the economic value of a particular genetic improvement, but also the rapidity and certainty of its progress under selection. Some selection goals may have to be sacrificed, provided that an even greater success can be made towards other goals. As an example, one breeding strategy might be to make a high maintenance species cheaper to grow (and yet provide the same economic value) while another breeding strategy might be to make a low maintenance species more attractive to consumers at the same management cost. Both concepts are equally valid and probably both should be pursued as goals of a turfgrass breeding program.

Although rapid growth and early establishment of turfgrasses indicate good adaptation, longer term studies might also reveal that these characteristics are related to future thatch problems.

Although economic models for directing the goals of turfgrass breeding can be based on generalized functions (Fig. 1), there are discontinuities that may make such an approach difficult without specific attention to specific problems. For a particular species there may be erratic but devastating problems—chinchbugs in St. Augustinegrass, for example—that require special screening. Although rapid growth and early establishment indicate good adaptation, longer term studies might also reveal that these characteristics are related to future thatch problems. The need for long-term studies is not unusual in a perennial crop, but evaluation of the ornamental value of turf is difficult. The large number of selection criteria for new turf varieties require simplification.

The approach suggested to achieve low-energy grasses (2) was "establishment of minimal management plots for long-term adaptation studies." To date, this approach has been effective in identifying significant differences among energy-related traits (Table 2), but considerable additional experimentation is required. To substantiate the proposed energy savings it will be necessary to evaluate larger turf plantings than have been used in preliminary field trials. More representative evaluation can also be obtained by broadening the geographic range of testing environments. This, in turn, requires not only an expansion of activities in a breeding program, but a more careful assignment of priorities in order to breed and select the best plant materials in the fastest time possible.

The most thorough studies of variety research and development have been performed in field crops, and a number of statistical approaches have been suggested. LeClerg (10) suggested that "Since varieties usually interact with locations and seasons, the early phase of the selection program can be more efficient by sowing materials in one replicate per location and in as many locations as resources will permit." This is presently being considered in the Florida turfgrass breeding program. It is expected that although genotype comparisons over broad regions of Florida will appear to provide lower heritabilities and larger error variances, the net result will be a more useful prediction of energy costs and utility in the landscape.

There is at present no one option in breeding low-energy grasses, but a restricted number of goals for various species. Bahiagrass has an excellent potential for development and release of a variety with rapid coverage ability and high competition to weeds. Such a variety should have shorter stature and lower seedhead numbers than presently available types. It should also have improved density and darker green color, making it more acceptable to consumers wishing a lower energy landscape than obtainable from St. Augustinegrass. Priority should be placed on developing a lower maintenance St. Augustinegrass, similar to 'Floratam,' but with better color and finer texture and a better root system in order to withstand drought. At the same time, a St. Augustinegrass variety with improved appearance and rapid growth rate, but at an equal or higher maintenance cost, might serve as an alternative to bermudagrass for some sports areas. In the case of bermudagrass, lower maintenance types are already available that could probably be grown on fairways with lower inputs of fertilizer and pesticides. For zoysiagrass there is a strong potential for developing strains that would fill the place of higher maintenance bermudagrasses and for extension to high quality miniature landscapes. Finally, as for centipedegrass, there is a great need for more genetic diversity (2) before significant improvements can be made through

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Table 2. Low-energy traits recognized in warm season turfgrasses, ARC-Fort Lauderdale, 1976-79.

Species	Trait	Rationale	Experimental basis
Bahiagrass	Fewer seedheads	Permits less frequent mowing	Replicated field trials
	Faster coverage	Prevents weed encroachment	Replicated field trials
	Shorter stature	Improves utility at a comparable energy input	Replicated field trials
St. Augustinegrass	Improved color and density	Improves acceptability to homeowners	Contemplated for evaluation
	Faster coverage	Prevents weed encroachment	Replicated field trials
	Tolerance to fertility stress	Permits less frequent fertilization	Hydroponic greenhouse expt.
	Gray leafspot resistance	Improves utility at the same energy input	Field and greenhouse comparisons
Bermudagrass	Survival under low maintenance	Permits less frequent mowing, fertilization and pesticide use	Replicated field trials
Zoysiagrass	Faster coverage	Cuts energy costs in production	Replicated field trials

breeding. In this species, a much greater need exists to develop sound management information, especially about the role of soil pH in susceptibility to disease and long term persistence.

Conclusions

Turf is likely to remain a dominant part of the Florida landscape, and to be a continuing drain in energy expenditures. Sizeable savings of energy may be obtained through the recommendation of lower maintenance species and the extension of available irrigation technology to turf managers. Examples of savings in energy through irrigation include the use of fertigation to provide more evenly available nitrogen, and moisture sensing devices to control water application according to plant requirements. Additional consideration should be given to making better economic use of turf, for example, the use of turfgrass clippings as a protein source for animal feeds (15), and the use of turf areas as a place to recycle urban wastes. Similarly, good turf provides erosion control, groundwater replenishment, and possibly reduced heat load in and around buildings. Improvements in the utility of grasses can be made through breeding, and preliminary field trials suggest that lower energy grasses can be developed. For example, in the case of bahiagrass mowing expenses should be reduced through genetically controlling seedhead production. In addition, improvements in the visual attractiveness of bahiagrass could be of great benefit, by permitting the extension of this low maintenance species to more areas of the urban landscape. Maintenance of established landscapes, although producing no exchangeable economic product (no "cashgate" value) is valued highly in Florida for aesthetic and recreational purposes. Adjusting the 1974 turf maintenance costs (7) for inflation would yield a 1979 expenditure in Florida in excess of $600 million. A wise management of turf is, in our opinion, critical in the proper use and conservation of water, energy, and other precious resources. **WTT**

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TURF PROGRAM ADVANTAGES OF SLOW-RELEASE FERTILIZERS

By John R. Hall, extension turf specialist, Virginia Tech, Blacksburg, VA.

Slow-release nitrogen sources have much to offer today's professional turfgrass manager. Even though they generally cost more per lb. of nitrogen than fast-release sources, they offer several advantages which contribute to their increasing popularity. When compared with fast-release sources, the slow-release sources of nitrogen provide the following advantages:
1. Reduced labor costs associated with fertilization, since the number of applications is generally reduced.
2. Reduced nitrogen leaching
3. Reduced risk of foliar burn or root plasmolysis
4. A more even supply of nitrogen is provided to the plant, avoiding the excess-deficiency syndrome associated with totally soluble nitrogen sources.

Today's professional turfgrass manager needs to be aware of the major factors which affect release rates of the more popular synthetic organic slow-release nitrogen sources: Isobutylidene Diurea (IBDU) Urea formaldehyde (UF), and sulfur-coated ureas (SCU).

IBDU

This product is available in several formulations providing a wide range of nitrogen release rates and N:P:K ratios. The basic slow-release nitrogen source is Isobutylidene Diurea (IBDU) which breaks down to isobutyraldehyde and urea in the soil. The isobutyraldehyde is of no value to the plant and is thought to volatilize. The urea eventually is converted to ammonium (NH_4^+) and with the help of microorganisms, finally changes to the most plant utilizable form -nitrate (NO_3^-). Particle size, soil moisture, soil pH and soil temperature affect the rate at which IBDU nitrogen is released to the plant.

Particle Size — IBDU is available in a coarse (.7 to 2.5 mm) and fine (.5 to 1.0 mm) particle size. The fine material releases nitrogen faster than the coarse. In a wet soil (50% moisture) at 80°F the fine material has been shown to release approximately 25% more nitrogen than the coarse material two months after application.

Soil Moisture — Water availability increases the breakdown rate of IBDU to urea. In experiments using fine IBDU and soils maintained at 80°F, wet soils (50% moisture) released approximately 56% more nitrogen in a 2 month period than dry soils (20% moisture).

Soil pH — IBDU's rate of nitrogen release will speed up in very acid soils (Ph < 5.0) and slow up in alkaline soils (Ph > 8.0). The availability of nitrogen from IBDU at alkaline pH's around 8.0 is somewhat depressed.

Soil Temperature — The temperature effect is minor when compared with other slow-release materials which depend upon microbial activity. However, in controlled studies fine IBDU applied on soil maintained at 80°F released approximately 37% more nitrogen in 2 months than fine IBDU applied to a soil maintained at 40°F. The soil in these studies was maintained at moderate soil moisture levels (35% moisture).

UF

Urea formaldehyde or ureaform (UF) is a generic name for several methylene urea formulations that are made from chemically condensing urea with formaldehyde. As the ratio of urea to formaldehyde increases the length of the methylene urea compounds formed, decrease. The shorter the methylene urea compound, the faster the urea is released for plant utilization. Nitroform is a common urea formaldehyde that has a urea: formaldehyde ratio of 1.3 to 1. It provides about 1/3 of its nitrogen as water soluble nitrogen and 2/3 as water insoluble nitrogen which becomes available to the plant predominantly as a function of microbiological activity. O. M. Scott utilizes urea formaldehyde solutions in the production of some of their products. These have a higher urea: to formaldehyde ratio and therefore are shorter chained methylene urea compounds that generally release a greater proportion of the applied nitrogen quicker than traditional urea formaldehyde materials. Because of this release pattern, they tend to provide less residual nitrogen than Nitroform when equally compared.

Since microbiological activity influences the rate of release of the urea formaldehyde products, any factor that increases microbiological activity will increase the release rate of the water insoluble nitrogen from UF. Therefore temperature, soil pH, aeration, soil texture and many other factors have been noted to affect UF release rates. Soil temperatures below 55°F generally decrease microbiological activity enough to significantly slow UF breakdown. Acid soil pH's and poor aeration will also slow breakdown of UF, through their negative effect upon microbiological activity.

SCU

Sulfur-coated urea (SCU) is a slow release nitrogen source made by coating hot (140°F) urea with molten (300°F) sulfur. The prill is then sealed with a polyethylene oil or a microcrystalline wax and conditioned with diatomaceous earth or some other suitable material. A 36% nitrogen SCU product will also contain 16% sulfur and about 5% conditioner + sealant. The nitrogen in these products is released through membrane rupture or diffusion of solutes through pores or imperfections in the coating. Solubility is varied by varying coating thickness or sealant weight. Nitrogen release rates in these products are characterized by determining the amount of nitrogen released in 7 days in water at 100°F. Therefore SCU-30 means the product releases 30% of its nitrogen under the conditions prescribed above. Therefore, an SCU-30 will theoretically release 1½ times as much nitrogen as an SCU-20 under the same conditions. These dissolution values are a measure of the relative number of imperfectly coated granules. Therefore, controlled release of nitrogen occurs from many granules providing nitrogen at different times rather than all granules slowly releasing nitrogen at the same time.

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Slow-Release *from page 43*

Many factors affect the release rate of nitrogen from sulfur-coated urea. Soil temperature, soil moisture, fertilizer placement and root action appear to be the most important.

Soil Temperature — Warm soils will accelerate release of N from SCU. Breakdown of the coating by microbial decomposition of the sealant or oxidation of the sulfur does speed up nitrogen release.

Soil Moisture — Soil moisture stress has been shown to *increase* the rate SCU breakdown. Dry soils (10% moisture) have been shown to release SCU nitrogen faster than moist (20% moisture) soils.

Fertilizer Placement — Surface applications have provided faster SCU dissolution than soil mixed applications. It is thought that the fluctuating soil temperature and moisture conditions on the surface of the soil increase dissolution.

Root activity — Root activity is thought to accelerate SCU dissolution. SCU release rates have been observed to be much slower on fallow soils than in soil containing actively growing plants.

There is evidence that from 5 to 30% of the applied nitrogen in SCU products may not dissolve during the season of application. Since membrane rupture significantly affects nitrogen release in this product, methods of application which crush granules could alter the release rate. Variable and somewhat unpredictable release rates on golf greens (close mowed turf) have led us to the position of currently not recommending coarse particle size SCU products on golf greens.

All three slow-release nitrogen products mentioned above have a place in turf management. It is important that the professional turf manager be aware of how these products might most effectively be used to enhance the quality of turf in his operation. **WTT**

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CITY OF MADISON COMPROMISES IN EMOTIONAL 2,4-D CONTROVERSY

By John A. Kerr, Associate Editor

In a decision that leaves a controversial issue still unanswered, the Madison (Wisconsin) City Council has reached a compromise decision on the use of the herbicide 2,4-D. It has restricted spraying from city parks and highway medians but allowed use to continue on most vegetation.

The issue has been argued hotly in Madison as well as in other parts of the U.S. and Canada in recent months. The sides are usually the same: townspeople who fear the use of chemicals and Vietnam Veterans Against the War against the agricultural/horticultural community and university and corporate scientists. Confrontations have peaked recently in Madison, the capital of Wisconsin, where many of the DDT hearings of the 1960's occurred and also where pesticides are used abundantly because of the many specialty crops produced.

Last October a member of the city's Parks Department was spraying 2,4-D and a child in a nearby home suffered a seizure. The child's parents, James and Mary Wachtendonk, felt the chemical triggered the seizure and called officials to stop the spraying. James Wachtendonk, 30, is a Vietnam veteran who was sprayed with Agent Orange at least three times and attributes his nervous system problems and the congenital problems of his son, Zachary, to the chemical. Parks Superintendent Daniel R. Stapay issued a moratorium on 2,4-D.

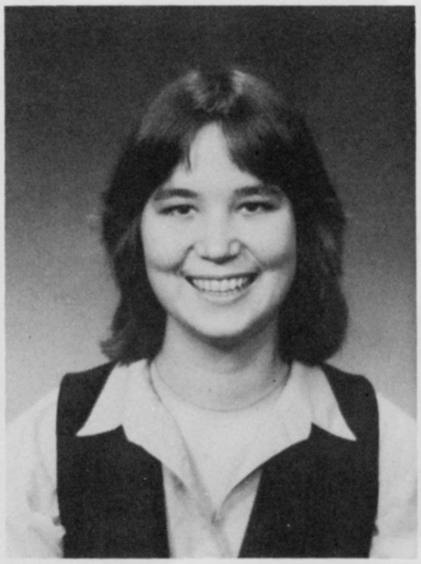
Since the moratorium, a member of the Dane County (Madison area) Board of Supervisors, Lynn Haanen, adopted a resolution to ban 2,4-D use in the city; the mayor issued the ban; and hearings were held before various city and county commissions. On January 27, the City Council met to issue a final ruling. A public hearing was held in conjunction with the meeting, at which a handful of University of Wisconsin professors along with Russ Weisensel, executive director of the Wisconsin Agri-Business Council, spoke against the ban. A much larger force of townspeople and Vietnam Veterans Against the War spoke in favor of the ban.

The total ban was defeated by an 11-10 vote. The final decision removes the use of 2,4-D in city parks and on highway median strips, and allows it on athletic fields, botanical gardens, farmlands, and for poison ivy and noxious weed control. This affects 50 to 60 percent of the herbicide's use in Madison. Also, a sign must be posted where 2,4-D is used for 48 hours after the application.

Weisensel says, "We (the agricultural and scientific communities) both won and lost." One vote the other way would have meant a total ban. "I hate to see a ban of any kind," says Weisensel. "It's not warranted by research." Yet he thinks they will never have a tougher group to face than the Madison City Council.

Weisensel does not consider losing 2,4-D in parks and highway medians an unmanageable loss. His major fear is that any ban will start a precedent that would give opponents impetus in battles with the county and state and that may eventually lead to a total ban on 2,4-D.

Weeds Trees & Turf spoke to leaders on both sides of the issue. Lynn Haanen of the County Board of Supervisors introduced a resolution before the city to ban 2,4-D after the incident with the child. R. Gordon Harvey, a professor of agronomy specializing in weed science at the University of Wisconsin-Madison, did his research thesis on 2,4-D and spoke at a couple of the public hearings against the ban.



Lynn Haanen

WTT: How are you involved in this issue?

Lynn Haanen: I'm on the County Board of Supervisors. I served on the City Council last fall for about a month in an interim appointment. During that month I introduced a resolution to the City Council and the County Board calling for a moratorium on use of 2,4-D in the parks. There was an incident — I'm sure Russ Wiesensel has told you about it — with a family that lived across the street from Warner Park. I had talked to people before that about specific use of herbicides. That incident quickened my action. I acted sooner than I had planned on.

WTT: What do you think of the 11-10 vote at the City Council meeting?

L H: I'm very satisfied with the compromise. It does what I think needs to be done, which is taking the heavy use of it out of the parks where there's no control over people walking in it and no way to block off the area where you're spraying it. It limits the use to the cemeteries, botanical gardens, golf courses, and the natural prairie areas. And the use in those areas, beside the golf courses, will be spot applications.

WTT: Russ Weisensel said it would cut use about 50 percent.

L H: Yes. One of the things I kept bringing up to people and bringing up to Russ was he has this theory that there will be a domino effect, that other places will stop using 2,4-D, and that fairly soon down the line agricultural use will be restricted. I don't think that's what's going to happen at all. I'm not opposed to agricultural use of it. I think there's a big difference between the use of an herbicide in a rural area and its use in an urban area. If I were in agri-business, I would favor the restriction of its use in urban areas. The heavier it's used in urban areas the more people will object to it and the more chance people will demand it stop being used. Whereas if they use it correctly, in a rural area in agriculture where I think it belongs, people will not have a strong reaction to it because it won't be being sprayed across the street from them and in heavily populated areas. I don't have any objection for its use in agriculture; I just don't think it belongs in the city.

WTT: Did you follow the talks 10 to 15 years ago when they had the DDT hearings and after that 2,4,5-T? Isn't that what happened when banning started in small areas, spread to county and state levels, and then a total ban?

L H: The evidence against DDT and 2,4,5-T was much stronger at that point and it got much stronger. I think some chemical companies are still saying they're safe, but I think most people I've talked to agree that they're not safe and should not be used. In that case, there probably was a domino effect, but I think the reason that happened was that people recognized that those chemicals had serious flaws in them, and that even moderate use was not safe and in the long range effective to use them. I think with moderate, cautious use 2,4-D probably is safe. It probably can be continued to be used. I've seen contrary studies that say it's dangerous, it's very safe, and some say it's not all that dangerous and it's not all that safe. There's evidence on both sides and there's a lot of conflicting evidence. I really disagree with someone who will say it's perfectly safe. And I hear farmers say that they've been practically weaned on this stuff so it must be safe. I think that's the wrong attitude towards any chemical that you use.

WTT: You don't think it will affect the parks in any way or the highway medians by not using it?

L H: No, because the use that they're restricting in Madison is to kill the dandelions. I personally feel — and I've talked to a lot of people about this — that it's not important to have a perfectly green park. I personally consider it rather ugly. I think for its use to kill dandelions and thistles, we can either not kill them or remove the growth of thistles manually. I don't think it will affect the parks adversely.

WTT: So it's not allowed to be used in any area of the parks?

L H: It will not be allowed in the turf areas of the park. However, it does allow them to use 2,4-D in the Madison Park areas that are prairies. I think there are two areas where they're trying to preserve the natural prairie. I think in those areas they spot applicate to kill the black lotus and some of the European plants that are taking over. I feel more comfortable with that also because the people who are doing that are botanists who I think have a healthy respect for chemicals and who use them very judiciously.

"I personally feel that it's not important to have a perfectly green park."

WTT: Do you think this issue will go to the county?

L H: It will be going to the county but you have to remember that the county does not have home rule. So when we talk about limiting county use, we're talking about county governmental use, not use by private citizens in the county. What I anticipate will happen is that the county will establish criteria and restriction for its use. The county is a different situation than the city in that Dane County previously stopped using all chemicals, and since then has slowly added a few chemicals that they will use in very limited amounts. The county's use has been much less than the city's use in the past.

WTT: Doesn't the county do the work along the highways, too?

L H: Yes. The person who supervises that is very careful and they don't use it unless it's absolutely necessary. They also have the option of going in and doing the work manually. They don't have to use a chemical if they prefer not to. There's at least one area supervisor I know who prefers to do the work manually and not use a chemical. There's also a real big difference between using it along the county roadsides and along the city parks or even in the county parks.

WTT: Because of the population?

L H: Yes. There aren't as many people who will be walking along the roadsides. Use along the roadsides also blurs into the whole agricultural use because one of the main reasons we do that is so the noxious weeds don't spread into the fields right next to them. And so it's to assist the farmer because if we don't control the weeds and vines on the property we own, it spreads into their property.

WTT: The supporters heavily outnumbered the proponents to the ban at the City Council meeting. Who are the majority of supporters?

L H: They're just people. There's no organized group. Most of the people there I did not know. They heard about it and came themselves. They're people who live in the city and are concerned about it and want to see the use of 2,4-D cut back or stopped.

WTT: Isn't the Vietnam Veterans Against the War a big

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Selective effects of 2,4-D on dandelion while neighboring turf is unharmed. Higher mowing and physical removal are the park systems recommended alternatives to 2,4-D.

2,4-D *from page 49*

group against the use of 2,4-D?

L H: They are nationwide working to get people to reexamine their use of chemicals. I have worked with them in Madison, but they are by no means the overriding force and organizers behind it.

WTT: We have heard that one reason the Vietnam Veterans Against the War support the ban is that they have a lot of court cases, and if a ban would go through they'd have more success in those cases.

L H: I don't quite understand that rationale because 2,4,5-T is under very restricted use right now and that's one of the components of Agent Orange. And I think they already have quite a good case in terms of what dioxins can do. I've never heard anyone relate it to their court case. They're simply concerned because they feel they cannot afford to be exposed to any phenoxy herbicides anymore. And they feel that when they are exposed it hurts them. Some people might consider their reaction to be an overreaction but considering what they have gone through and the kind of treatment they've gotten from the government, I don't consider it to be an overreaction at all.

WTT: There seems to be no medical evidence that the seizure the child had was caused by the herbicide. Has there been anything more said about that?

L H: The doctor examined the child and wouldn't say conclusively what it was. However, the Department of Agriculture came out and tested the house, both inside and outside, for how much herbicide was in the air and on the surface. And it was pretty astounding how much they found. So the drift was quite large. It's a real hard issue, because Zak (the child) was doing fine until they started spraying that evening and he got progressively worse as they continued spraying the next morning. And I guess I tend to feel that since they found at least a half dozen children in the neighborhood also got sick when the park people were spraying, there's reason to believe that some people are sensitive to the chemical when exposed to it.

WTT: There was more than one child who got sick?

L H: Yes, there were other people in the neighborhood who have children that got sick. People are real hesitant to talk about it and real hesitant to go public with it because the reaction they get from some people is that you're overreacting and hysterical.

WTT: You don't think farmers should stop using 2,4-D?

L H: No, personally unless the EPA were to decide that farmers couldn't use it, I don't feel that the farmers should stop using it. My only concern is that they look at how they're using it and that they look at whether the amount they're using is necessary. At this point I don't think there's going to be a domino effect. The domino effect I would like to see is that cities reevaluate their use of it and decide how much they're going to use and whether it's necessary to use it if they're spraying it in a densely populated area.

WTT: Do you think the use it's being taken away from is going to have any effect on the park lands?

L H: No, the only harm might be more dandelions, but I don't particularly consider that a harm.

WTT: Do you think it will cost the city more to maintain the parks?

L H: They're going to have to cut the grass higher. The grass is not going to be as short as it has been in the past. There may be more labor time, but at this point the