nearly complete growth restriction during the second and third weeks after application. Paclobutrazol and flurprimidol were slow acting with an average of 16 percent growth reduction which peaked 5 and 10 weeks after treatment, respectively. Ethephon effects were continuous throughout the 10 week measurement period, restricting growth an average of 30 percent. Flurprimidol was most effective in Summer, whereas ephephon and paclobutrazol had similar effectiveness across seasons. Mefluidide prevented spring heading completely while amidochlor reduced heading by 79 percent. Mefluidide was the only chemical to reduce turf quality severely. Ethephon was the only chemical to stimulate internode elongation. Measurement of individual phytomers within shoots from two sampling dates provided a continuous record of plant growth response to treatment over a 6 week period. Blade growth was affected more strongly than sheath growth by all growth retardants except paclobutrazol. Consistent differences in seasonal plant response to treatments, in spite of yearly climate variations support the hypothesis that unique combinations of season with growth phase influence the response of Kentucky bluegrass to turfgrass growth retardants.

ROOT AND RHIZOME GROWTH OF KENTUCKY BLUEGRASS FOLLOWING APPLICATION OF PENDIMETHALIN

R J Cooper, P C Bhowmik and L A Spokas
HortScience
Volume 25 Number 1
Pages 84 - 86
1990

Preemergence herbicides are applied routinely to turfgrass for control of annual grassy weeds. Although the benefits of annual grass control are well known, concerns exists as to whether preemergence herbicides may adversely affect the growth of desirable turf species. Many of the commonly used preemergence herbicides have been shown to have inhibitory effects on the growth of cool-season turfgrasses. In addition, cultivars within a particular species may vary in their ability to tolerate preemergence herbicides without injury.

Research at the University of Massachusetts has been conducted to determine the response of Adelphi, Baron, Bensun, Merion and Touchdown Kentucky bluegrass to preemergence applications of the herbicide pendimethalin applied during 2 years at 1.7 or 3.4 kilogram per hectare - active ingredient [1.5 or 3.0 pound• per acre - active ingredient]. Pendimethalin controlled smooth crabgrass effectively without injury to turf. Pendimethalin at 3.4 kilogram per hectare [3.0 pound per acre] resulted in a short-term suppression of root growth immediately following application in the first year of the study. The reduction was transitory and subsequent rooting and rhizome growth were unaffected by pendimethalin. Thus, the herbicide appears to be a safe, effective preemergence material for crabgrass control in Kentucky bluegrass turf.



Soils and Soil Water

RESPONSES OF TALL AND HARD FESCUE TO DEFICIT IRRIGATION

J D Fry and J D Butler
Crop Science
Volume 29 Number 6
Pages 1536 - 1541
1989

Potential evapotranspiration rates of many turfgrass species have now been determined. Turfgrass water use rates often exceed natural precipitation, and during extended periods without rainfall, restrictions may be imposed limiting water that can be applied to turf areas.

To conserve water during periods of restricted irrigation, water may be applied to turf areas in amounts less than the potential evapotranspiration. This is referred to as deficit irrigation. Ideally, deficit irrigation would be used to supply less water than lost by potential evapotranspiration with little resultant loss of turf aesthetic quality.

Research at Colorado State University was conducted on Rebel tall and Reliant hard fescue to determine turf responses to deficit irrigation and to evaluate the effect of irrigation frequency on turf quality. Turf was irrigated at 50, 75, and 100 percent of potential evapotranspiration on 2, 4, and 7 day intervals.

Both species performed best when irrigated every 2 or 4 days at 75 or 100 percent potential evapotranspiration. Tall fescue exhibited exceptional drought resistance. When watered every 2 days, irrigation at 50 percent potential evapotranspiration resulted in only small reductions in tall fescue visual quality. Hard fescue performed poorly under the same irrigation regime. Increased water conservation in semi-arid regions may result if tall fescue is used more extensively and irrigated at 50 percent potential evapotranspiration every 2 days or 75 percent potential evapotranspiration every 2 to 7 days.

SEASONAL AND SPECIES VARIATION IN BASELINE FUNCTIONS FOR DETERMINING CROP WATER STRESS INDICES IN TURFGRASS

G L Horst, J C O'Toole, and K L Faver
Crop Science
Volume 29 Number 5
Pages 1227 - 1232
1989

Methods of estimating plant water status and indicators for irrigation scheduling are needed in the turfgrass and landscape maintenance industries. Improved water stress indicators would use the plant as it responds to aerial and soil environments.

Empirically, based relationships between canopy temperature minus air temperature regressed on vapor pressure deficit have been described as measures of crop water stress indices and as indicators for irrigation scheduling. Research at Texas A & M University has been conducted to determine seasonal and turfgrass species variation in empirical-baseline functions. Empirical and energy-balance crop water stress indices functions also were compared to determine which was the most accurate estimate of crop water stress indices over the range of turfgrass species and conditions studied. Texoka buffalograss, Arizona common bermudagrass, Raleigh St Augustinegrass and Falcon turf type tall fescue were studied. The crop water stress indices relationships were calculated from the two lowest canopy temperatures in each plot during 7 July to 1 August 1986 and 30 August to 11 September 1987.

Differences between crop water stress indices baseline functions from 1986 and 1987 for common bermudagrass, buffalograss and tall fescue were highly significant. Mean values of net radiation, vapor pressure deficit and wind speed also were significantly different for the seasons. Vapor pressure deficit usually accounted for more than 50 percent of the variability in canopy temperature minus air temperature across seasons and turfgrass species.

INFLUENCE OF SILT AND CLAY ON THE PHYSICAL PERFORMANCE OF SAND-SOIL MIXTURES

R W Whitmyer and G R Blake
Agronomy Journal
Volume 81 Number 1
Pages 5 - 12
1989

Modifying soil for landscaped areas with unique constraints, such as athletic fields and roof gardens, has become accepted as a means of assuring optimum plant development. The addition of a preformulated soil mixture to an area provides for uniform texture, structure and profile characteristics necessary for successful plant management practices.

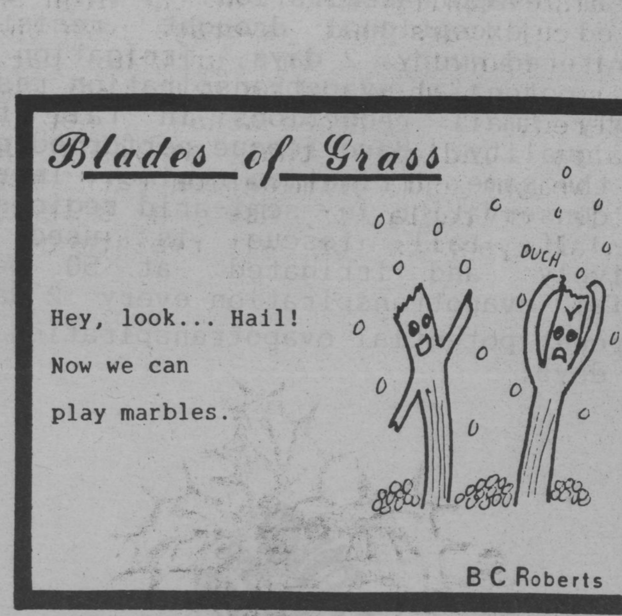
Commonly recommended mixture formulations include sand with added soil and an organic component, such as peat. Soil mixtures having high sand content provide a physical environment suitable for the growth and development of plants, even after compaction and consolidation. The soil and organic components add to the water and nutrient holding capacity of the substrate and provide a buffer to desiccation and nutrient deficiencies.

Although specific recommendations for mixture composition and performance characteristics have been proposed, the sensitivity of the mixture to small differences in component properties can result in final mixtures that differ markedly in physical performance. Specifications for sand, the major component of mixtures, have undergone the most refinement. The structural quality of the soil used in sand-soil mixtures is important in the performance characteristics of the mixtures.

Research at the University of Minnesota has been conducted to determine the effect of variation in the relative amount of silt and clay in soil mixtures having high sand content, on soil physical properties, including direct shear strength, air-filled porosity, saturated hydraulic conductivity, and unsaturated hydraulic diffusivity, and the effect on the type and degree of particle migration occurring during near-saturated water flow. Soil mixtures having sand contents ranging from 80 to 92 percent by weight and silt/clay ratios varying from 0.2 to 4.8 were formulated using seven soils. For 28 mixture combinations, determinations were made for shear strength, air-filled porosity, saturated hydraulic conductivity and hydraulic diffusivity. The extent and texture of particles migrating during saturated water flow were also determined.

Sand content was the primary variable determining physical properties of the soil mixtures, the magnitude of measured differences being greater for variations in sand content compared to variations in silt/clay ratio. Variations in the mixture silt/clay ratio did however result in significant differences in properties. As the silt/clay ratio increased from 0.2 to 4.8 in a soil sample having a sand content of 88 percent, shear strength decreased and air-filled porosity increased. Saturated hydraulic conductivities and the volume of migrating particles increased as the silt/clay ratio increased at a given sand content.

It is concluded that the lower the silt/clay ratio within the limits studied, the better the substrate for plants. As a practical consideration, soils with silt/clay ratios lower than 2 to 2.5 are uncommon, and it is therefore unfeasible to expect that those soils with silt/clay ratios below this range will be available for most construction.



GERMINATION AND SEEDLING GROWTH OF PERENNIAL RYEGRASSES IN SOLUBLE SALTS

G L Horst and N B Dunning
Journal American Society of Horticultural Science
Volume 114 Number 2
Pages 338 - 342
1989

Perennial ryegrasses are widely used in the southern and southwestern United States for overseeding dormant warm-season turfgrasses. However, saline conditions often limit the establishment and quality of perennial ryegrasses for turf use. Salts concentrate in the soil from use of poor-quality water; soil solutions can reach harmful concentrations.

Research at Texas A & M University was conducted with seeds of perennial ryegrass cultivars germinating and growing on floating mats in saline hydroponic solutions. This study was done to determine the relative intraspecific salt resistances of 48 perennial ryegrasses during germination and seedling growth. Total germination, germination rate, leaf blade length, root length and total seedling fresh and dry weight were measured after 21 days. Test solutions utilized equal quantities of sodium chloride and calcium chloride by weight to create low, medium and high salinity levels.

Cultivars had highly significant total germination and germination rate responses to salt stress. Seedling growth responses as measured by blade and root length and weights were also significant. At the high salinity level, cultivars that average less than a 50 percent reduction in growth parameters relative to high-yielding cultivars should be considered. Broad-sense heritability estimates indicate that seedling dry and fresh weight and germination rate would be valuable criteria for use in selection of perennial ryegrass for salt resistance.

Evapotranspiration

EFFECTS OF FLURPRIMIDOL, MEFLUIDIDE, AND SOIL MOISTURE ON ST AUGUSTINEGRASS EVAPOTRANSPIRATION RATE

R L Green, K S Kim and J B Beard
HortScience
Volume 25 Number 4
Pages 439-441
1990

Plant growth regulators have been effective in suppressing shoot growth and/or seedhead development of cool-season and warm-season turfgrasses. Since water costs are projected to increase and water availability to decrease, research is needed concerning methods to reduce turfgrass water used. Shoot growth rate and evapotranspiration rate of Texas common St Augustinegrass and Tifway bermudagrass have been reduced by applications of plant growth regulators. Vertical leaf elongation rate was a prime determinant for assessment of evapotranspiration rate of turfgrasses.

Research at Texas A and M University has been conducted to determine the effects of plant growth regulators and soil moisture level on evapotranspiration rate, leaf extension rate and turfgrass quality of Texas common St Augustinegrass grown under glasshouse conditions. Both flurprimidol and mefluidide affected evapotranspiration rate, leaf extension rate and turfgrass quality, whereas the durations of the responses to both plant growth regulator treatments were affected by soil moisture level. For both soil moisture levels, the durations of significant reduction in evaportransporation rate, leaf extension rate and turfgrass quality were longer for flurprimidol than for mefluidide. Application of either plant growth regulator at either soil moisture level caused a reduction in evapotranspiration rate averaging 18 percent and a reduction in leaf extension rate averaging 83 percent. **Flurprimidol was more effective than mefluidide in terms of evapotranspiration rate and leaf extension reduction. However, the considerably longer duration of reduced turfgrass quality of flurprimidol-treated turf was a negative effect.**

EVAPOTRANSPIRATION OF COOL-SEASON GRASSES GROWN WITH MINIMAL MAINTENANCE

J A Doty, W S Braunworth, S Tan, P B Lombard and R D William
HortScience
Volume 25 Number 5
Pages 529 - 531
1990

In Western Oregon, some fruit and vines are not irrigated. Crops rely on stored soil moisture during the hot, dry periods. The Willamette Valley receives an average of 760 to 1020 millimeters [31 to 41 inches] of precipitation per year, most occurring in the fall through early summer. Orchard or vineyard alleys are typically maintained with sod cover or as bare ground using herbicides or a flail. Grass strips are recommended to reduce soil erosion, improve traffic conditions, and reduce soil compaction. In addition, sod extracts soil moisture and can reduce late-season vegetative growth on certain grape production sites. Disadvantages of using grass-cover crops include possible increased frost hazard and competition for soil nutrients and water.

Research at Oregon State University measured evapotranspiration of three perennial ryegrass cultivars, Elka, Manhattan II and Derby, and one cultivar each of colonial bentgrass [Highland] and tall fescue [Olympic] in the field. Under minimal maintenance [no irrigation and infrequent mowing], evapotranspiration was not different for the five perennial grasses. All grasses used more water than was lost from the bare-ground treatment. Soil water uptake was greatest in the upper soil layer - 0 to 25 centimeters [0 to 1 inch] and decreased with depth. Few differences in water uptake were noted among grasses within each soil layer.

Grass water used in western Oregon peaks in late Spring or early Summer and declines as soil water is depleted through the season. Other characteristics, such as establishment rate and wear tolerance may be more important considerations than water use when choosing a grass species as a cover crop in a low-maintenance system.

LEAF BLADE STOMATAL CHARACTERIZATIONS AND EVAPOTRANSPIRATION RATES OF 12 COOL-SEASON PERENNIAL GRASSES

R L Green, J B Beard and D M Casnoff
HortScience
Volume 25 Number 7
Pages 760-761
1990

A major concern in the development of minimal maintenance turfs is the breeding of grasses with increased drought resistance and/or reduced evapotranspiration rates while maintaining acceptable turf quality under irrigated conditions. Although stomata comprise only about 1 percent of the total leaf blade surface area, they serve as key sites for transpiration and thus are of interest in reducing water loss. St Augustinegrass that is adequately watered has 20 to 30 percent of actual evapotranspiration controlled by resistance of the leaf epidermis and stomata, but evapotranspiration is influenced to a much greater extent by aerodynamic and canopy resistances. Differences in evapotranspiration rate and stomatal density have been found among turfgrasses.

Research conducted at Texas A and M University has characterized the stomatal densities of 12 perennial cool-season turfgrasses, including nine species and has assessed their associated evapotranspiration rates under nonlimiting soil moisture conditions and uniform cultural practices in a controlled-environment simulation chamber.

Significant differences in stomatal density were found among the 12 grasses on both leaf surfaces. Significant differences were also found in evapotranspiration rates. The Kentucky bluegrass cultivars exhibited the highest evapotranspiration rates, while the fine-leaved fescues exhibited the lowest rates, except for Big Horn sheep fescue which exhibited an intermediate rate. No correlation was found between evapotranspiration rate and either adaxial or abaxial stomatal density. It was concluded that, under nonlimiting soil moisture conditions, stomatal density was not reliably associated with evapotranspiration rate.

Breeding programs designed to develop water-conserving turfgrasses, especially for irrigated conditions, should place priority on plant characteristics that increase canopy resistance and decrease leaf area, rather than attempting to manipulate leaf stomatal density, which has little effect on evapotranspiration rate under nonlimiting soil moisture conditions.

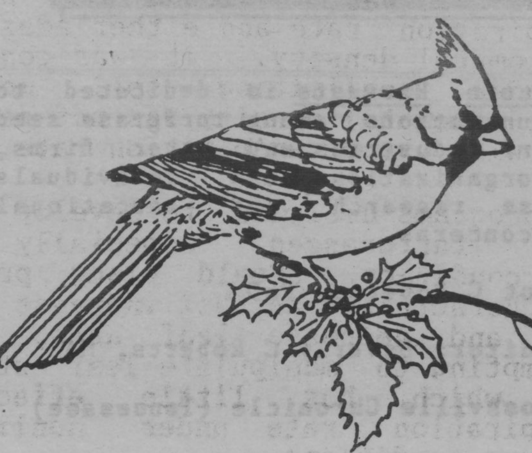
PLANT COMPETITION

PEACH TREE GROWTH AS INFLUENCED BY GRASS SPECIES USED IN A KILLED-SOD PLANTING SYSTEM

W V Welker and D M Glenn
HortScience
Volume 25 Number 5
Pages 514-515
1990

The traditional method of soil preparation for planting fruit trees has been to plow and cultivate the soil to provide a vegetation-free area. This type of soil management results in unprotected soil and potential soil erosion. Erosion losses can be excessive under certain rainfall and topographic conditions. The establishing of a living sod and then killing the sod with herbicides and planting peach trees in the undisturbed killed sod, resulted in greater tree growth and fruit yield than the conventional method. The killed-sod system retarded the depletion of organic matter and increased water infiltration rates, aggregate stability and macroporosity, while reducing rainfall runoff.

Research at the Appalachian Fruit Research Station, Kearneysville, West Virginia has had the objective of evaluating grass species in a killed-sod management system to determine whether Kentucky-31 fescue was unique in its ability to influence peach tree growth when used to develop a killed-sod mulch. Canopy width, tree height, and trunk cross-sectional area were all greater in the killed-sod treatments than in the bare soil treatments. All five grasses tested: Kentucky-31 fescue, Falcon turf type tall fescue, orchardgrass, perennial ryegrass and Kentucky bluegrass were acceptable for developing a killed-sod mulch.



COMPETITION BETWEEN PERENNIAL RYEGRASS SOD AND CHARDONNAY WINE GRAPES FOR MINERAL NUTRIENTS

S Tan and G D Crabtree
HortScience
Volume 25 Number 5
Pages 533-535
1990

Sod management is a common orchard practice that reduces soil erosion, increases soil organic matter and water infiltration into the soil, may improve crop nutrient status, limits weed invasion and improves traffic and working conditions. Effective use of sod systems depends on an understanding of competitive interactions, including nutrient interactions between sod and crop plants. Competition between sod and tree fruits suggests that nitrogen is of primary importance. Possible methods to reduce the nutrient competition include sod suppression with chemicals or by mowing and provision of additional nutrients.

Research at Oregon State University has been conducted to evaluate the competition between Manhattan II perennial ryegrass sod and wine grapes for mineral nutrients with three methods of vineyard floor vegetation management - bare floor, mowed and unmowed sod and three rates of urea application - 0, 137 and 274 kilogram nitrogen per hectare [0, 115 and 230 pound nitrogen per acre]. Sod decreased nitrogen concentration of grape leaves in both 1986 and 1987; iron concentration in 1986 and sulfur, calcium, boron and manganese in 1987. Sod also reduced total content of all measured nutrients in grape leaves. Mowing did not alleviate this reduction in leaf nutrient content. A high rate of urea compensated for nitrogen reduction in grape leaves caused by sod competition.

THE LAWN INSTITUTE

County Line Road
P. O. Box 108
Pleasant Hill, Tennessee 38578-0108

ADDRESSEE....
HELP US KEEP
YOUR ADDRESS
CORRECT..........
If address is wrong
in any respect, please
correct directly, and
return to us.
THANK YOU

Lawn Institute Harvests is published four times a year by The Better Lawn and Turf Institute. The headquarters office address is P O Box 108, Pleasant Hill, Tennessee 38578-0108. Phone: 615/277-3722. Inquiries concerning all aspects of this publication may be addressed to the headquarters office.

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.

Editor: Eliot C Roberts, PhD

Associate Editor: Beverly C Roberts, MA

Printer: Crossville Chronicle (Tennessee)