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Sulfur-Coated Urea for Lawn Care Programs

by Norman W. Hummel, Iowa State University

Norman W. Hummel is an Assistant Professor and Extension Turfgrass Specialist at Iowa State University. He received his B.S. degree from New Mexico State University in Agronomy and his M.S. and Ph.D. degrees from Penn State University, also in Agronomy. Dr. Hummel's research interests lie in the areas of N nutrition and pesticide screening.

Sometimes there seem to be as many nitrogen (N) fertilizers on the market as there are days in the year. And every manufacturer, formulator, and distributor claims that theirs is better than the rest. While every N source or formulation probably has its place, one material that has become popular in granular lawn care programs is sulfur-coated urea (SCU). Its popularity should come as no surprise. Research has consistently shown SCU to produce favorable results in turfgrass field trials. Also, the cost of SCU is competitive with other slow-release N sources.

Sulfur-coated urea is produced by spraying granular or prilled urea with a layer of molten sulfur. When the sulfur hardens it forms a coating that is impermeable to water around the soluble urea. Since defects such as cracks, pinholes, and pores develop in the coating as the sulfur hardens, a mixture of polyethylene and heavy weight oil is usually sprayed on the SCU pellets to seal these defects. Finally, diatomaceous earth is added as a conditioner to prevent sticking and to make the surface hydrophilic. The final product contains 32 to 38% N, 13 to 20% sulfur, 2 to 3% sealant, and about 2% conditioner.

The real advantage of SCU is the nonuniform coating that produces a uniform, extended response to N when applied to turf

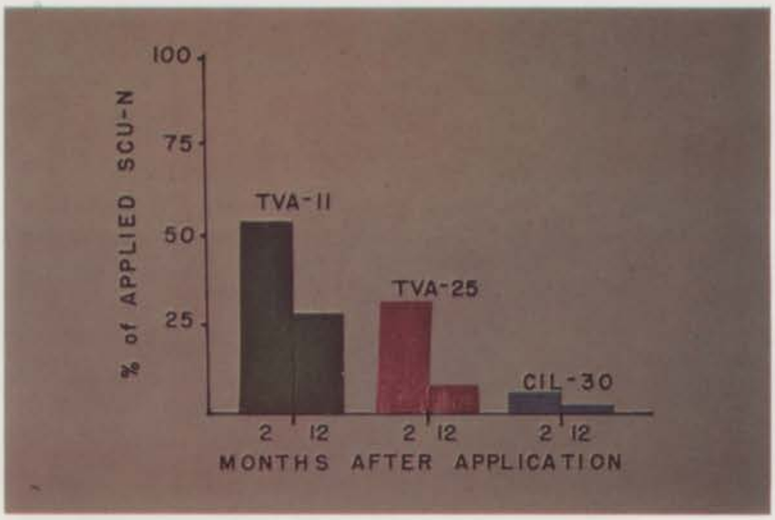
It is possible to produce SCU with different N release rates by varying the coating thickness. The real advantage of SCU, though, is that the coating thickness of the final product is not at all uniform. A mixture of fractured, thin, and thick-coated urea pellets provide for immediate, intermediate, and long-term release of N. The result of this nonuniform coating is a product that will produce a uniform, extended response to N when applied to turf.

The rate of N release from SCU is often classified by a 7-day dissolution rate. This refers to a laboratory test that determines how much SCU-urea dissolves in water at 100^{o} in a 7-day period. The higher the dissolution rate, the quicker the SCU will release N in the soil. Most commercial sulfur-coated ureas have dissolution rates ranging from 20 to 35%.

One of the first SCU materials made available for turfgrass fertilization was "Gold-N", an SCU prill made by Imperial Chemical Industries (ICI). Studies in England found that "Gold-N" applied twice a year produced high quality turf similar to that produced by multiple applications of ammonium sulfate. A new process for coating urea granules was later developed by the Tennessee Valley Authority (TVA). Researchers in Florida found that TVA SCU with a 9% dissolution rate produced more favorable results than IBDU, ureaform, and activated sewage sludge. More recent work has shown turfgrass response to different SCU materials to be very favorable. However, response may vary depending on coating thickness and coating method.

While the agronomic potential of SCU as a turfgrass fertilizer was recognized, there were still some unanswered questions regarding how SCU could be used in a fertilizer program. In 1978 a cooperative study was started between Penn State University and the Tennessee Valley Authority (TVA) to take a closer look at SCU. Similar experiments were conducted in State College, Pennsylvania, and Muscle Shoals, Alabama, so that two climatic regions and different grass species would be represented.

Several fertilizer programs were evaluated. Three SCU materials were applied at different rates and timing of application to an established stand of Merion Kentucky bluegrass. Tifway bermudagrass and Meyer zoysiagrass were the turfgrasses used in the Alabama study. Two of the SCU products were made by the TVA process; one with an 11% dissolution rate (SCU-11) and the



(Figure 1) Percent of applied SCU-N recovered from the soil 2 and 12 months after application.

other with a 25% dissolution rate (SCU-25). Agricultural Industries Manufacturing Corporation holds the patent for the TVA process and they produce an SCU for Lakeshore Equipment Company that is similar to the SCU-25. The third material, CIL SCU, is a sulfur-coated urea prill from Canada Industries Limited. The CIL SCU is distributed in various formulations by the Andersons, Estech Chemicals, and several other distributors in the United States.

One thing the lawn care professional should consider when selecting an N fertilizer is the type of response to expect after application. Homeowners expect to see a marked improvement in the appearance of their lawn shortly after it is treated. This is just one reason why the quickly available, or water soluble fertilizers are so popular in the industry. Fertilizers with a high percentage of water insoluble nitrogen (WIN), such as ureaform and IBDU, should be supplemented with water soluble nitrogen to provide quick greening, especially in the early rounds.

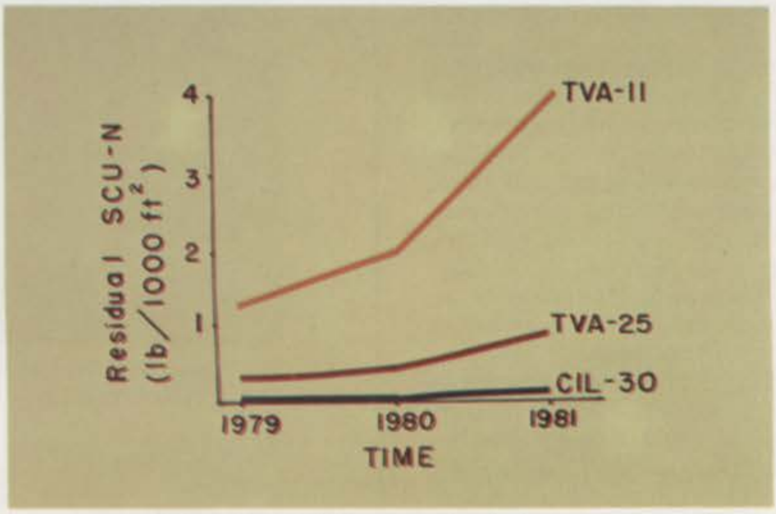
Of the three SCU materials tested, CIL SCU provided the quickest green-up. This response to CIL SCU is due to the rapid dissolution of the SCU pellets. About 95% of the applied pellets were dissolved 2 months after application, compared to 70% for SCU-25 and 40% for SCU-11 (Figure 1). These results suggest that more frequent applications of CIL SCU may be necessary to maintain high quality turf uniformly through the season.

When CIL SCU and SCU-25 were applied at an annual rate of 5 lb N/1000 ft^2, splitting the rate into spring and fall applications produced a uniform, high quality stand of turf through most of the year. However, the SCU-25 often produced darker color than the CIL SCU 2 and 3 months after application. These results suggest that the slower dissolution of SCU-25 provided more available N later in the growing season than CIL SCU.

Since the release of N from SCU is somewhat temperature dependent, the annual rate of N from CIL SCU and SCU-25 should be split into three or four applications in warmer climates.

Studies in Alabama support this because the dissolution of SCU-25 was about 20% faster than in Pennsylvania. In fact, the response of zoysiagrass and bermudagrass suggested that the only advantage to using SCU-25 over water soluble N was that the foliar burn hazard was removed. The SCU-25 was simply too quick to maintain quality for any great length of time.

The slow dissolution of SCU-11 resulted in an accumulation of SCU pellets over three years that totalled 26% of the applied fertilizer. After three years, almost 4 lb. N/1000 ft^2 had accumulated in the soil (Figure 2). Turfgrass response to SCU-11 tended to be poor the first two years of the study. Only high rates of N (5 lb N/1000 ft^2) applied in the spring provided enough available N to maintain quality turf. The performance of SCU-11 did improve substantially in the third and fourth year due to the release of accumulated pellets. In Alabama, the response to the SCU-11 was much more favorable than to the SCU-25. These differences in climatic effects, especially temperature, suggest that microorganisms may play a role in the degradation of the sulfur coat.



(Figure 2) Residual SCU-N accumulated after one, two, and three fertilization years for SCU materials.

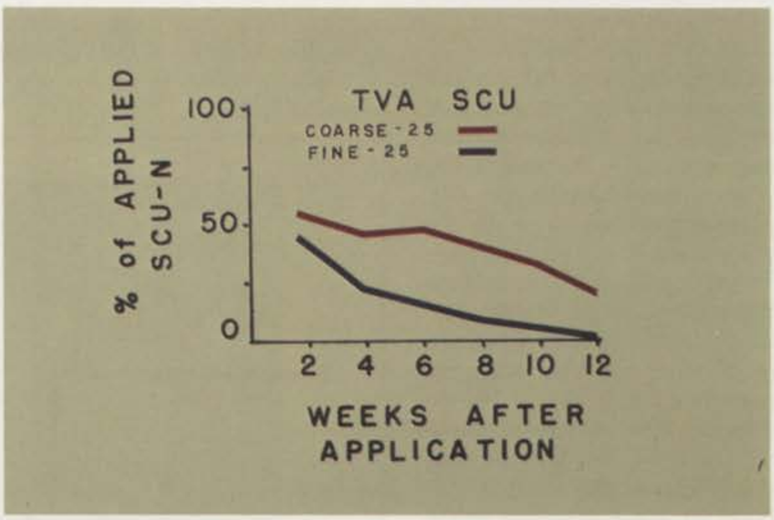
Sulfur-Coated Urea

One of the objectives of this study was to see if season-long turf quality could be maintained from a single application of fertilizer. The CIL SCU and SCU-25 applied at a rate of 5 lb N/1000 ft^2 produced very dark green color. However, the growth produced by this high rate of N would require more frequent mowing, probably to the dissatisfaction of most homeowners. These materials did not provide enough residual N to maintain acceptable quality turf for a full year. In fact, the turf was very chlorotic and thin within five growing months after application (Figure 3). Higher rates of N have also been shown to deplete carbohydrate reserves making the turf more susceptible to environmental stress and other related problems. In areas where heat and drought stress frequently occur, applying high rates of N should be avoided, regardless of the N source.

An annual rate of 3 lb N/1000 ft^2 was not high enough to maintain quality turf through the year. Data from a similar study at Iowa State University on soils inherently high in nitrogen suggest the same. A minimum of 3 to 4 lb. N/1000 ft^2/year is necessary to maintain high quality Kentucky bluegrass turf.

Sulfur-coated ureas are available to turfgrass managers in different particle sizes. Advantages to using a smaller particle size include: better coverage due to more particles per unit area; better size for blending; and reduced mower damage and pick up. However, as particle size decreases, the surface area increases per unit weight of fertilizer to be coated. If sulfur is applied at the same rate per weight of fertilizer, decreasing the particle size will decrease the coating thickness. A material with a thinner coating will tend to have a faster release rate. This faster release rate should be reflected in a higher 7-day dissolution rate. However, there has been some question as to whether the dissolution rate accurately predicts the rate of release in the field, especially

(Figure 3) Plot in upper left is SCU-25 applied at 5 lb N/1000 sq.ft. in the fall, compared to the SCU-25 split treatments in the foreground. The picture was taken in mid-summer.



(Figure 4) Effect of particle size on the amount of SCU-N recovered from the soil over a 12 week period.

where particle size differences are concerned.

A study was conducted at Penn State to see if particle size had any effect on release rate in the field. Five fine and four coarse SCU materials were selected to represent a range of 7-day dissolution rates. Despite having similar dissolution rates, the fine SCU materials released N faster than the coarse materials. This was true for all comparisons of similar dissolution rates (Figure 4). In fact, the rate of N release from the fine SCU treatments was similar to coarse SCU materials with dissolution rates 15% higher. Thus, if fine SCU is used in a turfgrass fertilization program, materials with dissolution rates greater than 20% would require more frequent applications at lower rates of N.

Some professional lawn care people are reluctant to use SCU because they may have heard that traffic will break the SCU pellets, increasing the potential for burn. The Penn State studies showed that routine mowing traffic may have caused some breakage of CIL SCU during the year after the turf was established. The effects of this breakage were small. There was no breakage of the other SCU materials. As density increased and thatch accumulated, no breakage of the CIL SCU was observed.

When SCU was subjected to intense pressure, some pellet breakage did occur. Pellet breakage decreased as thatch depth increased; however, these differences were small. Mowing height had no effect on breakage. All these data point out that it is unlikely that traffic will cause SCU breakage. If it does occur, it is not likely to affect the agronomic performance of SCU.

Sulfur-coated urea has once again proved to be an outstanding slow-release fertilizer. Although a minimum of two applications of SCU will probably be needed to maintain quality turf through the season, it is versatile enough to fit into nearly any fertilization program.

The author would like to acknowledge Dr. Seward Allen from the National Fertilizer Development Center of TVA for sharing his information on SCU work in Alabama.

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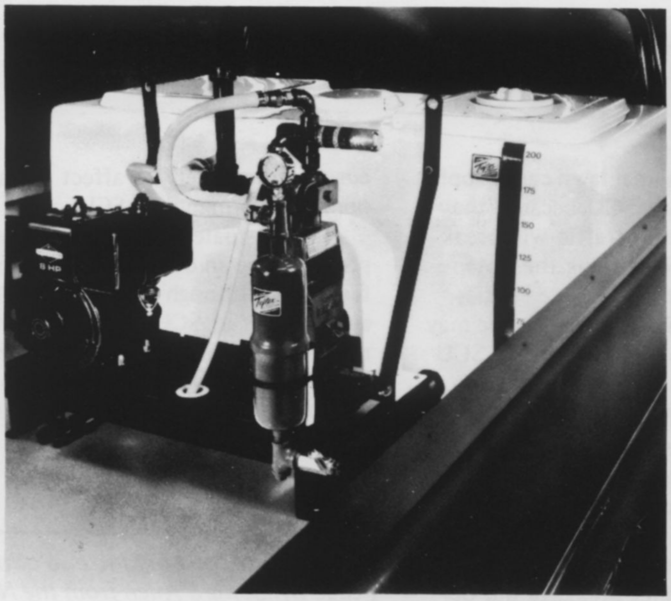

PC200 gallon spray unit shown mounted in bed of pick-up.

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Phosphorus: the Neglected Lawn Nutrient

by Richard J. Hull, University of Rhode Island

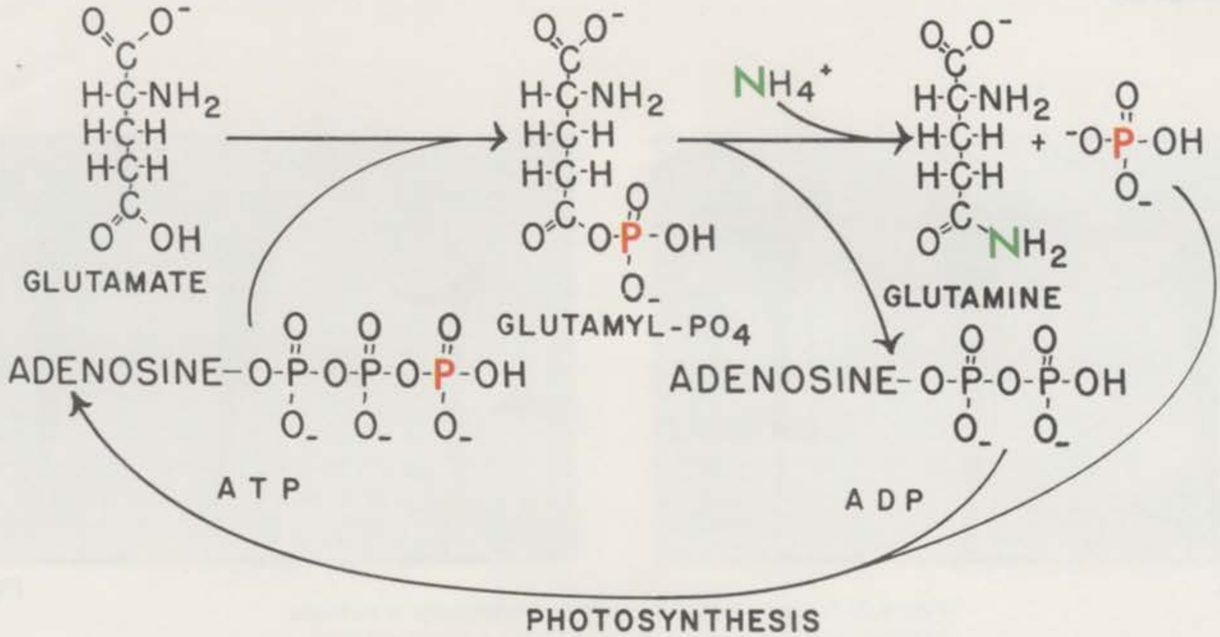
Richard J. Hull is Professor of Plant and Soil Science at the University of Rhode Island. He received his B.S. and M.S. degress from the University of Rhode Island in agriculture ana agronomy respectively and his Ph.D. in botany from the University of California at Davis. For five years, Dr. Hull studied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

Of the three macronutrients normally included in a lawn fertilizer application, the least abundant element is usually phosphorus. Typical analysis of a fertilizer used for lawn care is 20-4-10 (N-P_2O_5-K_2O). Many large lawn care companies have adopted a fertility program which utilizes less phosphorus than nitrogen or potassium. Since the recent work reported from Ohio State University (Christians, Martin, and Wilkinson, 1979) and reviewed for **ALA** by Nick Christians (1980) the amount of potassium applied to lawn turf has increased over that which was used earlier. Their research demonstrated that the ability of turfgrasses to utilize nitrogen efficiently was directly related to the amount of potassium available to the turf. That is, turf responded better to lower nitrogen rates when potassium levels were increased.

The argument for including more potassium in lawn fertilizers is certainly valid but one might question if this should be accompanied by reduced phosphorus levels. As a general rule, fertilizers should be formulated to provide plant nutrients in approximately the quantity and ratio required by plants. Based upon published data reviewed by Madison (1971), cool season turfgrass leaves contain approximately 3.5% N, 0.35% P and 1.5% K. This translates into a fertilizer nutrient ratio of 20-4.5-10 (N-P_2O_5-K_2O) which is not very different from the typical lawn care fertilizer ratio of 20-4-10. Such logic suggests that fertilizers currently used for lawn care are reasonably well balanced to meet the nutritional needs of turfgrasses. What is not considered in this argument is the relative availability of nutrients to grass roots in the soil. Because roots derive most of their nutrients from the soil solution, the composition of the soil solution becomes a matter of interest. Based on data compiled by Fried and Shapiro (1961) for many soil types, the average composition of the soil solution from water saturated acid soils is 169 ppm N, 0.3 ppm P, and 27 ppm K. This is equivalent to a fertilizer ratio of 20-0.08-4 (N-P_2O_5-K_2O). Thus, the typical soil solution contains less than 1/50 of the phosphorus required by plants relative to available nitrogen.

This low phosphorus content of the soil solution is a result of the rapid fixation of soluble phosphate which occurs in most soils. Soon after soluble phosphate is applied as a fertilizer, most of it precipitates out of solution or binds with soil colloids resulting in a soil solution concentration of less than 1 ppm. Much of this fixed phosphorus may slowly become available by reentering the soil solution as root absorption draws down the phosphorus content in the soil water. This labile phosphorus, as described by Mengel and Kirkby (1978), can be viewed as reserve phosphorus because it buffers the soil solution preventing the phosphorus concentration from dropping below 0.2 to 0.3 ppm. Thus, while the concentration of phosphorus in the soil solution is quite low compared to that of nitrogen or potassium, phosphorus rarely becomes deficient because the reserve labile pool constantly replaces the phosphorus removed from the soil by plant roots. It follows, therefore, that phosphorus fertilizer applications do more to establish and maintain a reserve supply within the soil than they do to meet the needs of lawn grasses directly. A fertilizer application made today may contribute to the phosphorus needs of the lawn for the next fifty years.

To understand why lawn grasses require a constant supply of phosphorus, it is important to know how this nutrient functions in plant metabolism. Basically, phosphorus has two roles: a structural and energetic function. Phosphorus, together with the five-carbon sugars ribose and deoxyribose, forms the backbone of the nucleic acids RNA and DNA. Without phosphorus, the fundamental structure of these critical molecules would be impaired and nucleic acid production will decline. This means protein synthesis, which depends upon RNA, will be inhibited and metabolic processes generally will slow down. Phosphorus also is a structural



(Figure 1) Reaction catalyzed by the enzyme glutamine synthetase. Note transfer of P from ATP to glutamate before $NH_4{+}$ is added to glutamate.

component of many polar lipids which constitute the core of cellular membranes. A lack of phosphorus will retard membrance synthesis which, in turn, will depress cellular development and proper membrane functions such as nutrient transport and the perception of environmental stimuli. These uses of phosphorus bind the element into complex organic molecules and make it relatively immobile within the plant. When this occurs at the expense of the soluble phosphate supply within plant cells, it interferes with the second role of phosphorus, that involved with energy metabolism.

Probably the most important function of phosphorus in plants is its central role in activating small organic molecules so they can enter into metabolic reactions. For this role, phosphorus is normally transferred via the molecule adenosine triphosphate (ATP). To illustrate this function of phosphorus, let us consider the reaction catalyzed by the enzyme glutamine synthetase (Fig. 1). This is a very important chemical reaction because it is the primary route by which nitrogen enters into the metabolic pathways of plants. The purpose of this reaction is to combine ammonium ion with the amino acid glutamate to form glutamine. Once glutamine is made, its amide-nitrogen can then be transferred from molecule to molecule, resulting in the biosynthesis of all amino acids, proteins, hormones, and other nitrogen containing compounds.

Phosphorus' most important function is its central role in activating small organic molecules so they can enter into metabolic reactions

One problem with this reaction is that its equilibrium favors the production of glutamate and ammonia from glutamine which is the reverse of the reaction needed to assimilate nitrogen. To make the reaction proceed in the forward direction and make glutamine, the glutamate molecule is first activated by forming the phosphate ester. Here a phosphate is donated by ATP and this reaction is strongly favored in the forward direction. The ammonium ion will now react readily with the phosphate ester displacing the phosphate and forming the amide glutamine. This reaction is also strongly favored in the forward direction. The phosphate released during glutamine synthesis can be recombined with ADP to reform ATP through the energy derived from photosynthetic light reactions.

In this reaction as in numerous other metabolic operations, an energetically unfavored reaction is allowed to occur by first forming a more highly reactive phosphate ester which then can enter into a chemical reaction and form the desired product. Phosphorus in these reactions can be thought of as the grease which allows the metabolic machinery to operate smoothly. Phosphorus in ATP can also be used directly to provide the energy for nutrient uptake into plant cells. This process was described in an earlier **ALA** article (Hull, 1982).

The critical role played by phosphorus in plant metabolism becomes apparent when the element is withheld. Red fescue and creeping bentgrass were grown hydroponically with nitrogen and

Phosphorus

Figure 2a

Figure 2b

(Figure 2) Turfgrass cultures grown hydroponically in nutrient deficient solutions. Left to right: complete nutrient solution, minus N, and minus P.
A. creeping bentgrass B. red fescue

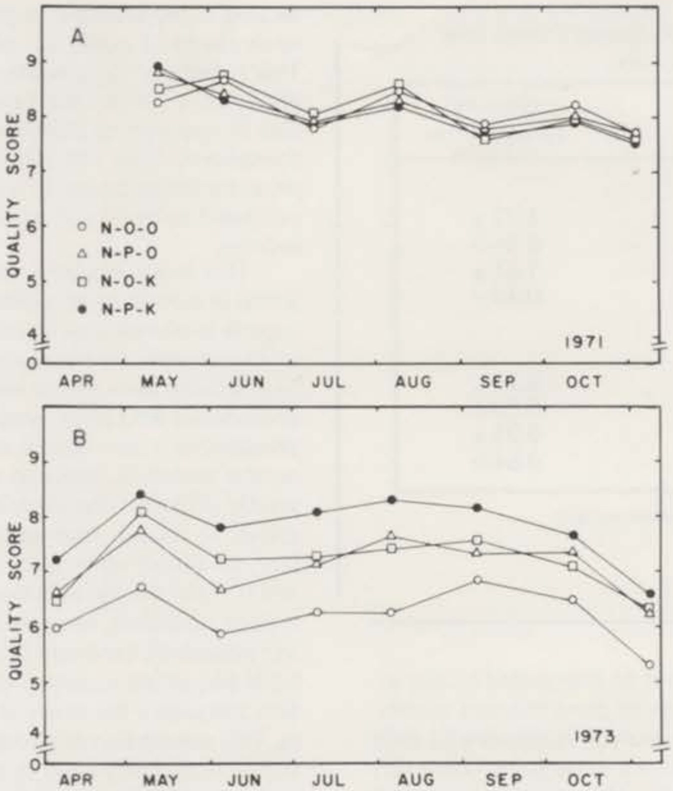
TABLE 1: Marion Kentucky bluegrass response to eight Phosphorus levels incorporated into the soil (Hall and Miller 1974).

Phosphorus added	Clipping growth rate	P-leaf content	Soil Test†	Turf Quality‡
parts/2 million	$g/m^2/day$	%	Kg P/ha	
0	0.22 e	0.27 c	14.0 a	2.4 a
10	0.54 d	0.26 c	10.4 a	4.7 b
20	0.60 d	0.28 c	9.6 a	4.6 b
40	0.93 c	0.30 c	11.5 a	5.9 c
80	1.19 b	0.34 b	10.1 a	7.1 d
160	1.24 b	0.39 a	22.7 a	7.3 d
320	1.33 ab	0.45 a	37.4 b	8.0 e
640	1.41 a	0.45 a	224.4 c	8.4 e

** Means in a column followed by the same letter are not significantly different at the 5% confidence level.*
† Soil tested 5 October.
‡ Turf quality scores: 10 = ideal turf.

phosphorus omitted from some cultures (Figure 2). The most obvious response to limiting phosphorus was a smaller, more fragile, root system, especially in red fescue. By comparison, deficient nitrogen resulted in more extensive root growth. This root response to low nitrogen supply has been discussed by John Street (1982) in terms of less energy consumption for shoot growth leaving more energy for root development. When phosphorus was deficient, metabolic activity declined in both roots and shoots resulting in less growth generally. The extensive study by Hall and Miller (1974), summarized in Table 1, demonstrated the dramatic increase in shoot growth promoted by a greater phosphorus supply. This growth stimulation was reflected in improved turf quality. Phosphorus stimulated growth affects shoots and roots equally. It does not favor shoot growth at the expense of root growth as nitrogen does. From these observations, it is clear that adequate phosphorus is essential for optimum lawn growth and quality which in turn can contribute to greater disease resistance and recovery from injury.

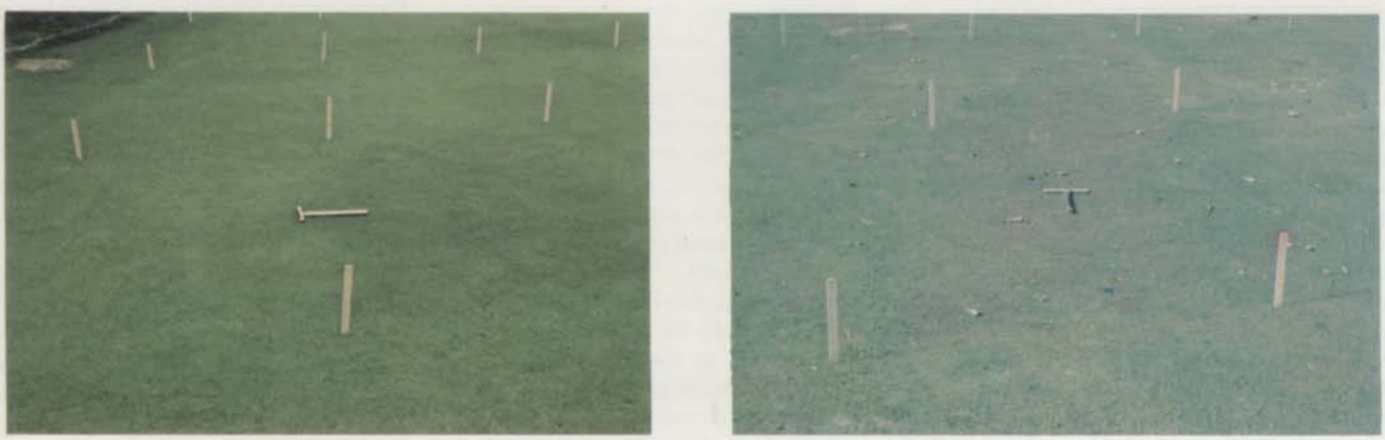
In a Rhode Island study (Hull et al. 1979), we demonstrated that the inclusion of phosphorus or potassium with nitrogen fertilizer tended to increase the resistance of "Merion" Kentucky bluegrass turf to stripe smut (Fig. 3). When the grass was free of disease (Fig. 3A), no differences in turf quality could be detected between the four fertilizer nutrient combinations used. However, when stripe smut was prevalent, turf receiving nitrogen alone was most infected and this resulted in lower quality scores (Fig. 3B). Bluegrass receiving phosphorus or potassium along with the nitrogen was of significantly higher quality because it was less diseased. Stripe smut was least damaging to the turf which had received the fertilizer containing phosphorus and potassium along with the nitrogen. Again, because phosphorus promoted efficient metabolic activity, the grass was better



(Figure 3) Seasonal turf quality scores of Merion Kentucky bluegrass plots fertilized with four nutrient combinations. A. Healthy turf. B. Turf infected with stripe smut. (Hull et al. 1979)

able to resist infection.

Phosphorus is easily overlooked in turfgrass nutrition because there normally is no obvious rapid response following the addition of phosphorus. Certainly no response anything like that observed after a nitrogen application is ever noted for phosphorus. Normally lawn grasses do not show phosphorus deficiency symptoms even when that element is in short supply. In a carefully maintained field experiment at the University of Connecticut, Professor Bill Dest obtained phosphorus deficiency symptoms on "Penncross" creeping bentgrass grown on a sandy soil with a history of little phosphate fertilizer use (Fig. 4). The purple coloration of the low phosphorus grass was caused by an accumulation of the pigment anthocyanin which is synthesized when simple carbohydrates accumulate in leaf cells. Because proteins and complex carbohydrates depend upon the presence of phosphorus for their synthesis, simple sugars tend to accumulate when phosphorus is lacking and these in turn stimulate anthocyanin production.



(Figure 4) Phosphorus deficiency symptoms on Penncross Creeping bentgrass turf. A. July 1979. Left: Normally Fertilized. Right: Minus P. Kodachrome. B. October 1978. Center plot minus P. Ektachrome. (Photos by William M. Dest, Univ. of Connecticut)

Phosphorus

TABLE 2: Phosphorus content of dry leaf tissue and clipping growth rate (grams/sq. meter/day) of 15 Kentucky bluegrass cultivars.

Date	% P	% K	Clipping Growth Rate
1978			
26 May	0.44 a*	2.54 a	1.72 a
28 July	0.33 c	2.31 b	0.96 b
8 Sept.	0.27 d	2.47 a	1.61 a
23 Oct.	0.35 b	1.73 c	0.39 c
1979			
22 June	0.19 b	1.68 d	0.14 c
31 July	0.10 d	1.79 c	0.10 c
31 Aug.	0.17 c	2.55 a	0.94 a
15 Oct.	0.44 a	2.42 b	0.84 b

**Numbers in a column for each year followed by the same letter are not significantly different.*

Professor Dest also determined that leaf tissue from phosphorus deficient turf contained approximately 0.15 to 0.20% phosphorus compared to 0.34% found to be required for normal turf growth by Madison (1971). Leaf tissue analyses can be interpreted as an indication of the phosphorus nutritional status of turfgrasses if the grass is actively growing. A recent Rhode Island study (Mehall et al. 1983) compared the phosphorus and potassium content of leaf tissues from 15 Kentucky bluegrass cultivars throughout two growing seasons (Table 2). When the grass was producing clippings at a respectable rate, greater than 0.4 grams dry matter/square meter/day, the phosphorus content of leaf tissue was in the range of 0.25 to 0.45% indicating adequate phosphorus nutrition. However, during the dry summer of 1979 when turf growth was slowed dramatically, the phosphorus content of leaf tissue was in the range which could indicate a phosphorus deficiency, 0.17 to 0.19%, yet no phosphorus deficiency symptoms were observed. This indicates that tissue analyses of environmentally stressed plants or plants that are growing very slowly cannot be interpreted readily as an indication of plant nutrient status. Leaf tissue analysis is meaningful only when plants are undergoing reasonably rapid growth. The creeping bentgrass analyzed in the Connecticut study was so maintained that growth was active and as such, the leaf tissue analyses could be interpreted as a nutritional indicator.

By comparison, the potassium content of drought stressed bluegrasses showed much less variability. Apparently the ability of turfgrasses to obtain potassium is less controlled by environmental factors than is phosphorus recovery. Consequently, leaf tissue analysis for potassium is a more reliable indicator of nutritional status than is leaf phosphorus analysis.

Soil analyses also frequently fail to indicate accurately the amount of phosphorus available to lawn grasses. Madison (1971) provided an instructive review of the relationship between extractable soil phosphorus and that recovered in lawn clippings. It is not uncommon for clippings collected over a growing season to contain two to five times as much phosphorus as was indicated being available to plants based upon chemical extraction of the soil. This is because the amount of labile phosphorus which enters the soil solution in response to plant removal of phosphorus from this solution (phosphate buffering capacity) is only partly estimated by most soil extraction procedures.

This leaves the lawn care professional in something of a dilemma with regards to phosphorus fertilizer use. Soil and tissue tests are not easily interpreted and turfgrasses almost never exhibit phosphorus deficiency symptoms. Yet phosphorus is an essential element for normal metabolic function which can greatly influence the capacity of lawn grasses to recover from mechanical injury, to absorb other plant nutrients, and to resist disease infection. It is convenient, therefore, to apply little fertilizer phosphorus and rely upon the soil's labile phosphate to enter the soil solution and satisfy the needs of turfgrasses. This assumption of phosphorus availability is probably valid in most soils with a long history of garden or agricultural use. Phosphate fertilizers applied over many years may have increased the labile pool within the soil to such an extent that new phosphorus may not be needed to support good lawn growth. On the other hand, lawns established on forest sites or on areas long out of agricultural production may have little labile soil phosphorus to draw upon and may experience incipient phosphorus deficiency. It is probably in the lawn managers best interest to consider the history of fertilizer use on each site and increase the phosphate application to equal that of potassium on those areas where phosphorus reserves may be low. In any event, phosphate fertilizer applied to the soil is never wasted because most of it enters the labile pool and will slowly become available to plants for many years.

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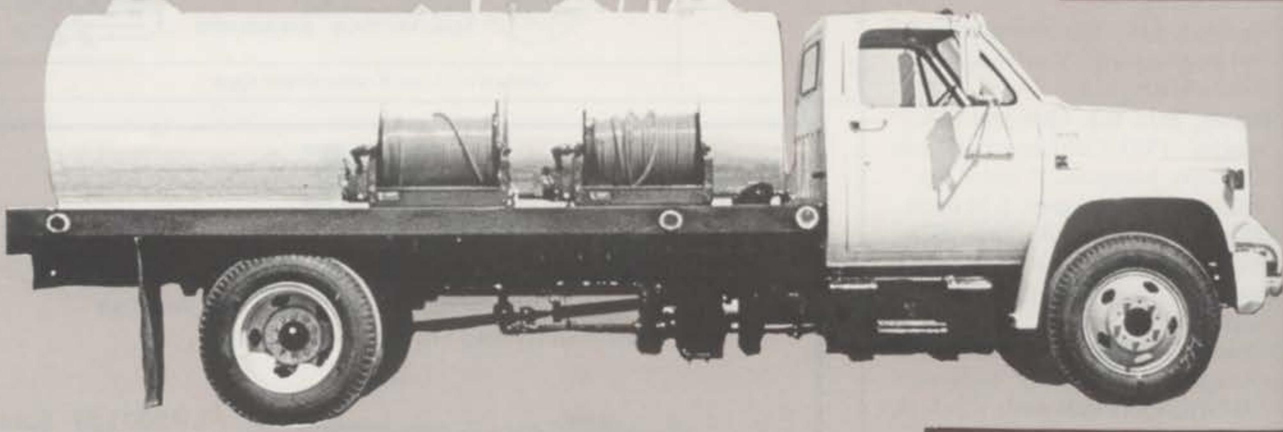

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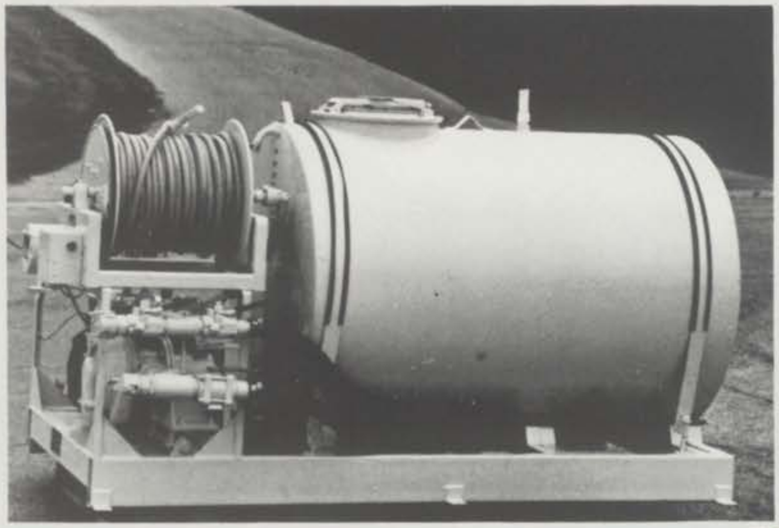

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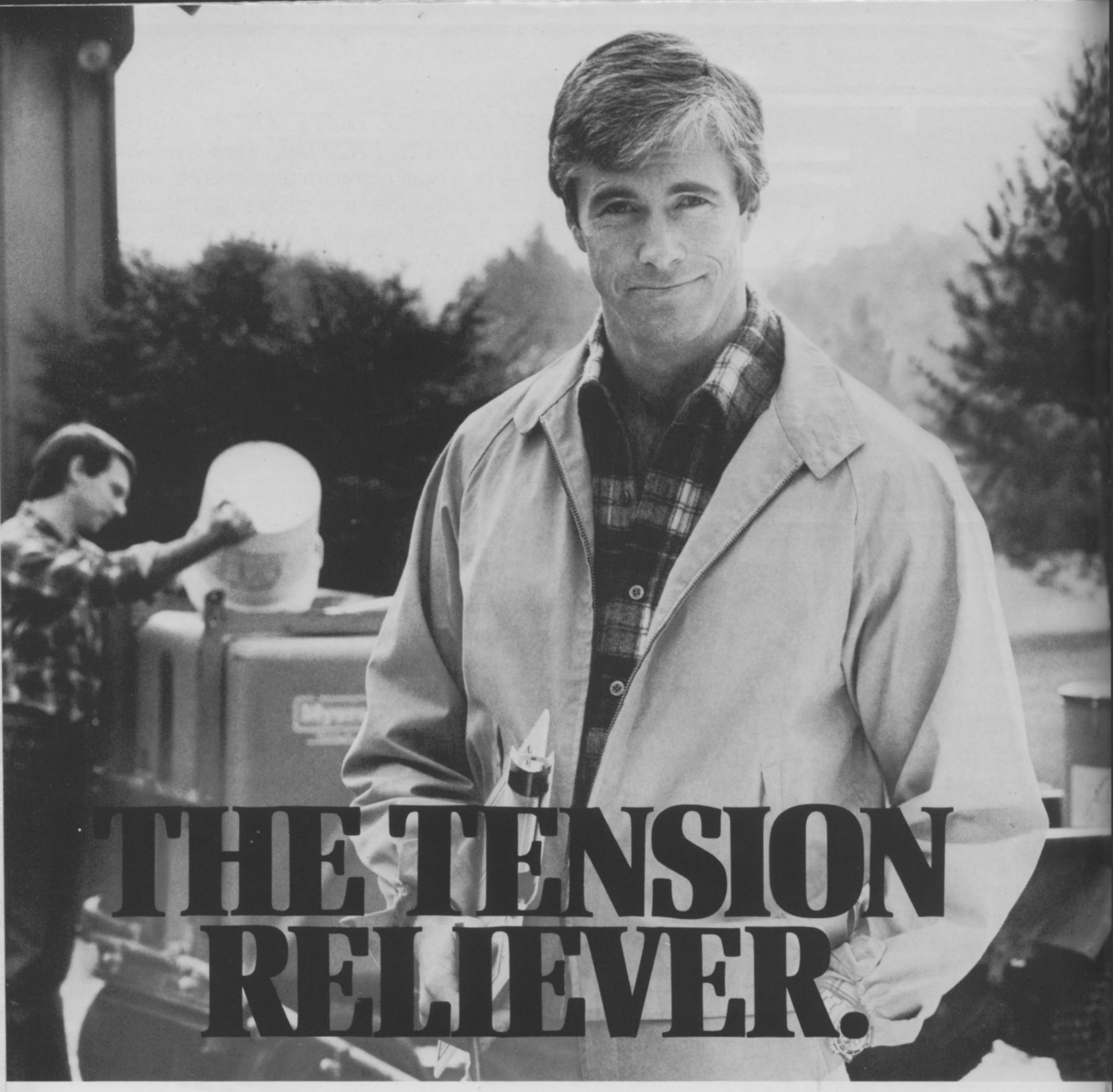

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Circle No. 9 on Reader Reply Card

Chemical Additives— Clearing the Confusion

by Robert Moore, Aquatrols Corp.

Robert Moore is a chemical engineer and developer of a commercially available soil wetting agent. Moore earned a chemical engineering degree from Cornell University, and was formerly a research scientist with Mobil Oil Company.

There are a host of chemical additives available that increase the performance and effectiveness of many spray solutions— including water— commonly used in turf and horticultural management. These additives, known as adjuvants, surfactants, penetrants, emulsifiers, spreaders, wetting agents and many other names, are all too often confused and misunderstood, and in some instances even misrepresented by their manufacturers. This article is intended to clear the confusion surrounding these useful tools, and to replace the vague miracles and mysteries with concrete results and reasons.

The first term, adjuvant, is the most general of all the terms previously mentioned. The chemical dictionary defines an adjuvant as: "A subsidiary ingredient or additive in a mixture which contributes to the effectiveness of the primary ingredient." In other words, an adjuvant is any substance which, when added to a chemical treatment, increases the performance of that chemical. For example, a chelating material, which improves a chemical's availability, is an adjuvant.

Most of the adjuvants that turf and horticultural professionals tank mix with liquid chemicals fall into the category of chemical additives known as surfactants. The word surfactant comes from a contraction of "surface-active-agent". The chemical dictionary definition of a surfactant is: "Any compound that reduces surface tension when dissolved in water or water solutions; or which reduces interfacial tensions between two liquids, or between a liquid and a solid." This again is a very general definition, and covers a multitude of materials.

There are three categories of surfactants: (1) detergents; (2) emulsifiers; and (3) wetting agents.

All three types of surfactants have the same basic chemical mechanism, but each behaves differently depending on the nature of the surface or surfaces treated. More simply stated, adjuvants differ in how they are adsorbed on soil or leaf surfaces. Surfactants can improve the effectiveness of pesticide and fluid fertilizer solutions, as well as increase the availability of water in the plant root zone. However, certain types of surfactants are phytotoxic and should not be used in the turf and horticultural situation. Which types of surfactants are phytotoxic? That depends largely on whether the detergent, emulsifier or wetting agent surfactant is anionic, cationic, or non-ionic.

Before explaining each of the three categories of surfactants, it is important to understand the difference between anionic, cationic and non-ionic types of surfactants. The anionic types of surfactants are negatively charged. They are generally composed of either sodium, potassium, or ammonia salt, and are most frequently used to reduce surface tension or for rapid wetting. Many types of detergents are anionic surfactants; and some are phytotoxic.

The cationic types are positively charged surfactants. Phosphates or quaternary ammonium compounds are examples of cationic surfactants. These materials tend to exhibit the highest degree of toxicity to plants.

The lease phytotoxic, the non-ionic types of surfactants, do not form charged particles at all. They are therefore much less chemically active and have wider use applications in the turf and horticultural industries.

Three categories of surfacants: detergents; emulsifiers; and wetting agents

Now let's take a look at each of the broad catagories of surfactants in greater detail.

First, let's look at detergents which reduce the surface tension of water and are rapid wetters. Detergents work by concentrating at oil-water interfaces. Detergents emulsify dirt particles and allow them to be rinsed away. In the turf and horticultural situation, detergents should be avoided because of their tendency to weaken soil structure (by decreasing soil aggregation) and their high degree of toxicity to plant tissue. Detergents, however, can be used on plant tissue in small amounts, but they

Water drops are held together by natural molecular bonds, known as surface tension. Wetting agents reduce water surface tension, encouraging more uniform water penetration and distribution.

should be generally avoided.

The second type of surfactant, emulsifiers, are compounds that hold two or more materials— usually liquids that do not mix— in stable suspension. Emulsifiers are a type of surface-active-agent, and like detergents reduce surface tension at the interface of the suspended material and the solution. Many pesticides commonly used in the turf and horticultural situation are emulsions, also known as flowables and emulsifiable concentrates. The surfactants in these materials are tied up by stablizing the suspension or emulsion, and usually have little or no effect on any other solution with which they may be mixed.

The third surfactant category, wetting agents, are surface-active-agents which, when added to water, cause water to penetrate more easily into, and to spread over the surface of another material by reducing the surface tension of the water.

Frequently, you hear the statement that detergents and wetting agents are the same. Yet, there are significant differences between the two types of surfactants. It is important that you see the difference. Detergents primarily wet and emulsify oils, dirt, soils, while wetting agents primarily penetrate, wet, and spread.

Wetting agents work by reducing the strength of the natural molecular bonds— surface tension— that hold a water drop together. There are several classes of wetting agents, each with its own unique function and purpose in the turf and horticultural setting.

First, wetting agents are used as spreaders; by lowering the surface tension of water they allow the pesticide with which the spreader is mixed to spread out and wet a larger area.

A wetting agent combined with a resinous material is a spreader-sticker. Upon drying, a spreader-sticker forms a film that is tacky, aiding the pesticide with which it is mixed to resist washing by rain, or irrigation water. Unfortunately, some spreaders are sold as spreader-stickers. These products do a good job of wetting but little to aid pesticide retention. Let the buyer beware.

Spreader-activators are yet another class of wetting agent. They exhibit good penetration, adsorption, wetting and spreading characteristics. Spreader-activators improve the effectiveness of the chemical solutions with which they are mixed by improving absorption and penetration.

The final class of wetting agents are called soil wetting agents. These materials, while similar to the spreaders and spreaders-activators, have some unusual characteristics that set them apart from the other types of wetting agents, surfactants and adjuvants. Soil wetting agents are used to control conditions in the root zone of plants. They enhance water distribution, drainage, and nutrient availability as well as improve aeration. In order to work effectively, much larger quantities of soil wetting agents are required as compared to wetting agents used as spray adjuvants. University tests from Cornell, Michigan, Maine, Nebraska, Ohio, Texas, California, and other universities, all show the need for a minimum of approximately 16-oz. of active ingredient/1000 sq.ft. to effectively correct or prevent adverse growing conditions in the root zone of

Chemical Additives

turf or ornamental plants. Compare this to a spreader treatment of about 16-oz. active ingredient/100 gallons of spray which will cover three acres. Soil wetting agents work at a concentration 100 to 150 times that of spreaders, therefore, wetting agents that are horticulturally safe as spreaders may not be safe as soil treatments.

In addition, the way in which a given wetting agent adsorbs on the soil particles can determine its degree of plant toxicity, its proneness to leaching and the length of its residual activity. A weakly adsorbed soil wetting agent remains in the water phase of the soil solution. Heavy rains or excess irrigation will rapidly leach weakly adsorbed wetting agents out of the root zone. In addition, if the wetting agent remains in the soil solution, it may be translocated into the plant. Recent data from the University of California and Michigan State have shown that translocated soil wetting agents have a detrimental effect on turf and ornamental plants.

Thus, the soil wetting agent of choice, besides being a good penetrant and spreader, must exhibit very low plant toxicity and very high adsorptive behavior. Obviously, the type of adjuvant-surfactant that is most appropriate for use in turf and horticultural work is the non-ionic wetting agent.

When purchasing an adjuvant, it is important to match the adjuvant to the job. Read the label and ask questions. Don't accept hearsay and generalizations.

The following are some guidelines for choosing a wetting agent. First, don't buy water. Ten out of 12 products on the market contain between 75 percent to 90 percent water. Second, take the time to learn about the chemistry of the wetting agent. Is it a single type or a blend? Blends are broad spectrum and are active in more types of soils. Third, find out the residual. One wetting agent on the market biodegrades in only four to seven days. Some are weakly adsorbed and leach readily. Fourth, ask about phytoxicity. Wetting agents that don't adsorb can be taken up by the plant and effect its growth.

Become a wise buyer so that you get the best results from your investment of time and money.

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What Is P3F?

by Jerry Faulring, Hydro Lawn

On September 21, 1983, representatives from pesticide manufacturers, formulators, distributors and users met in Washington, D.C., for the sixth time since December 1982, to formally implement, for the benefit of pesticide users and the public at large, a pro-pesticide foundation. P3F (Pesticide Public Policy Foundation) will serve anyone interested in the continued and safe use of pesticides.

WHAT ABOUT NELF?

For those of you who have been following the development of this effort, do not be confused by the previously announced name NELF (National Environmental Lawn Foundation). The same organizing group has been involved with this issue from the beginning and elected to change the name from NELF to Pesticide Public Policy Foundation for a variety of reasons. PPPF more clearly represents the issue:

Pesticide— specific use of this word zeros in on the issue.

Public Policy— indicates that the effort is directed at guiding and moulding policy in general, regarding the use of pesticides for the benefit of society.

Foundation— implies the need for aggressive educational programs for both pesticide users and the general public.

WHO ARE P3F RESOURCES?

At this writing, P3F has received formal endorsement by the urban foresters via the National Arborist Association, and the lawn care industry via the Professional Lawn Care Association of America. Efforts are under way to obtain the endorsement of all the national, regional, and state organizations that have an interest in the continued and safe use of pesticides. This effort is not limited to only the obvious groups who could be characterized as direct pesticide users. Essentially, everyone is a consumer of pesticides, directly and indirectly.

WHY ANOTHER ORGANIZATION?

There are hundreds of so-called special interest groups at the national, regional, state and local level who, for a variety of reasons, would like to, restrict the use of pesticides. On the other hand, there is not one single national organization that generically, crossing all disciplines, exists to provide balance in this increasing national debate. Likewise, there are several groups positioned to preserve pesticide use, but without exception, each group or organization focuses on only a very small part of the issue. Therefore, the need for a single, national organization postured to represent the balancing entity in the debate is needed and in fact is long overdue.

Why have the Arborists and Lawn Care Industries taken a lead role in the development of P3F when so many others are affected by the issue? In a word, it is VISIBILITY.

Not a day goes by when one cannot find an arborist or lawn care truck plying its trade in a highly visible manner in the urban/suburban setting. Thus, the opposition in many cases has focused their efforts toward these user groups in recent months and years. Even though the entire society will be affected by pesticide use restrictions, and therefore have a vested interest in the issue, opposition momentum is most readily mobilized against the most visible pesticide users first.

WHO WILL FUND P3F?

It would be nice if everyone who is a beneficiary of pesticides would, upon solicitation, write out a check to P3F to accomplish its purposes and goals. This will not happen.

The populace will react when food costs rise sharply, food supplies are interrupted, our trees and recreational turf disappear, our clothing costs rise sharply, our homes and offices decay, our lives are shortened or lost due to vector transmitted disease and so on.

To answer the question, however, P3F will be funded by those who have the most to lose NOW. It's you and me, and organizations like ours that will not be in business if restrictions and over-regulation preclude us from using pesticides. And, at least initially, those with the greatest visibility in the issue have the mandate to carry the ball.

WHAT ARE THE IMMEDIATE PLANS FOR P3F?

The Pesticide Public Policy Foundation has established three primary purposes:

1. Organize a network of state organizations for the purpose of insuring the presence of a response mechanism when state and local governments consider pesticide use legislation. Further, these state organizations will provide the now missing vehicle for alerting P3F of pending local issues.

The state organization, for the most part, will be comprised of volunteers such as yourself. If you have an interest in serving at this level, please write to your trade association or P3F at the addresses listed below.

2. Assist the public in determining what constitutes reasoned public policy. In other words, educate people so that societal behavior patterns match facts in assessing risks for purposes of regulating desirable health and economic pesticide related activities. Although the results of this effort will take time, we must concern ourselves with adjusting attitudes on a more permanent basis as opposed to the first purpose which serves to satisfy immediate concerns.

3. Respond to federal legislative and regulatory issues of general concern to pesticide dependent users. Examples of immediate concern are House Bill 3818, and Senate Bill 1774, which were introduced last August. These identical Bills would amend existing FIFRA legislation and, if passed, would have profound effects on the entire pesticide user community.

These Bills will affect almost every aspect of pesticide manufacture, distribution and use, but of particular interest to users are the call for:

a. increased record keeping;
b. establishment of buffer zones when using pesticides to protect against overspraying and drift;
c. pre-notification and sign posting to warn individuals present in the areas to be sprayed.

IS P3F OPERATIONAL?

The P3F is more than just talk even at this writing. A firm that has specialized in representing the positions taken by P3F for several years has been contracted with to represent P3F and manage its daily affairs. An organizing Board of Directors is meeting regularly to drive P3F with an aggressive action plan. Nearly $200,000 has already been pledged to fund the operation. Two offices have been established, one in Washington, D.C. and one in Oregon. "800" numbers are being installed for your use to insure adequate and timely communication. Several printed promotional and educational pieces are being developed and should be available within weeks.

(continued on page 24)

New Sprayer from FMC

Agricultural Machinery Division of FMC announces availability of its high pressure sprayer with fiberglass tank. Tanks are available in 50, 100, 200 and 300 gallon sizes. There are four pump and engine configurations of this new sprayer, two with a 5 HP Briggs and Stratton engine, one with a 7 HP Kohler engine and one with a 12 HP Kohler engine equipped with an electric starter. Depending on the configuration, sprayer may deliver up to 5 GPM at 400 PSI, 10 GPM at 350 PSI, 10 GPM at 500 PSI and 20 GPM at 500 PSI.

A stainless steel agitator keeps spray material from settling or coagulating and the required pressure is generated by a Bean piston pump with non wearing ceramic cylinders. A full range of accessories, such as hose, guns, reels, booms and two-wheeled trailer kits for this sprayer are available from FMC. For more details, contact Marion Meredith, FMC Corporation, Agricultural Machinery Division, 5601 East Highland Drive, Jonesboro, AK 72401, or use reply card.

Circle No. 18 on Reader Reply Card

(continued from page 23)

WHAT SHOULD YOU DO?

First, volunteer to become active in the state organizations. Some already exist. Second, make a financial commitment to P3F. If we are to continue using pesticides in our businesses with a minimum of excessive regulation, we must accept the fact that this effort will be costly.

This job can be done but not without your financial support and personal involvement. View your expense (time and money) as insurance that assures you will stay in business.

HOW MUCH MONEY SHOULD I PLEDGE?

No one can really identify what this project will cost. However, it has been estimated, with serious analysis, that at least a $1,000,000 annual budget will be required.

Many ratios have been suggested, such as 1/10 of 1% to 1/2 of 1% of chemical sales or one dollar per account from pesticide users and so on. The important thing for you to recognize is that your livelihood is at stake. What amount is justifiable to insure that happens?

To aid in accommodating your cash flow, installment payments on a monthly or quarterly basis are acceptable.

To answer the question, the amount you give or pledge is your decision, but in this case, the obligation to yourself requires contributions at a level far greater than you have probably ever experienced previously.

Where to write for information, to volunteer your time, or to make a financial pledge:

If you DO NOT belong to a national trade association:

Pesticide Public Policy Foundation
1511 K Street, N.W.
Washington, D.C. 20005

Pesticide Public Policy Foundation
253 13th Street N.E.
Salem, OR 97301

If you DO belong to NAA or PLCAA:

National Arborist Association
3537 Stratford Road
Wantagh, NY 11793
(516) 221-3082

Professional Lawn Care Assoc. of Amer.
1225 Johnson Ferry Rd., N.E.
Marietta, GA 30067
(404) 977-5222

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LAWN SPRAY BUSINESS For Sale in Florida. Ask for Wayne. (305) 567-1706.

SPRAY TRUCK— 1979 Chevy one ton truck- 750 gallon tank— mechanical agitation. Excellent spraying condition. Low mileage. Must sell. $9200. Call (502)456-6777, ask for Pat McConnell.

1979 Louisville **FORD TRUCK** with custom designed storage compartments. 1979 FINN LAWN FEEDER with power take off. Both like new, will sell separately or together. (313) 468-5285.

SPYDER FORKLIFT/TRAILER, 200 hours, exc. condition, Zionsville, IN $12,400. Call George (317)873-5231 or 873-5937.

SPRAY TRAILER— 300 gal. poly tank, electric hose reel, brake & lights. Centrifugal pump and 8 HP motor, excellent condition. $2,850. Atwood Lawnspray (313)939-3636.

QUALIFIED INDIVIDUAL needed to work my turf spraying business in the N.Y., N.J. area. He or she must be licensed appropriately and be willing to work long hours March-Oct. Contact Tony Cioffari, Creative Landscaping, 398 Garibaldi Ave., Lodi, NJ 07644 (914)356-2074.

WANTED TO BUY— Lawn spray/tree spray company or accounts. S.E. Penn., central and southern NJ. Residential, commercial and industial accounts any size including sterilization. Contact Steve after 6 p.m. (215)357-8875, or write to Spray Associates, Box 445, Warrington, PA 18976.

TRACTOR/LAWN COMBINE UNITS (2) No. 179 IH Hydrostatic tractors w/10 gal. tank on tractor. Combines are stainless steel with aerators, 4 granular bins and 20 gal. spray tank. $3,500 per unit. Call (315)637-6001 or (315)492-3217.

ACCOUNTS WANTED— national chemical lawn care company seeks accounts to acquire. Selling price open for negotiation. If interested, send name, address, phone number and number of accounts available to Dept. B, American Lawn Applicator, 31505 Grand River Ave., Suite One, Farmington, MI 48024.

WANTED TO BUY— Lawn care company in Midwest (Mich., Ill., Ind., Wisc.) area. Small to med. size. Chemical turf applications only— no mowing or tree care. Send information to Lawn Care, P.O. Box 361, Grosse Isle, Mich. 48138.

WANTED— Used four wheel self-propelled Hahn or Cushman 120-175 gallon sprayer for greens. P.O. Box 191, Brentwood, TN 37027. (615)794-6646.

LAWN SPRAY COMPANY— For sale with 5 trucks, grosses $150,000. Accu-Spray, (313) 977-8300, ask for Diane.

WANTED—Dealers/Distributors for Ag Spray Hose. Hose is of finest quality and fully guaranteed. Receive distributor discounts and supplement your winter income. Call Dick Charles, Green Thumb Spray. (516) 485-1919.

SPRAYING EQUIPMENT— pump, hose and reel. Price $300 negotiable. Call Northville, MI. (313)348-6251. Ask for Bob.

FOR SALE— 1979 Ford tractor/loader, 545 tractor, rops, cab and box scraper. A-1, 800 hrs. (414) 387-4542 ask for Dick.

SPRAY TRUCK—1973 F-600 1200 gal., 1976 C-60 1500 gal., 1978 C-60 1200 gal., all have mechanical agitation Hannay reel, FMC pump, aux. 8 H.P. engine for pumping system. Excellent condition. Biddle Lawn Care Inc., (217) 359-7012 ask for Dick.

ACCOUNTS WANTED— in Ohio: Cleveland, Akron, Canton, Ashtabula, Youngston areas. Selling price open for negotiation. If interested, send name, address, phone number and number of accounts to: Robert Naylor, P.O. Box 201, Hudson, OH 44236, (216) 656-1111.

Calendar of Events

DECEMBER

NEW JERSEY TURFGRASS EXPO '83— December 5-8. Resorts International Hotel, Atlantic City, New Jersey. Contact Dr. Henry W. Indyk, Soils and Crops Dept., Cook College, P.O. Box 231, New Brunswick, NJ 08903 (201) 932-9453.

14th ANNUAL G.G.C.S.A./U. of Ga. TURFGRASS CONFERENCE— December 14-15. Center for Continuing Education, University of Georgia, Athens, GA.

OHIO TURFGRASS CONFERENCE & TRADE SHOW— December 6-8. Contact Dr. John Street, OTF, 2021 Coffey Rd., Columbus Ohio 43210 (614) 422-2047.

1983 PENNSYLVANIA TURFGRASS CONFERENCE AND TRADE SHOW— December 12-15. Contact Christine King, 412 Blanchard St., Bellefonte, PA 16823 (814) 355-8010.

JANUARY

MICHIGAN TURFGRASS CONFERENCE— January 17-18. Long's Convention Center, Lansing, MI. Contact Paul Rieke, Dept. Crop & Soil Science, Michigan State University, East Lansing, MI 48824. (517) 355-0266.

22nd ANNUAL NORTH CAROLINA TURFGRASS CONFERENCE— January 3-5. Pinehurst, N.C. Pinehurst Hotel. Contact W.B. Gilbert, 1119 Williams Hall, NC State University, Raleigh, NC 27650. (919) 737-2657.

18th ANNUAL CONFERENCE OF THE TENNESSEE TURFGRASS ASSOCIATION— January 10 & 11. Music City Rodeway Inn, Briley Parkway at I-40, Nashville, TN 37217. Contact Brenda Goins, Exec. Secretary, 25 Coach House, 523 Harding Place, Nashville, Tennessee 37211, (615) 832-6493.

UNIVERSITY OF TENNESSEE DEPARTMENT OF ORNAMENTAL HORTICULTURE AND LANDSCAPE DESIGN THREE DAY "TURF & GROUNDS MAINTENANCE" SHORT COURSE— January 23-25. U.T. Knoxville Contact Dr. L.M. Callahan, Prof. of Turf Management, Box 1071, Univ. of Tennessee, Knoxville, TN 37901. (615) 974-7324.

24th ANNUAL VIRGINIA TURFGRASS CONFERENCE AND TRADE SHOW— January 18-20. Williamsburg Hilton and National Conference Center, Williamsburg, VA. Contact Dr. John R. Hall, III, Agronomy Dept., VPI&SU, Blacksburg, VA 24061-7294, (703) 961-5797.

MAY

NORTH CAROLINA TURFGRASS AND LANDSCAPE FIELD DAY— May 23. NCSU Turf Field Plots, Raleigh, NC. Contact J.M. DiPaola, 1126 Williams Hall, NC State University, Raleigh, NC 27650. (919) 737-2657.

TENNESSEE TURFGRASS MANAGEMENT RESEARCH FIELD DAY & EQUIPMENT SHOW— May 29. University of TN Turfgrass Management Research Field Plots on the Agricultural Campus at U.T. Knoxville. Contact Dr. L.M. Callahan, Ornamental Horticulture and Landscape Design. (615) 974-7324.

Texas Research Report

The 164-page Annual Texas Turfgrass Research Progress Report for 1983 is now available, according to Dr. James B. Beard. It is published as Consolidated PR 4147-4170 of the Texas Agricultural Experiment Station. Individuals wishing to request copies should contact Tom Sneed, Department of Agricultural Communications, Texas A & M University, College Station, TX 77843.

Resting Site Preferences for Sod Webworm Moths

by Mike P. Tolley, Ohio State University

Mike Tolley received his B.S. degree from Roanoke College, VA in 1980 and M.S. degree from the Virginia Polytechnic Institute and State University. He is currently working on a Ph.D. in Entomology at The Ohio State University.

Sod webworms (SWW) are common in turfgrass in the eastern, southeastern, and midwestern parts of the U.S., and have reached pest status in some areas. The damage to fine fescues and bluegrasses are usually seen during periods of stress in the hot, dry part of the summer. There has been some research on developing varieties of turfgrass resistant to the feeding of sod webworm caterpillars (6), and there are a number of new insecticides developed for controlling these insects.

There are a large number of SWW species that are associated with turfgrass, but only a few species are present in numbers large enough to cause aesthetic or economic damage. Fourteen species have been reported to occur in Virginia (5), 41 species in Florida (1, 2), and 32 species in Tennessee (4). The biology and habits of the immature (caterpillar) stages of sod webworms, and the seasonal abundance of important species have been well researched (4, 5). However, little is known about the habits of the adult moths (Figure 1).

The adult moths are most often seen at dusk as they are flying over infested turfgrass. When not flying at night, and during the day, adult moths rest in protected areas. Some species prefer broadleaved plants to rest upon (3), some rest in the turfgrass on grass leaves and stems, others prefer shrubs that are adjacent to infested areas (6). The presence of large numbers of SWW adults in turfgrass or shrubs may indicate an economically important infestation, and may be developed into a tool for locating and estimating population size.

The objectives of the research presented here were to determine where certain species of SWW adults prefer to rest during the day, and what grass or shrubs are preferred resting sites.

The study site was located on the Virginia Polytechnic Institute and State University in Blacksburg, Virginia. The site consisted of a turfgrass area (bluegrass-ryegrass mix) completely surrounded by two types of garden shrubs *(Buxus* and *Juniperus sp.*). Sod webworm moths were sampled from the turf and shrubs via a flushing device and a beating technique (Figure 2), respectively. Moths were sampled daily from August to October, 1982.

Three species of SWW moths were sampled in abundance during this time of the year. These were *Microcrambus elegans, Parapediasia teterrella,* and *Agriphila ruricolella.* There was a significant higher relative abundance of all three species of SWW moths in the

Figure 1: Sod webworm moth.

shrubs than in turfgrass. In addition, there was no significant difference in moth abundance between the two shrub species. This information indicates that these three species of SWW moths use shrubs to a larger degree than turfgrass as resting sites during the day, with no preference for either shrub species.

Such information can be of value to the turfgrass manager or homeowner in indicating the presence of SWW moths. In view of their presence, one can better anticipate possible SWW caterpillar infestations. If certain turf areas are known to have frequent infestations of SWW caterpillars, it might also be of some benefit to time the spraying of shrub pests with known SWW moth flight peaks (4, 5). Such a management technique could conceivably reduce a large percent of the SWW moths, thus hindering reproduction and egg deposition.

Although such techniques might offer some additional hope on controlling possible SWW infestations, or merely indicate their presence, more research is needed. These concepts need to be expanded to further study other SWW species and shrubs commonly associated with turfgrass and lawn landscaping.

Figure 2: Beating technique to sample shrubs for the occurrence of sod webworm moths.

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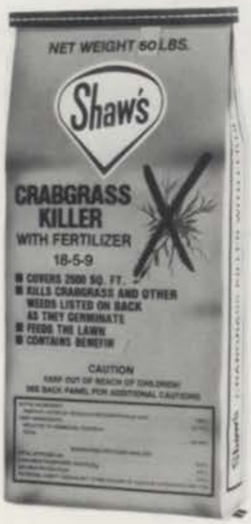

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Financial Seminars

The Associated Landscape Contractors of America, the National Arborist Association, and the Professional Lawn Care Association of America will jointly sponsor a series of two-day financial seminars December 1-8, 1983 for owners, chief executive officers, chief operating officers and other top management of green industry companies. Conducted by Ross-Payne & Associates, Inc., a well known financial consultant firm, each of the three seminars will be held in the Chicago area at the Schaumberg Marriott Hotel.

"Compensation Planning", which will investigate the entire gamut of direct and indirect income, will be presented December 1 and 2. Enrollment is open.

"Financial Analysis", designed to analyze the full spectrum from bank negotiations to competitive pricing will be given December 5 and 6. Enrollment is limited to 40 attendees.

"Financial Planning" presented December 7 and 8 will focus on a step-by-step procedure of how to prepare an annual financial plan and how to monitor and up-date during the year. Enrollment is limited to 40 attendees.

For registration forms and detailed program information, contact any of the sponsoring trade associations. Enrollment is open to any interested green industry businessman on a first come basis.

Associated Landscape Contractors of America, 1750 Old Meadow Road, McLean, VA 22102 (703) 821-8611.

National Arborist Association, Inc., 3537 Stratford Road, Wantagh, NY 11793 (516) 221-3082.

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