

1966

December 1966

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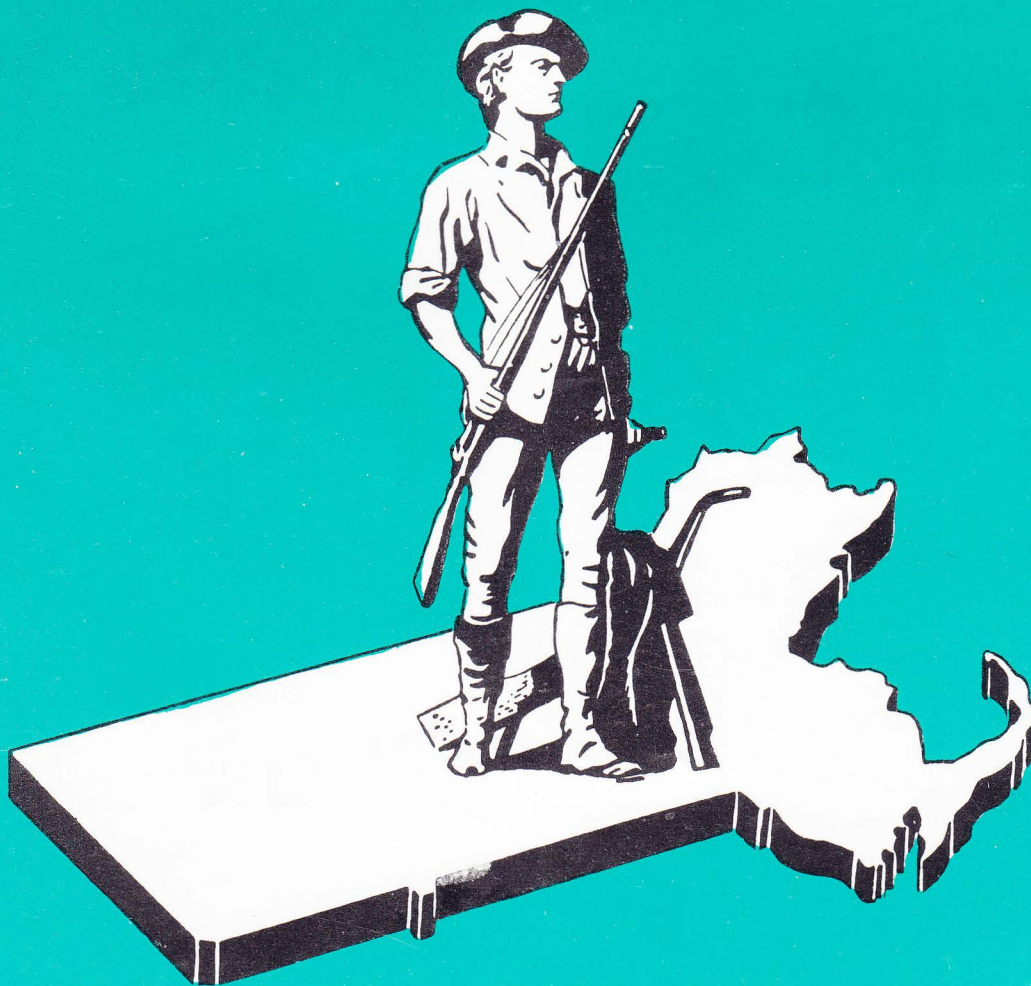
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TURF BULLETIN

MASSACHUSETTS TURF
AND LAWN GRASS COUNCIL
I N C O R P O R A T E D



DECEMBER 1966

BETTER TURF THROUGH RESEARCH AND EDUCATION

Editor

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TURF BULLETIN

Vol. 4, No. 2

December, 1966

ABOUT THE NEW EDITOR

In the previous edition you may have noticed that the *Turf Bulletin* has a new editor.

Edward (Ted) Horton became interested in turf maintenance while attending McGill University in Montreal, Canada. During his study of Agricultural Biology, Mr. Horton gained an insight into golf course construction when he worked for three summers on the construction crew of a thirty-six hole course.

To further his experience in turf maintenance Mr. Horton worked for eight months on a golf course in Florida after which he enrolled as a Turf Management student at the Stockbridge School of Agriculture. After an academically outstanding year, he took his placement training at Winged Foot Golf Club in Mamaroneck, New York.

Mr. Horton was recently selected as a recipient of a Golf Course Superintendents' Association of America Scholarship.

Upon graduation in June, Mr. Horton hopes to further his career in golf course maintenance.

The Massachusetts Turf and Lawn Grass Council Incorporated is chartered under the laws of the Commonwealth of Massachusetts as a non-profit corporation. The turf council seeks to foster "Better turf through research and education".

More detailed information on the subjects discussed here can be found in bulletins and circulars or may be had through correspondence with the editor.

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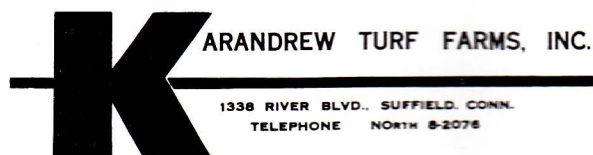
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UNDERSTANDING NITROGEN AS REPORTED ON THE FERTILIZER TAG

G. C. Horn

Associate Turf Technologist



The cost of fertilizer is second only to labor in the total annual cost of maintaining turf. Very little can be done to reduce the labor requirements; but a good understanding of fertilizer relationships and proper use can result in substantial savings.

A good knowledge of the fertilizer tag is essential in purchasing the proper fertilizer and appraising its value after it is delivered. The fertilizer tag tells more about nitrogen than any of the other fertilizer elements.

UNDERSTANDING THE FERTILIZER TAG

In the past a 1-1-1 ratio fertilizer has been recommended for turf fertilization. We now know the 4-1-2 ratio is better for turf and the University of Florida will recommend this ratio in the future.

The ratio of 4-1-2 is the ratio of nitrogen (N) to phosphorus (P_2O_5) to potash (K_2O). This means that there is four times as much nitrogen as phosphorus and twice as much potash as phosphorus.

The fertilizer analysis is the percentage nitrogen, phosphorus and potash in the bag. A fertilizer with 4% nitrogen, 1% phosphorus and 2% potash would have the analysis of 4-1-2 which is exactly the ratio. However, Florida law requires that a mixed fertilizer contain a minimum of 16 per cent plant food. If you add 4+1+2 it equals 7. This tells you that the 4-1-2 analysis contains only 7% plant food, which is less than the law allows.

An 8-2-4 analysis (which has twice as much N, P_2O_5 and K_2O as the 4-1-2) contains only 14% plant food, two per cent below the minimum. Therefore, the lowest analysis of mixed fertilizer that can be sold in Florida, having a 4-1-2 ratio, is a 12-3-6 which contains 21% plant food. Another 4-1-2 ratio fertilizer is a 16-4-8, which is four times as concentrated as a 4-1-2 would be. Several 16-4-8 or similar analysis fertilizers are currently available on the market. The 16-4-8 fertilizer contains 28% plant food. After ratio and analysis are understood the next most important information on the fertilizer tag is that concerning nitrogen.

Using the 16-4-8 discussed above we have already established that the 16 represents 16% nitrogen (N). There are many sources of nitrogen that can be used in formulating this 16% nitrogen. There are even more combinations of these sources of nitrogen possible. For the purpose of this discussion, a 50% organic nitrogen formulation will be put together.

The nitrogen part of a 16-4-8 fertilizer comes in four forms and could look something like the two examples shown below.

Example 1

Total Nitrogen, not less than	16.00%
Nitrate Nitrogen, not less than	4.00%
Ammonical Nitrogen, not less than	4.00%
Water Soluble Organic Nitrogen, not less than	8.00%
Water Insoluble Organic Nitrogen, not less than	0.00%

Example 2

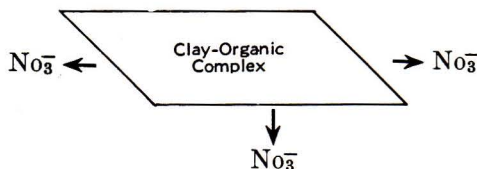
Total Nitrogen, not less than	16.00%
Nitrate Nitrogen, not less than	4.00%
Ammonical Nitrogen, not less than	4.00%
Water Soluble Organic Nitrogen, not less than	0.00%
Water Insoluble Organic Nitrogen, not less than	8.00%
Total	16.00%

The nitrogen contents of examples 1 and 2 above are identical but their cost and value would be quite different. Both could be sold as 50% organic nitrogen fertilizers but the formulation shown in example 2 would be far superior. The reason for the superiority

of the formulation shown in example 2 is the 8% water insoluble organic nitrogen that it contains and the total absence of water soluble organic nitrogen.

The formulation in example 1 contains just the reverse and is still considered as a 50% organic formulation. However, it is of no more value than an all chemical formulation that contained 8.00% nitrate and 8.00% ammonical nitrogen. Both are much less valuable than the formulation shown in example 2. The reasons for the value of the water insoluble organic nitrogen will be discussed below.

NITRATE NITROGEN—Most of the nitrogen that is absorbed by grass roots is in the form of nitrate nitrogen. The chemical designation for nitrate nitrogen is NO_3^- . The small dash above the 3 tells us that it carries a negative charge. Organic matter and clay particles have a negative charge (like nitrate nitrogen). These clay and organic particles are responsible for holding certain fertilizers against leaching. As we know from elementary physics, like charges repel each other and unlike charges attract. In symbolic language, this is shown below.

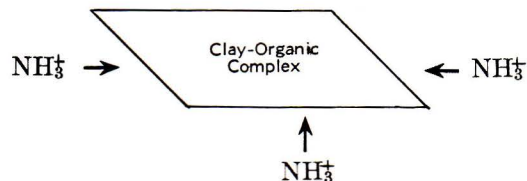


The clay-O.M. (clay and organic matter) particles and nitrate (NO_3^-) form of nitrogen both carry negative charges and therefore repel each other. There is no chemical or electrical bonding between the clay-organic particle and nitrate nitrogen. Therefore, when the first good leaching rain (more than one-half inch for most sandy soils) comes, all of the nitrate-nitrogen can be leached downward in the soil profile and out of the root zone.

We have established two facts: One, that nitrate-nitrogen is the form of nitrogen most readily absorbed by grass roots; and two, that it is not held by the soil against leaching. If we did not have to worry about losing nitrogen by leaching, then a nitrate source would be best and all 16% of the nitrogen in examples 1 and 2 could be in the form of nitrate-nitrogen. With more than 60 inches of rainfall plus heavy irrigation we have serious leaching problems in Florida. Other nitrogen sources available for use have different properties that somewhat reduce the leaching losses.

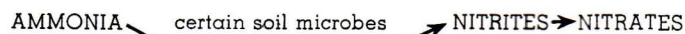
AMMONICAL NITROGEN—Although most of the nitrogen absorbed by grass roots is absorbed in the nitrate form; substantial quantities are absorbed in the

ammonical form (NH_4^+). However, unlike nitrate-N (NO_3^-) ammonical-N (NH_4^+) carries a plus or positive charge. Since unlike charges attract, the negative charge of the soil-organic particle attracts and holds the positively charged ammonical-N (NH_4^+). This is shown below:



A lot of water would be required to separate the hold that the clay-O.M. particle has for the NH_4^+ . Therefore, this form of nitrogen is not subject to leaching. For this reason, it is a good practice to put some of the nitrogen in the fertilizer bag and on our turf in this form.

Ammonical nitrogen does not remain in the soil in this form very long because it is rapidly changed to the nitrate form by certain micro-organisms. This change of ammonical-nitrogen to nitrate-nitrogen is known as **nitrification** and is one of the most important soil reactions known. The nitrification process is as follows:



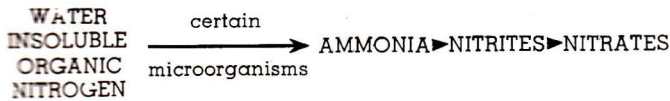
This change of ammonical nitrogen to nitrate nitrogen proceeds continuously in the soil if moisture is adequate and temperatures are not too low. Conditions that favor grass growth are similar to those required for nitrification.

WATER SOLUBLE ORGANIC NITROGEN—The name is very descriptive of this compound because it is both organic and water soluble. This form of nitrogen should be listed as an ammonical because it behaves like ammonical nitrogen. Water soluble organic nitrogen does not have the slow release properties that are found in water insoluble organic forms of nitrogen.

The principle sources of water soluble organic nitrogen are urea and calcium cyanimid. Urea is the one most used in mixed fertilizer. Very soon after urea is added to the soil, the enzyme urease changes urea into ammonia. This change can occur within a 24-hour period. For this reason, the water soluble organic sources of nitrogen should be considered as ammonical nitrogen.

WATER INSOLUBLE ORGANIC NITROGEN — This form of nitrogen is highly desirable because of its slow release properties. When buying a mixed fertilizer that contains organic nitrogen, most of the organic nitrogen should be the water insoluble form.

Several sources of water insoluble organic nitrogen including the synthetic ureaformaldehydes, sewerage sludge, agrinite, cottonseed meal, tung meal, etc. Water insoluble organic nitrogen is not available to turf in this form. It must undergo microbiological changes before it can be absorbed by grass. This process is shown below:



The above process takes longer than the simple change of ammonia to nitrites and then to nitrates which requires 7-10 days, under favorable conditions. The change of water insoluble organic nitrogen to nitrates requires 14 to 21 days under the most favorable conditions. As long as the nitrogen is in the water insoluble or ammonia form it is not leachable; however, once it is changed into nitrites or nitrates it is subject to leaching.

Certain soil and climatic conditions are necessary before water insoluble nitrogen can be changed into a form of nitrogen that turf can absorb.

CLIMATIC CONDITIONS NECESSARY FOR NITRIFICATION

TEMPERATURE — Optimum temperatures for changing unavailable nitrogen to an available form is between 40° F and 90° F. Below 40° F the change is extremely slow and may stop completely. For this reason, water insoluble organic nitrogen should not be used in winter time. As the temperature increases above 40° F the rate of conversion is increased until the temperature becomes too hot for the micro-organisms to survive. Usually, temperatures that are favorable to the best growth of turfgrass is suitable for converting insoluble nitrogen to nitrate-nitrogen.

WATER — The conversion of insoluble organic nitrogen to nitrate-nitrogen is carried out by several different groups of micro-organisms. These organisms must have moisture to survive. Fortunately, these micro-organisms can withstand a drier soil than any of the southern turfgrasses. If the amount of water in the soil is suitable to good grass growth the nitrifying organisms will have ample moisture to function properly.

SOIL CONDITIONS NECESSARY FOR NITRIFICATION

AERATION — The oxygen content of the soil should be 10 per cent or greater for best growth of the

micro-organisms that change insoluble nitrogen into an available form. An excessively wet soil will have less than 10 per cent oxygen and the organisms that convert nitrogen to an available form die because of an oxygen deficiency.

pH—Soil pH is a measure of the acidity or alkalinity of the soil. A pH of 7.0 is neutral, neither acid nor alkaline. A pH of 6.0 is 10 times more acid than a pH of 7.0. Further, a pH of 5.0 is 100 times more acid than a pH of 7.0. The same is true on the alkaline side of the pH scale. A small change in soil pH can result in a significant change in degree of acidity or alkalinity.

The optimum pH for conversion of insoluble nitrogen to an available form is within the range from 6.0 to 8.0. Below a soil pH of 6.0 and above pH 8.0, conditions are not favorable for the growth of nitrifying organisms. As the soil acidity increases the population of nitrifying organisms decreases rapidly.

FERTILIZER ELEMENTS — Calcium and magnesium (both found in dolomite limestone) favor growth of nitrifying organisms and increase the rate of nitrification.

Organic soils and mineral soils very high in organic matter can maintain a fair population of nitrifying organisms at a lower pH than mineral soils low in organic matter.

Phosphorus and potash are especially stimulating to nitrification.

CARBON NITROGEN RATION—The change of insoluble organic nitrogen to available nitrogen continues (under favorable soil and climatic conditions) as long as there is a source of nitrogen for the micro-organisms and carbon compounds for them to decompose. Excess carbon causes a shortage of nitrogen because the micro-organisms consume the nitrogen and little or none is available for turf. Where sawdust is added to a soil as an amendment (without extra nitrogen), little decomposition of the sawdust occurs until extra nitrogen is added and a more favorable carbon to nitrogen ratio is established.

SOURCES OF NITROGEN

Most of the commercially available sources of nitrogen are listed in Table 1. The discussion above covers most of the important factors that should be considered in selecting a source of nitrogen and how the fertilizer tag should be interpreted.

Table 1
Chemical Composition of Nitrogen Containing Fertilizer Materials
(Average Percentage Composition)

Material	N	P ₂ O ₅	K ₂ O	CaO	MgO	CuO	MnO	Cl	SO ₃	B ₂ O ₃	Others	
Nitrate Sources of Nitrogen												
Sodium nitrate (Chile)	16.66	—	—	0.16	0.10	0.004	—	0.40	0.19	0.040	Na ₂ O-35.98 I ₂ O ₅ -0.042	
Sodium nitrate (Synthetic)	16.22	—	—	0.08	0.06	—	—	0.24	0.17	—	Na ₂ O-36.19 I ₂ O ₅ -None	
Ammonium nitrate	33.60	—	—	—	—	—	—	—	—	—	—	
Ammonium nitrate-lime	20.70	—	—	10.18	7.46	—	—	—	—	—	—	
Calcium nitrate	15.43	—	—	27.24	2.49	—	—	—	—	—	—	
Potassium nitrate	12.96	—	44.51	0.59	0.38	—	—	1.14	0.73	0.28	I ₂ O ₅ -0.024	
Nitrate soda-potash	15.00	—	14.00	—	—	—	—	—	—	0.39	Na ₂ O-18.00	
Ammonical Sources of Nitrogen												
Anhydrous ammonia	82.2	—	—	—	—	—	—	—	—	—	—	
Ammonium sulfate	20.84	0.07	0.47	0.37	0.032	—	0.001	0.49	59.35	—	Fe ₂ O ₃ -0.018 ZnO-0.015 Free H ₂ SO ₄ -0.12 Total	
Ammonium nitrate	(see above)											
Ammonium metaphosphate	16.7	51.2	—	—	—	—	—	—	—	—	P ₂ O ₅ -73.4	
Ammonium phosphate (mono)	11.27	48.48	0.22	1.51	0.46	0.02	0.04	0.10	5.59	0.06	Na ₂ O-0.63 Fe ₂ O ₃ -2.24 Al ₂ O ₃ -1.98 ZnO-0.42 F-0.1 to .75	
(TVA) ammonium phosphate Di	21.21	53.76	—	—	—	—	—	—	—	—	—	
Ammonium phosphate sulfate	16.40	21.06	0.18	0.40	0.17	0.03	0.30	0.20	38.49	.09	Fe ₂ O ₃ -0.88 Al ₂ O ₃ -0.97 ZnO-0.023 F-0 to 1.5	
Water Soluble Organic Sources of Nitrogen												
Urea	45.10	—	—	—	—	—	—	—	—	—	Ca(OH)-19.0 CaCO ₃ -6.0	
Calcium cyanamid	21.7	—	—	—	—	—	—	—	—	—	—	
Water Insoluble Organic Forms of Nitrogen												
Dried blood	12.91	1.50	0.57	0.34	0.17	0.0009	0.0005	—	0.43	0.0032	ZnO-0.003	
Raw bone meal	3.87	22.46	—	30.68	Trace	Trace	Trace	Trace	Trace	Trace	—	
Steamed bone meal	2.24	27.42	—	35.28	—	—	—	—	—	—	—	
Castor pomace	5.20	1.81	1.09	0.58	0.53	0.006	0.05	—	—	0.042	Fe ₂ O ₃ -1.21 Al ₂ O ₃ MoO ₃ -0.003 ZnO-0.06	
Urea formaldehyde	38.00	—	—	—	—	—	—	—	—	—	—	
Cocoa shell meal	2.45	1.01	2.68	1.31	0.57	0.021	—	—	0.23	0.004	—	
Cotton seed meal	6.43	2.59	1.74	0.34	0.70	0.0055	0.0026	—	0.75	0.0046	ZnO-0.028	
Tankage	2.77	3.06	1.14	4.20	0.45	0.05	—	1.27	1.52	—	—	
Peruvian guano	12.49	11.23	2.41	12.27	1.00	0.01	0.025	—	2.75	0.015	ZnO-0.003	
Peat	1.86	0.25	0.16	1.58	0.60	0.075	0.025	—	0.64	0.21	ZnO-0.005	
Process tankage	8.10	0.98	0.10	1.00	0.02	—	—	0.85	2.26	0.088	Fe ₂ O ₃ -3.14	
Sewage sludge	5.59	5.14	0.44	1.86	0.94	0.12	0.02	0.65	2.45	0.011	Na ₂ O-1.07	
Raw sludge (local sewerage)	1.5-3.5	1.00	(various concentrations of secondary elements)								0.011	Fe ₂ O ₃ -7.95 Al ₂ O ₃ -4.43 ZnO-0.312 MoO ₃ -0.002 Fe ₂ O ₃ -0.012 ZnO-0.002
Soybean meal	6.76	1.61	2.37	0.36	0.51	0.002	0.003	—	0.53	—	—	
Tobacco stems	1.99	0.70	6.02	5.02	0.60	0.016	0.041	1.23	0.96	0.064	—	
Tung nut meal	4.34	1.73	1.31	0.64	0.86	—	0.0034	—	—	—	—	

The Problem of Insects

"Watchfulness is important if injury is to be avoided in your turfgrasses."

ANDREW S. DEAL

VARIOUS symptoms of injury occur in turfgrasses and dichondra when attacked by insects and other pests. These symptoms may be: turning brown, dying back in spots or irregular areas, stunting of growth, yellowing or bleaching of leaves, and others. Similar symptoms may also be caused by diseases, unfavorable soil conditions or poor cultural practices.

Several methods may be used in detecting the presence of insect pests of lawns. One of these is the *pyrethrum test*. Mix one gallon of one of the common garden insecticides containing pyrethrum in a sprinkling can. Mark off a square yard of lawn area and apply the entire gallon of mixture as evenly as possible to that area. Pyrethrum is very irritating to many insects and within ten minutes will cause them to come to the surface where they may be seen. Insects which may be detected in this way are cutworms, sod webworms, lucerne moth larvae, skipper larvae, and vegetable

weevil larvae. A strong solution of one of the common liquid dishwashing detergents can also be used in this way, but may take longer to bring the insects to the surface.

White grubs or the larvae of billbugs will not be brought to the surface by the pyrethrum test. They may be found, if present, by carefully digging around the roots of the grass. If more than five cutworms, ten skipper larvae or fifteen sod webworms per square yard, or more than three or four white grubs or billbug larvae per square foot are found, control measures should be taken.

Pests such as leafhoppers, scale insects, leaf bugs, spider mites, and flea beetles can be found, if present, by carefully examining the leaves, stems, and crowns of the grasses or dichondra. Accurate identification of insects in lawns is important for at least two reasons. First, many insects found in lawns may not be pests at all and thus control measures may not be neces-

sary. Secondly, certain pests require different control methods than others. Assistance in identifying lawn pests may be obtained by contacting your local university farm advisor or county agricultural agent in other states, nurseryman, or insecticide dealer.

Sod webworms, the larvae of lawn moths, are the most common pests of turfgrasses. The moths are whitish or buff-colored and fold their wings close to their bodies when at rest, giving them a slender appearance. The larvae are slender, grayish, black-spotted caterpillars about three-quarters of an inch long when fully grown.

The moths hide during the day in the grass and surrounding shrubbery and fly over the lawn from dusk into the night laying their eggs on the leaves and stems of grasses. The larvae hatch in a few days and begin to feed. They feed on the grass blades, growing tips, and greener portions of the crowns, but not on the roots. Damaged areas appear as scattered, irregular, brown patches in the turf. Bent and blue grasses are most susceptible to injury. The moths begin flying as soon as warm evenings come in the spring and continue until October in most areas.

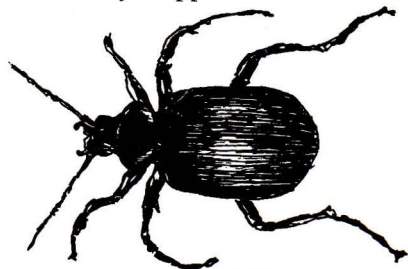
There are several species of cutworms. They are thick-bodied cat-



Mr. Deal is extension entomologist at the University of California in Riverside. He presented this material at the Turfgrass Problem Diagnosis and Correction Clinic at Lake Arrowhead November 1965.

erpillars from one to two inches long when fully grown. They vary in color and may be greenish, gray, brown or black, often with stripes or spots. The adults are dull or somber-colored moths with a wing span of one and a quarter to one and a half inches. The moths fly at night laying their eggs on the leaves of grasses, dichondra or nearby plants. The larvae feed at night on the leaves and stems of the plants and hide during the day in holes in the ground, or beneath the mat of organic matter near the surface of the soil. Cutworms may be active throughout the warm season of the year.

The fiery skipper is a small but-



GROUND BEETLE

terfly with a wing span of a little more than one inch. The adult male has orange-yellow wings spotted with black. The female has dark brown wings with orange-yellow spots. The adults feed on nectar from various flowers. The females lay their eggs on turfgrass leaves during the daytime. The larvae are about an inch long when fully grown and are brownish-yellow in color, with a black head. Skipper larvae are easy to distinguish from other caterpillars because the first two segments behind the head are constricted and smaller than the others. This gives the larva the appearance of having a "neck." The larvae feed on the leaves and crown of grasses, but not usually on dichondra. Skippers are active during most of the warmer season of the year.

The lucerne moth has a wing span of an inch or slightly more. The hind wings are gray. The forewings are mottled gray-brown with two pairs of indistinct dark spots.

The females fly at night and lay their eggs on clover and other legumes as well as on turfgrasses and dichondra. The larvae are slender, black-spotted caterpillars similar in appearance to sod webworms, but slightly larger. Feeding damage is to the leaves and stems.

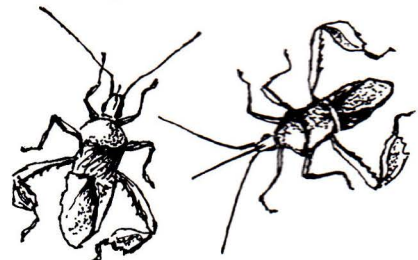
The vegetable weevil, unlike most of the other pests of lawns, is a winter and spring pest. The adults are brownish or grayish weevils or "snout" beetles about three-eighths of an inch long. The surface of the bodies of these weevils is very rough or punctuated with sparse short setae or hairs. There is a short, pointed protuberance on each side of the upper surface of the body near the posterior end. The adults cannot fly. No males are present and the females produce young without mating.

Vegetable weevil larvae are small, green, legless grubs about three-eighths of an inch long when fully grown. Both adults and larvae are active at night when they feed on the leaves of dichondra. Most of the damage is done by the larvae. The larvae hide in the soil beneath the plants during the day. Damage first appears as small holes in the dichondra leaves, but when the weevils are numerous, the leaves may be skeletonized or completely removed, leaving only the bare stems.

Adult flea beetles are shiny black and about a millimeter (1/25 inch) long. They jump readily when disturbed, hence the name "flea beetle." The adult beetles feed on the upper surfaces of the dichondra leaves and may completely skeletonize them. Heavily damaged areas may at first appear to be suffering for water but close inspection will reveal the feeding injury and the presence of the beetles. Little is known about the larvae, but they are believed to feed in the soil on the roots of plants.

The frit fly is a very small black fly about a sixteenth of an inch long. The adults lay their eggs on the

grass and the yellowish-colored larvae feed on the leaf sheaths and the stems. The result is a killing of the leaves, especially the lower ones, and the stems. Injury usually appears first as brownish areas around the edges of golf greens, but may later extend onto the greens. Bent and blue grasses are most susceptible



LEAF-FOOTED PLANT BUGS

to injury.

Several species of spider mites may cause damage to turfgrasses or dichondra. The common "red spider" or two-spotted spider mite is globular in shape, about a fiftieth of an inch long and may vary in color from red to yellow to green. Some have one or two conspicuous dark or black spots on each side of the body. These mites spin very fine webbing on the plants and when populations become large this webbing may sometimes cover the infested plants like a sheet. Under such conditions, many thousands of mites may be seen crawling about the webbing.

The clover mite is slightly larger than the spider mites described above (about 1/30 inch long). Its body is somewhat depressed rather than globular and it has conspicuously long front legs. It is reddish-brown to greenish in color. The legs are amber to orange-colored. The oxalis mite is bright red in color and approximately the size of the two-spotted mite, but with all legs conspicuously long.

All of these mites feed by puncturing the leaves and sucking out the plant juices. First symptoms of this injury appear as a yellow or whitish stippling or speckling of the leaves. If populations are heavy, this may be followed by a yellowing, bronzing or bleaching

and drying of the leaves.

The eriophyid mite which attacks Bermuda grass is quite different from the mites described above. It is too small to be seen with the naked eye, and even appears to be very small when viewed with a 10X hand lens. This mite is whitish in color and wormlike in shape. It can be found on infested Bermuda grasses by pulling the leaf sheaths away from the stems. The feeding of this mite causes a shortening of the internodes of the grass stems which gives a stunted, bushy appearance to the grass.

Bermuda grass scale adults are about a sixteenth of an inch long and are covered by a whitish, clam-shaped shield. It occurs primarily on the stems, but may also be on the leaves. It is most likely to occur in lawn areas shaded by trees or buildings and is favored by the development of a heavy thatch. The stems and crowns of heavily infested grass appear whitish or "moldy."

(Cont. on Page 10)

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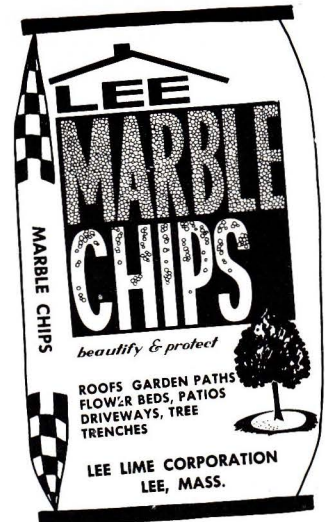
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Closer examination with a hand lens or microscope reveals the white or "moldy" grass to be covered with the clamshaped shields of the scale. Bermuda grass scales suck juices from the plants. Heavily infested grass takes on a brown, dry appearance and new growth is retarded.

All of the pests described thus far feed on the above-ground portions of grass and dichondra. Two pests which feed on and may destroy the roots of turfgrasses are white grubs and billbugs. White grubs are the larvae of beetles commonly called May beetles, June beetles or June "bugs." These larvae are from one to one and a half inches long when fully grown. They are C-shaped when at rest with many folds or wrinkles in the front part of the body. The rear half of the body is usually smooth and slightly larger in diameter than the fore part. White grubs have three pairs of conspicuous legs which distinguishes them from most other kinds of grubs found in turf which are

legless. Symptoms of white grub injury are browning and dying of the grass in localized spots or large irregular areas. Damage is usually most severe in September and October when the larvae are reaching maturity and the growth of Bermuda grasses is slowing down.

Billbugs are small, black weevils or "snout beetles" about a quarter to three-eighths of an inch long. The larvae are white, legless grubs of about the same length as the adults. Billbug larvae feed on roots of grasses producing symptoms similar to those caused by the white grubs just described. Old lawns in warm inland areas seem to be the most susceptible to billbug damage.

The first line of defense against turfgrass and dichondra pests is the following of good cultural practices. Poorly kept lawns show pest injury sooner and recover more slowly than vigorous, well-kept lawns. Regular thatch removal discourages insect pests and aids in obtaining better penetration of the grass with

insecticide sprays should these be necessary.

Lawns to be sprayed for control of above-ground pests should first be irrigated well. As soon as the grass has dried the spray should be applied and further irrigation withheld until it is necessary to water to prevent the grass from wilting. This procedure allows the insecticide to remain on the leaves, stems, and crowns for the longest possible period and thus increase the effectiveness of the treatment. When lawns are to be treated for pests that feed below-ground, such as white grubs or billbug larvae, the spray should be applied and then followed with a heavy irrigation to carry the insecticide into the soil.

Watchfulness or regular inspection of lawn areas is very important if injury from these various causes is to be avoided. This is particularly important in the case of insects, as large populations of certain pests may develop rapidly and cause severe injury within a short period.

Top Lawngrasses Need Little Mowing

DR. ROBERT W. SCHERY, *Director*
The Lawn Institute

Kentucky bluegrass-fine fescue lawns require little mowing in autumn. This despite generous fertilizing highly recommended at that time of year. Bentgrasses such as Highland should be mowed on schedule right up until frost. Bents make those deliciously neat swards which look a bit unkept if there is even a fraction of an inch surface irregularity.

Merion Kentucky bluegrass is characteristically rather low-growing. But even it, along with natural Kentucky bluegrass and other select varieties such as Park, respond strangely to autumn conditions, growing unusually squat. The shorter days of autumn set off the growth-regulating "clock" in bluegrass that causes the grass leaves to be stubbier and bend lower. Fine fescues, including prime varieties such as Chewings, Illahee and Pennlawn, are closely related to the Kentucky bluegrasses, and follow a similar pattern.

Of course this doesn't mean that you can abandon mowing entirely for a well-kept lawn, come September or early October. But it does mean that aids such as watering and fertilizing, which ordinarily stimulate extra growth (and thus increase mowing), will produce very little in the way of added chore work. The lawn thickens and fills rather than growing tall. A combination of bolster seeding, feeding and just occasional mowing suffices in autumn for a luxuriantly thick lawn that carries over for top performance in spring. Mowed reasonably tall the grass becomes so thick that weeds stand little chance.

—*Seed World*

Vol. 99, No. 3, Page 22, Sept. 9, 1966

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Over \$5,000,000,000 is spent each year in the United States for turf maintenance

Turf Maintenance Costs

THE COST of turf maintenance has risen dramatically in recent years. A survey indicates an average annual expenditure of \$103,000 for turf maintenance at a typical California golf course. This represents seventy percent of total course operating expenses. Similar increases have been experienced at cemeteries, parks, and athletic fields, where approximately two-thirds of the maintenance dollar is devoted to turf. These increases, averaging from five to ten percent each year since 1955, are not uniform across every category of maintenance cost. Some have risen while others remained constant or even declined.

An analysis indicates labor and water are the chief components of turf maintenance expenses, representing eighty to ninety-five percent of the total. The study further indicates that, because of its impact on labor usage and water consumption, the type of irrigation system is a critical factor influencing turf maintenance costs.

FIVE MAJOR COST ELEMENTS

An examination of the literature and statistical surveys prepared in recent years reveals a wide divergence in the methods used to categorize elements of turf maintenance cost. A number of approaches have classified costs by operating function. For example, mowing, trimming, and irrigating are shown as major cost elements. Other approaches break these costs down by type rather than function; for example, labor, water, or equipment repairs. In the judgment of Economics Research Associates, the functional approach to cost accumulation does not permit a valid comparison or

accumulation of historical data. The costs assigned to mowing and trimming, for example, often differ substantially among organizations. Thus, meaningful comparisons cannot be drawn.

This study utilizes a cost component breakdown similar to that of the Department of Agriculture, with only minor variations. In this manner more meaningful comparisons, both on an historical and comparative basis, can be effected. The five basic components of maintenance costs as developed in this analysis are discussed below.

LABOR

This cost element includes wages and salaries related to the maintenance of turf; typically, payment of caretakers, groundskeepers, assistants, maintenance men, and plumbers. Total labor costs, of course, include wages and salaries, payroll taxes, insurance, and fringe benefits such as vacation pay and pensions. A survey and analysis of this component in many different kinds of turf areas and conditions reveals that it normally comprises seventy to eighty percent of the total turf maintenance expense.

WATER

Water represents the second largest expense in turf maintenance. While rates vary substantially from area to area (reflecting availability and the quantity used), water generally accounts for over ten percent of maintenance cost. Actual proportions in the cases studied varied between eight and thirteen percent.

SUPPLIES

Several cost factors are included here. Fertilizer, seed, chemicals for insect and weed control, soil amendments, gas and oil for equipment operation, and sundry other items are generally allocated to this category. Supplies usually average nine percent of the total maintenance cost, thereby ranking it the third most important component.

EQUIPMENT REPAIR AND REPLACEMENT

This element of maintenance cost includes repair and/or replacement of such equipment as tractors, mowers, hand tools, sprinkler heads, valves, pipe, and the like. While the average percentage cost of equipment repair and replacement was only five percent among cases studied, the variation from installation to installation was larger than any other component. The overriding factor influencing this cost category is quality of the equipment initially purchased. This factor will be discussed in greater detail in the last section of the report.

MISCELLANEOUS COSTS

Classified in this category are all other expense items, including taxes, depreciation, general insurance, rent, and utilities other than water. The range is from

This material is taken from Section One of a report prepared for Thompson Manufacturing Company by Economics Research Associates entitled *The Economics of Large Scale Turf Irrigation*. Reprinted with permission Thompson Manufacturing Company, Los Angeles.

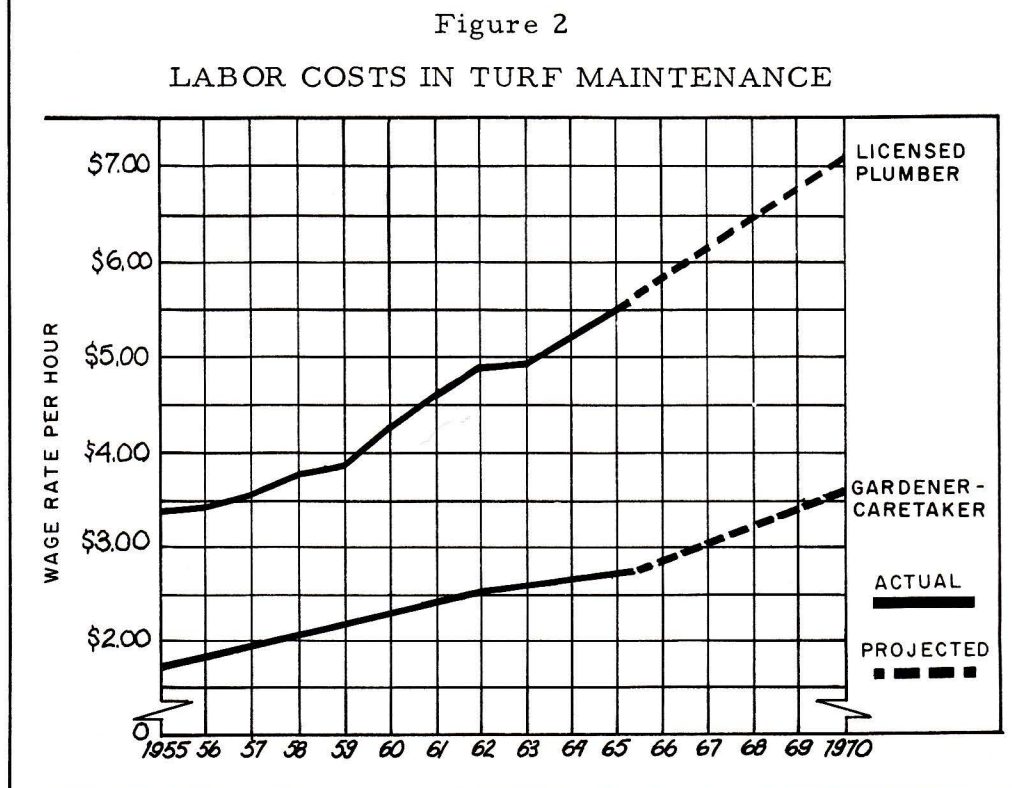
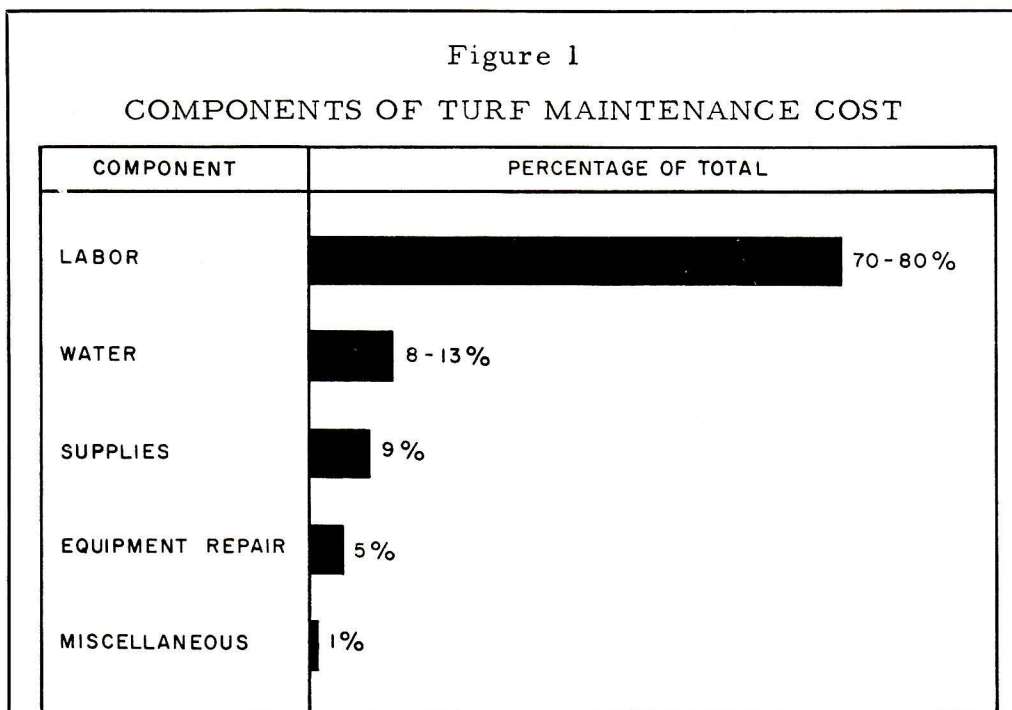
one to two percent, with an average cost slightly greater than one percent.

The relationship of these five major cost elements is graphically illustrated in *Figure 1*. Clearly, labor and water, which together account for approximately eighty-five percent of total turf maintenance costs, are the dominant components. While it is important to define these components of maintenance cost and to understand their relative significance, it is equally important to review these costs and to examine their likely course in the years ahead.

COST OF LABOR AND WATER

As indicated previously, the cost of maintaining large-scale turf areas has been steadily rising in recent years. The reason can be directly related to price increases in the two major components of turf maintenance cost, labor and water. The historical and probable future trend in each of these cost elements is described below.

Of the five basic components of maintenance cost, analysis indicates that the mounting cost of labor has been the dominant factor in the rise of maintenance



expense. *Figure 2* illustrates the dramatic increase in the cost of labor for the two occupations most closely associated with turf maintenance, plumbing and gardening. From 1955 to the end of 1964, combined wage rates of the two almost doubled. Plumbers have experienced the greatest annual gain in hourly wage rates, 5.2 percent, while wages of gardener-caretakers have increased 4.9 percent. The outlook for the future indicates that the cost of labor will continue to rise in both occupations. Unionization has made only limited inroads to date; however, a realistic appraisal of the labor market and the objectives of union leaders leads to the conclusion that further increases are likely. Furthermore, the sheer pressure of the wage-price spiral also points to a continued upward trend.

The second factor contributing to higher turf maintenance expense is the rising cost of water. For example, from 1955 to 1964, the price of a hundred cubic feet of commercial water in the Los Angeles area increased approximately sixty percent. Conservative estimates for this area indicate that an additional increase of forty percent can be expected in the next five years. While Los Angeles is perhaps an extreme example, substantial advances have been registered in major cities throughout the United States. Water costs in Detroit are up twenty-two percent in five years, in Chicago up forty-eight percent in ten years, and in Houston up thirty-five percent in five years.

A leading business publication (*Fortune*, April 1965) recently completed an extensive study of the future cost and supply of water in the United States. It described in detail the spiraling cost of water in the next two decades. In particular, the price of water used for irrigation will come under increasingly severe upward pressure. The article pointed out that, "As an expanding population uses a nonexpanding water supply, more and more wastes and contaminants will have to be removed from water either before discharge into streams or afterward. Whether the depolluting is done at outfalls or at intakes, the total public and private costs, by the sober estimates of experts, will run into billions of dollars a year, over and above current water costs in the United States."

The impact of rising water rates on maintenance costs will vary from location to location depending on the amount of water required to irrigate a particular area of turf. The amount of water required is in turn a function of climate and soil characteristics. Areas with sufficient natural rainfall to adequately irrigate local turf will obviously not be affected by the rising cost of water. Conversely, an area such as Southern California, not endowed with a climate providing sufficient natural water, must rely on artificial means of irrigation. The impact of the rising cost of water in such an area is substantial. For example, a 0.025 cent rise in price per hundred cubic feet of commercial water increases the average watering cost of an acre of turf by over \$27 a year.

TURF MAINTENANCE COSTS

The upward trend in labor and water costs will almost certainly combine to push turf maintenance costs to even higher levels in the years ahead. Using the anticipated rate of increase of seven percent per year, the effect of these two cost elements alone will be a forty-three percent increase in turf maintenance costs by 1970. Clearly, effort must be focused on the control of these cost factors if any meaningful improvements are to be made in overall turf maintenance expense.

Stated very simply, the maintenance of turf is accomplished through application of labor to the distribution of water through an irrigation system. Labor and water expenses are in themselves almost invulnerable to reduction. While some range for negotiation exists in the area of wage rates, it is highly improbable that any substantial reduction can be effected without corresponding losses in the quality and effectiveness of the work force. In fact, there is every indication, as discussed previously in this section, that wage rates will continue to rise by some five percent each year.

Similarly, the outlook for water prices is a continuation of the upward trend. New water sources, such as desalinization, will expand the supply and availability of water; but the innovations are expensive and can certainly be expected to raise the cost of the commodity. Thus, the obvious focus of attention in effecting maintenance savings is an irrigation system which can control the amount of water and labor used.

Reductions in the amount, rather than the cost, of labor and water is the logical source of future savings. This view was almost universally supported in field interviews. As one maintenance supervisor put it, "If we would spend less time complaining about higher wages and more time designing good irrigation systems, we could reduce labor and water costs twenty-five percent." Plainly, improved utilization of these "raw materials" is the key to reduced costs and good turf management. Yet, compared to other industries, the turf industry has not benefited from the application of modern analytical techniques and cost controls.

The potential for reducing labor and water expenses through more efficient irrigation is perhaps best illustrated by examination of the actual operating cost records of large-scale turf installations. Those with antiquated or poorly designed irrigation systems experienced from ten to over fifty percent greater operating costs than the few installations with modern, well-designed irrigation systems. The cost variations were much wider than those normally found in industry and reflect, in large measure, the benefits that can accrue to managers who apply a more sophisticated analytical approach to the irrigation problem.

ESTABLISHING TURF on Illinois roadsides

O. N. ANDREWS, JR. and J. A. JAKOBS

Species are being evaluated and other approaches made to the many problems of establishing and maintaining cover on our highway right-of-ways

ALL CITIZENS have a stake in the establishment and conservation of good cover on our roadsides. As travelers, they welcome a pleasant vista. As taxpayers, they want to see maintenance costs reduced and tax dollars effectively utilized. Those who own property near the highway right-of-way have a special concern for its tidy appearance.

Across the United States half a million acres are under construction in highway right-of-ways. Safe adequate highways are understandably expensive. About 2.5 percent of the construction cost goes to establish turf on the roadside. After highway construction has been completed and an initial effort made to stabilize the roadside, one of the primary costs is that of roadside repair.

Complex problems

In Illinois, where there are 21 million acres of the best tillable land in the world, turf establishment along the roadsides presents many complex, constantly changing problems.

Most roadside seedings must be made in subsoils, very often on cut slopes. Of the undesirable characteristics found in subsoils, these cause the most difficulties: poor moisture relationships, low soil nitrogen, acid or alkaline conditions, low available phosphorus, and minor-element toxicities and deficiencies.

The ideal turf species for roadside seeding would establish itself rapidly on subsoils; withstand drouth, flooding, and freezing; never grow very

tall; present no fire hazard; and remain green most of the year. Lacking such an ideal species, we have to search for those that come closest to filling the requirements.

The difficulties of roadside turf establishment are further complicated by the problems of construction contracts. Most highway right-of-way seedings are made under subcontracts. For the highway contractor to bid sensibly on the total contract, he has to know the fertilizer that will be used, seeds and seeding rate, mulch, method of seedbed preparation, and method of seeding. It is often difficult to obtain satisfactory turf establishment when planning has to be done before construction is started.

The Illinois Division of Highways has long recognized these problems and taken positive action toward their solution. One step has been to support grass-establishment research that has been underway for several years in the Agronomy Department of the Illinois Agricultural Experiment Station. The U.S. Bureau of Public Roads has also cooperated in this research.

What is being done

Several areas of research are included in the present turf-establishment project. Extensive work has been done to develop techniques for doing the research; a comprehensive review of literature has been compiled; and present procedures for turf establishment have been evaluated to determine their relationships to agricultural practices. These efforts have been necessary to provide a firm basis for roadside research.

Over 150 grass and legume species at several sites have been screened for roadside use. One of the most prom-

ising has been alfalfa, which is not normally considered a turf species. It has established itself quickly and provided excellent ground cover.

Of the grass species, tall fescue has proven most adaptable for highway right-of-ways. Kentucky bluegrass, normally an ideal turf species, has not performed well in highway seedings because of its lack of seedling vigor. It does, however, invade roadside vegetation, consequently providing an excellent turf. Despite its lack of seedling vigor, bluegrass is considered the most desirable grass species for roadside seedings in the northern third of Illinois.

Korean lespedeza provides good ground cover in most areas of the state. Because it is an annual and must re-establish, however, it varies widely from year to year in its contribution to the vegetative cover.

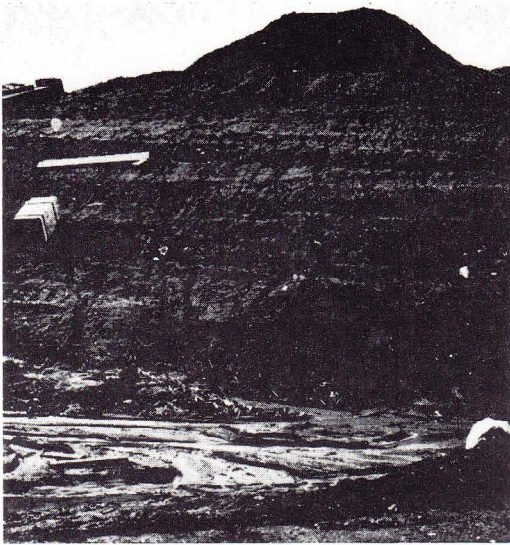
Soil samples from raw-cut highway slopes have been analyzed to determine their pH, available phosphorus, and available potassium. Many of the subsoils had a very high pH, indicating that lime was not needed. Samples were often extremely low in available and total phosphorus. Available potassium was deficient in some soils but was sufficient in others.

Experimental seedings responded well to applications of nitrogen. In roadside seedings 60 pounds of nitrogen per acre are considered sufficient. Split applications are desirable.

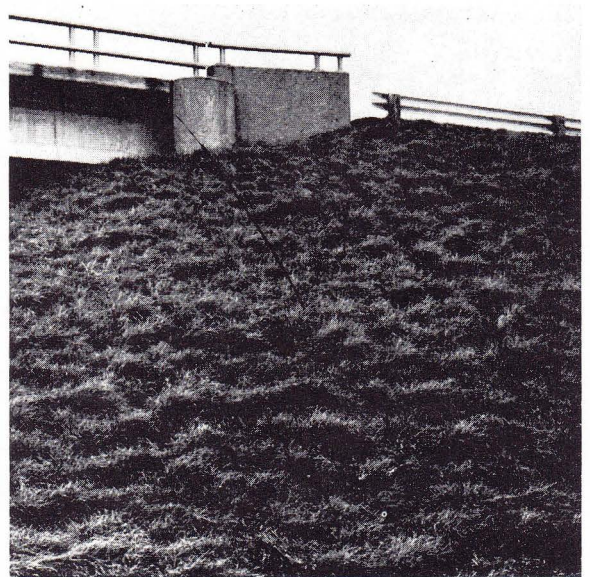
Because roadside seedings must be made after road construction is finished, it may be necessary to seed at any time during the growing season (May to November). In an experiment near Effingham, permanent seedings were successfully made throughout this season. Of the temporary species, oats were superior to

O. N. Andrews, Jr., is Assistant and J. A. Jacobs is Professor, both in Crop Production. This article reports work done by the Agricultural Experiment Station in cooperation with the Illinois Cooperative Highway Research Program. The authors acknowledge the assistance of the Project Advisory Committee: John E. Burke, C. R. Wright, Theodore H. Ebel, Harleigh R. Kemmerer, and B. J. Butler.

The challenge . . .



. . . and the goal



cereal rye in terms of the subsequent permanent cover. All temporary seedings, however, delayed the establishment of permanent species. The ground cover was improved by adding alfalfa to the seeding mixture.

An effort is being made to develop a mathematical model from which one can predict the rate at which an

individual species will become established. If the model is developed, it can be used in determining whether to reseed, renovate, or leave a new seeding undisturbed.

The results of these experiments are being incorporated into the work of the Illinois Division of Highways. The results will be better erosion con-

trol and a better appearance for Illinois roadsides. Although the difficult problems of roadside turf establishment are not completely solved, they can be minimized through the cooperation of the biologist and engineer working toward the common objective of beautification and erosion control.

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Principles In Lawn Renovation

Dr. Henry W. Indyk

Specialist in Turf Management
Rutgers — The State University

An attractive lawn is a primary feature contributing to the beautification of any landscape. The attractiveness of this living mat will be in large measure determined by the degree of uniformity in the stand, texture and green color of a dense community of adapted turfgrass plants growing in a complex environment. This environment consists of numerous factors which individually or collectively may be either favorable or deleterious to the growth of the lawn grasses.

The impact of the unfavorable factors becomes visibly expressed in a deterioration of the color, vigor, density and composition of the stand of turfgrasses. The net result is an overall decline or loss of attractiveness. Characteristic symptoms include a thin stand of turfgrasses lacking vigor and green color and infested with a wide variety of weeds. In order to restore the desired attractiveness corrective procedures must be undertaken.

Lawn renovation for the purposes of this discussion will be regarded as the technique or procedure necessary to re-establish a satisfactory stand of desirable lawn grasses in a previously established lawn which has partially or entirely deteriorated.

The first important consideration should be an attempt to determine the factor or factors which caused the failure. Most commonly involved are:

1. Unfavorable physical conditions of the soil.
2. Unadapted turfgrass or turfgrass mixture.
3. Inadequate lime.
4. Inadequate or excessive fertilizer.
5. Close mowing.
6. Improper watering.
7. Thatch accumulation.
8. Excessive shading.
9. Weed infestation.
10. Insect and disease injury.
11. Chemical injury.
12. Excessive wear.

Knowledge of the factors involved in a specific situation will aid in determining the necessary steps of the renovation program as well as an effective management program. If proper precautions are not taken to correct the source of failure, the results of a renovation program will be a

Talk given at Lawn Seed Division Winter Meeting

complete disappointment or short-lived.

The steps involved in a renovation procedure may vary considerably. The best renovation procedure to follow on a specific lawn will depend on its condition and the problems involved. It may be necessary to rebuild the lawn completely or it may be possible to renovate without destroying the existing contour and desirable lawn grasses. Therefore, it becomes essential to evaluate the over-all condition of the lawn in order to determine the approach to the problem.

Let us consider specific conditions characteristic of lawns in need of renovation and the necessary corrective procedure.

A. Good drainage, properly graded and level. At least 30% cover of desirable lawn grasses present in absence of difficult to control weed problems.

1. Selective weed control—apply at least 2 weeks before seeding date.
2,4-D for control of dandelion, buckhorn, broadleaved plantain, annual chickweed.
2,4,5-TP for control of perennial chickweed, clover.
2. Mow close and rake vigorously with a steel rake in preparation for seeding. Repeat this treatment 2 to 3 times or until a loose soil surface is exposed.*
3. Apply lime, if needed. Generally if no lime has been applied within the last 3 years, 75 pounds of ground limestone to each 1000 square feet of area is needed. The best guide is a soil test.
4. Apply 10-15 pounds of a 10-6-4 or similar fertilizer at equivalent rates unless soil test information indicates otherwise.
5. Rake lime and fertilizer into the soil as much as possible.
6. Seed with a high quality lawn seed mixture containing at least 75% permanent fine textured lawn grasses adapted for the conditions.
7. Rake very lightly and water or roll.

B. Good drainage, properly graded and level. Less than 30% cover of desirable lawn grasses and heavily in-

*In situations where the lawn area to be renovated is rather sizeable or has an accumulated layer of dead organic material (thatch) it would be advisable to use adequately powered vertical slicing or cutting equipment instead of the hand rake. The equipment selected should be sufficiently versatile in its adjustment of cutting depth to be capable of penetrating the thatch layer and displace a small amount of soil with a minimum of disturbance to existing grade, slope, and desirable lawn grasses.

festated with a wide variety of weeds other than deep rooted perennials.

1. Chemically eradicate with a non-selective herbicide such as sodium arsenite. Apply sodium arsenite (4 lb. active per gal.) at the rate of 2 pints in 3-5 gallons of water per 1000 square feet of lawn area. Sodium arsenite formulations other than the 4 pound active per gallon may be used at equivalent rates. The addition of 1 ounce of household detergent will increase its effectiveness. Immediate and best results are obtained if applied when temperatures are above 75°F.

Complete and even coverage is necessary. Re-treat any areas which do not show complete kill.

CAUTION: Sodium arsenite is a poisonous material and should be respected accordingly. Label directions for use should be followed very closely.

Equally as effective as sodium arsenite is an organic arsenical known as cacodylic acid. This chemical is available in liquid or dry formulations.

Other materials which may be used for eradication include potassium cyanate, calcium cyanamide, or high rates of fertilizer.

2. Proceed as outline in "A" after a 7-10 day waiting period.

C. Excessive accumulation of thatch layer (1.5 inches or more). Poor stand of desirable lawn grasses.

1. Strip off thatch layer to soil surface with spade, sod cutter, or thatching machines.
2. Proceed as outlined in "A" commencing with 3 if the area is level and properly graded. If regrading is needed prepare area with rototiller or other suitable equipment.
3. If you find that difficult to control weed problems exist, chemical eradicate before stripping thatch layer.

D. Poor drainage, improperly graded, deeply compacted, poor physical soil conditions.

1. Completely reconstruct making appropriate corrections.
2. Follow procedure for making a new lawn.

In preparing the area for seeding in any one of the procedures outlined above, it is essential that conditions be provided so that the lawn grass seed comes in direct contact with the soil. Results obtained from short-cut procedures such as seeding on the surface of a thatch layer usually are disappointing in spite of high quality seed. Under such conditions, the environment in which the seed is placed is not conducive to germination.

Turfgrass Abstracts

SEEDING RATES

ELWYN E. DEAL, *Turf Specialist*

For years there has been some disagreement about what the ideal seeding rate for turfgrasses really is. Most experiment station recommendations state that 2 to 4 pounds of Kentucky bluegrass seed per 1000 square feet of area are sufficient. Bentgrasses are usually seeded at 1 to 2 pounds of seed per 1000 square feet.

The Agronomy Journal (Vol. 58, pp. 441-443, 1966) has a recent article which describes research done by Dr. John H. Madison which answers some of the questions about seeding bentgrasses and Kentucky bluegrass. He seeded Kentucky bluegrass, Penncross bentgrass and Seaside bentgrass at rates of 1, 2, 4 and 8 pounds each. Then, to find out how deep they should be planted, he covered each grass and each seeding rate with plaster sand to depths of $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{1}{2}$ inch of sand and left one of each with no cover.

A substantial reduction in stand of all grasses was found when they were covered to a depth of $\frac{1}{2}$ inch. At the end of the first month after seeding, there were about 10 times as many young plants in the plots with the best seedling growth as in plots with the poorest seedling growth. As expected, plots with the highest seeding rates had the greatest population. Plots which started with the highest number of plants ended high but the differences were small.

Below are several important points brought out by Dr. Madison in his article.

Heavier seeding rates must be used if the seeds are covered. "Turf from seed sown at the 2-pound rate and covered $\frac{1}{8}$ to $\frac{1}{4}$ inch deep, or the 4-pound rate covered $\frac{1}{4}$ to $\frac{1}{2}$ inch deep, appeared to be in a range containing optimum populations for rapid maturity."

Very heavy seeding rates, such as the 8-pound rates in this experiment, produced a heavier stand of grass but the grass was softer, more delicate, easily scuffed loose and more subject to disease.

Two to three months after seeding, the Kentucky bluegrass planted at the 8-pound rate had about 6 times as much rust disease on their leaves as that planted at 1 pound. Seaside bent had 10 times as much *Fusarium nivale* at the 8-pound rate as at 2 pounds. The 1-pound rate had no *Fusarium* disease.

Turf produced from the 1-pound rate of each grass was excellent and was judged "playable" after 3 months of growing weather. Heavy stands required $3\frac{1}{2}$ to 4 months to mature. Even after 10 months, some of the heavily seeded bentgrass plots are still covered with a dense fuzz of seedling size plants and had almost no mature, stolon producing plants.

Another interesting point noted with this experiment was that the Penncross bent, because of its genetic vigor, produced a population 30 percent greater than Seaside bent.

Dr. Madison states that under the conditions of his experiment "At no time was there any evidence that a capable agriculturist would benefit by sowing more than 2 pounds of seed per 1000 square feet . . ." He does state, however, that his experiment was conducted on land fumigated with methyl bromide and that "Others have suggested weed land requires higher rates of seeding as an aid to weed suppression."

His theory for selecting a seedling rate for turfgrasses is as follows: The turf maturing in the shortest period is one that starts with somewhat fewer than the final number of plants and reaches its mature density by growing and tillering (or stolonizing). This theory appears to be particularly applicable to sod fields where a mature, deep-rooted sod with abundant rhizomes is needed.

—Agronomist
Vol. 3, Nov. 11, Page 6, Nov. 1966

THE BLACK SHEEP OF THE BLUEGRASS FAMILY

(A MATTER OF DOLLARS AND CENTS)

At the present time *Poa Annua* (Annual Bluegrass), a weed which occurs in bluegrass seed, is receiving critical attention.

One State passed a law this year which prohibits the sale of any seed containing *Poa Annua*, also the package label must state *where* the seed was grown. Another State will allow only 256 seeds of *Poa Annua* in 1 lb. of lawn seed, effective October 1, 1966. Several other States now require the number of *Poa Annua* seeds per pound to be printed on the label.

This means that some lawn mixtures now being sold interstate must be upgraded in 1967 in order to comply with all of the State laws. The alternative would be to stock two grades: one for the difficult States and one for the easier States.

Bluegrass seed containing *Poa Annua* is cheaper at the wholesale level where seedsmen trade with each other. For Example, in August 1966 bluegrass seed containing approximately 10,000 *Poa Annua* per pound was \$54.00 per 1,000 lbs. cheaper than bluegrass seed which contained no *Poa Annua*.

This difference amounted to \$3,240.00 on a standard 60,000 lb. car. Any seed packer, therefore, who uses the cheaper grade of bluegrass has a substantial price advantage over those competitors who prefer to use seed free of the *Poa Annua* weed.

This price advantage is hidden when the seed is packaged and delivered to the retail stores. There is, of course, an analysis label on every package as required by the State and Federal Seed Laws, but it is not understood by most consumers and very few understand the *Poa Annua* weed.

Therefore, Kentucky Bluegrass seed is now being sold through the East and Middle West at 98¢ per pound retail, part of it containing approximately 10,000 *Poa Annua* per pound, and part containing none.

Because of this fact, the lower-priced seed has been riding roughshod over the better seed. Packers of the cheaper seed have been able to use part of the price-advantage to pay for point of sale displays, service people to call at the stores, advertising promotions, two for one deals, and in some instances, lavish entertainment.

Poa Annua seed can be controlled, but the cost of doing so will wipe out most of the price advantage. This is why some producers and handlers of the cheaper bluegrass have been opposed to any change.

Public hearings have been held by several State Departments of Agriculture to consider ways and means of controlling the spread of *Poa Annua*. One dealer complained: "We are importing this bluegrass seed from friendly countries."

The answer is that all civilized nations have laws to control the spread of disease, bugs, and weeds. Canada is a good friend but we restrict the importation of seed containing Canada Thistle and certain other weeds.

*Jonathan Green & Sons, Inc.
Kearny, New Jersey*

PESTICIDE REGISTRATION

At a recent joint meeting of the Weed Control Committees of the U. S. Department of Agriculture and the U. S. Department of the Interior, registration of pesticides was discussed. Users of pesticides should note the following problems. For a complete list, the reader is referred to either the "New Hampshire Notes", Vol. 1, No. 15, July 1966 or the "N.A.C. News & Pesticide Review", Vol. 25, No. 1, Oct. 1966.

1. Is it legal to use mixtures of herbicides?

It is legal to use mixtures of herbicides. However, the user assumes the responsibility for freedom from residues if such mixtures are not registered. Some mixtures of pesticides have been registered, but relatively few. Most manufacturers are reluctant to spend money obtaining registration for use of another company's product in mixture with one of their own. Before a herbicide mixture can be registered, essentially the same data on performance and safety with respect to residues are required as with an individual herbicide.

2. What effect does the addition of additives such as surfactants, oils, or special solvents have on the use of registered pesticides?

If the addition or blending is done by the manufacturer, registration can be made for the blend provided the manufacturer supplies the necessary data. In such cases, there is no particular problem involved. If a user makes additions or changes which are not on the label, he assumes some of the responsibility that would ordinarily be borne by the manufacturer of the product he purchases. In this respect local agricultural authorities such as county agents and research personnel can be of help in providing users with details which do not appear on the label.

3. How can information be obtained on the registration of pesticides for non-food uses; that is nurseries, ornamental plants, turfgrass, etc?

At present, the user should read the registered label to determine possible uses. Direct and specific requests to the Pesticides Regulation Division of ARS, USDA, can be made to determine the pesticides registered for these non-food uses.

—N.A.C. News

**FAIRWAY IRRIGATION SURVEY
OF THE NATION'S GOLF COURSES**
by the National Golf Foundation

*Compiled by
JAMES E. THOMAS*

In response to the question: "Does your golf course have watered fairways?" submitted recently by the National Golf Foundation to 7880 golf courses in the United States, 3274 or 42% replied "YES."

Fifty four percent (54%), representing 4287 courses, replied "NO." Four percent (4%) did not answer the question. Replies were received from 7068 regulation length courses and 812 par-3's.

A study of the replies by five geographic regions of the country reveals the following: About 92% of the golf courses in seven far western states (Washington, Oregon, Idaho, California, Nevada, Utah and Arizona) have fairway irrigation systems. Of the 1002 courses reporting, 918 have watered fairways.

Replies from 1117 courses in the 10 western states area (Montana, North Dakota, South Dakota, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Texas and Oklahoma) show that 49% of their golf operations have fairway watering with 552 courses giving a "YES" answer.

In a seven state mid-western area (Minnesota, Wisconsin, Michigan, Illinois, Indiana and Ohio) the percentage of courses having fairway irrigation was only 30%. 641 of the 2112 courses reporting have fairway watering systems.

A grouping of 10 southeastern states (Missouri, Arkansas, Louisiana, Kentucky, Tennessee, Mississippi, Alabama, Florida, Georgia and South Carolina) have fairway watering at 473 of its 1456 golf courses according to the survey — 32%.

Fourteen eastern states (Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Maryland, Delaware, West Virginia, Virginia and North Carolina) reported that 31% (690 of its 2193 courses) have fairway irrigation.

Of the 7880 replies received from the nation's golf courses the breakdown by type of course replying and the number and percentage of the total of each type having fairway irrigation was as follows:

Type of Course	9's	18's	Total	Have Watered	
				Fairways	Percent
Private	1546	1715	3261	1445	44%
Semi-Private	2096	983	3079	1112	36%
Municipal	530	558	1088	518	48%
*Military	152	96	248	134	54%
School-College	88	45	128	38	30%
Industrial	51	25	76	27	35%
U. S. TOTALS	4458	3422	7880	3274	42%

* Includes 29 Veterans Administration golf courses.

This study is one of a series planned by the National Golf Foundation in conjunction with its continuing nation wide surveys of the country's golf facilities and its accomplishing a perpetual nation wide golf course inventory.

Since new golf courses come into being each month, questionnaires flow out of National Golf Foundation's headquarters constantly. As the data received is fed into computers and results analyzed, other detailed information on the nation's golf facilities will be released.

**RELATIVE MERITS OF THIN-CUT
vs. THICK-CUT SOD**

Thin-cut sod contains more roots at the contact horizon, knits more quickly, allows water to penetrate the sod bed more easily, conserves space and weight in handling, and leaves the topsoil in the production fields where it belongs. Thick-cut sod, the antithesis of everything above, brings with it a layer

of soil which frequently is so different from the sod bed that it introduces difficulties which persist for many years. It is more difficult to do a smooth laying job with thick-cut sod.

—Fred V. Grau
Goldom, Vol. 40, No. 10, Oct.-Nov., 1966

SEED MAY BE PREGERMINATED

Pregermenate seed to give grass the fastest possible start. Mix seed with expanded mica such as vermiculite (concrete aggregate grade) at a rate of 2 mica to one seed.

Moisten the mica slightly, and mix in the seed. Then add water until mixture is thoroughly wet. Cover with a plastic tarp and keep moist (not wet) for 7 to 9 days with temperature held at about 70° F. If the temperature reaches 80° F., reduce germination time to 5 days.

When most of the seed has started to germinate, mix with a processed sewerage sludge fertilizer until dry enough to spread. Calibrate the spreader for the proper rate and sow promptly. After seeding, water the field immediately and keep moist so that germination continues without interruption.

Iowa State University
Cooperative Extension Service
Pamphlet 314, Jan. 1965

SEED FORECASTS

Kentucky Bluegrass Seed Stocks

Kentucky Bluegrass seed is now being produced in three areas: the Pacific Northwest, the Middle West, and in Europe. Here is the estimated tonnage available for the 1967 season in round figures:

7,000,000 lbs. Carry over of old seed
18,000,000 lbs. Pacific North West
7,000,000 lbs. Middle West
10,000,000 lbs. Europe
—
42,000,000 lbs.

The U. S. consumption of Kentucky Bluegrass seed in past years has fluctuated with the size of the crop. When the crop was large, more Kentucky Bluegrass was added to the mixtures. When the crop was small, less was used. The total consumption, therefore, has fluctuated during the past few years between about 18 and 36 million pounds per year.

These are the estimated figures for Kentucky Bluegrass seed only. In addition there will be the supply of strains such as "Merion", "Newport", "Park", "Windsor", "Delta", and others. The combined supply of Kentucky Bluegrass seed plus its strains will probably exceed fifty million pounds of cleaned seed for 1967.

Jonathan Green & Sons, Inc.
Kearny, New Jersey

Ryegrass Seed Stocks

Carryover by Oregon growers of 1965 and older crops of ryegrass seed (annual and perennial) as of June 30, 1966, is estimated at 16,381,000 pounds, up 26 percent from the 12,987,000 pounds held by growers last year. This year's grower stocks plus the 34,325,000 pounds held by dealers and cooperatives on June 30 give a U. S. total carryover of 50,706,000 pounds, or 6 percent below the total of 53,792,000 pounds held a year earlier.

Dealers and cooperatives' ryegrass seed stocks consisted of 24,156,000 pounds of annual, 9,267,000

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pounds of perennial and 902,000 pounds of mixed annual and perennial compared with 31,547,000 pounds of annual, 7,797,000 pounds of perennial and 1,461,000 pounds of mixed seed on hand last year. Stocks of annual and perennial ryegrass seed in growers' hands on June 30 are not estimated separately. The first estimate of 1966 ryegrass seed production will be included in the Annual Seed Crops Summary to be released December 20th.

—*Seed World*

Vol. 99, No. 3, Page 12, Sept. 9, 1966

ZINC VITAL TO MANY CROPS

Research shows that zinc is present in soils in at least three different forms according to E. R. Graham, University of Missouri soil scientist.

In today's intensive agriculture, zinc is a soil trace element highly important in the production of many farm crops. Some forms of zinc are more easily absorbed and put to use by growing plants than are other forms. A good soil test should indicate the different forms of zinc available in soil rather than just the total amount, he says.

Soil zinc supplies are likely to become more important in the future. According to Graham, the use of lime and phosphorus fertilizers depletes soil zinc supplies at a rapid rate. And lime and phosphorus tend to tie up the zinc supplies left in the soil in a form that plants can't use.

Deficiencies of the trace element often appear in alkaline soils and soils put to grade for surface irrigation.

The Missouri study showed that the use of zinc varies according to soil type and the crop being grown. Four different soils and two organic materials were used in the research project. Crops tested were soybeans, corn, and wheat.

The zinc absorbed by the soil and later by the growing plants was traced with zinc sulfate treated with zinc-65. This radioactive material makes accurate determinations of minute amounts of trace elements in plants.

—*Crops and Soils*

Vol. 18, No. 2, Page 21, Nov. 1965

Fertilizer Consumption In The U.S. Continues To Increase

Consumption of primary plant nutrients in the United States during the year ended June 30, 1965 reached 10,963,064 short tons, an increase of 4.8 percent over 1963-64 consumption, according to the U. S. Department of Agriculture.

As has generally been the case for a number of years, the largest increase was in nitrogen consumption which jumped to 4,605,442 short tons, 5.8 percent over 1963-64. Consumption of phosphatic fertilizers in terms of available P_2O_5 was 3,529,164 tons, up 4.5 percent, and that of potash in terms of K_2O was 2,828,458 tons, up 3.6 percent.

The increases in nitrogen use in mixtures and in materials for direct application was the same (5.8 percent) so that the proportion did not change from 1963-64 (31.6 percent in mixtures and 68.4 percent in materials for direct application). In the case of phosphates, however, increased use in mixtures was 5.4 percent and in materials for direct application only 0.9 percent. Thus the proportion used in mixtures increased to 80.0 percent and that in materials for direct application declined to 19.2 percent.

The reverse was true of potash, which registered only a 1.8 percent increase in fixtures but a 13.1 percent increase in materials for direct application. The respective proportions during 1964-65 were 82.6 percent in mixtures and 13.1 percent in materials for direct application.

The total tonnage of all fertilizer consumed in 1964-65 was 31,326,159, an increase of 2.1 percent over the previous year. Tonnage of mixtures was up to 18,386,190, an increase of 1.6 percent, and that of direct application materials including materials containing secondary and micronutrients was up to 12,939,969, an increase of 2.8 percent.

The primary plant nutrient content of all fertilizers continued to increase, as it has done steadily over the years, and reached 36.78 percent compared with 35.82 percent in 1963-64 and 34.71 percent in 1962-63.

Total tonnage of secondary and micronutrient materials applied was 1,521,286 short tons compared with 1,475,428 short tons in 1963-64. However, these figures exclude products which also contain one or more of the primary nutrients and, therefore, do not take into consideration amounts of secondary and micronutrients added to such fertilizers, a practice which is growing in importance. Of the 1964-65 total above, calcium sulphate accounted for 1,410,857 tons or 92.7 percent. Elemental sulphur, applied as such, accounted for 24,001 tons.

—*The Sulphur Institute Journal*
Vol. 2, No. 2, Page 21, Summer 1966

NUTSEDGE CONTROL

ELWYN E. DEAL

Extension Turf Specialist

In recent months we have received numerous samples of nutsedge (formerly known as nutgrass) with a request for information on how to control it in turf. Nutsedge, because of its very deep root systems, has really flourished during the hot dry summer while bluegrasses were almost dormant.

According to the best information we can find, temporary soil sterilization with a fumigant such as methyl bromide is the only real control for it. This type of treatment usually gives complete control but kills all plants in the area that is fumigated. Methyl bromide is a poisonous gas that should be handled very carefully and only by experienced people. It should be used only in open areas where trees and shrubbery, including their roots, will not come in contact with the chemical. The high cost of methyl bromide makes it almost prohibitive to treat large areas. Small patches can easily be eliminated by this method before the spread.

Amino triazole can be used to kill all existing nutsedge plants but will not kill nutlets that are dormant in the soil. One application is usually sufficient to kill existing plants. Amino triazole is a non-selective herbicide — it kills all plants with which it comes in contact. Spot treatment then is the way to use this chemical. Reseeding or resodding of treated areas will be necessary. Frequent hand weeding during the next year or two will also be needed.

In a few instances where only a few scattered nutsedge plants are present, PERSISTENT hand weeding may be one solution. The word *persistent* is the key, however. New plants must be pulled from the sod before they have a chance to form new nutlets. The plants are removed and nutlets can be "starved" by this method until they have exhausted the stored food reserves and can no longer reproduce.

2,4-D was listed by early research workers as giving some nutsedge control when applied at least three times per summer for two successive years or more. Dicamba (Banvel-D, T.M.) has also been suggested for use this way. Several treatments are required each year since one spraying will not completely kill existing plants. Treatments are needed for two years or more to control plants from the nutslets that were dormant during previous treatments.

One golf course superintendent has told us that he used a combination of 2,4-D and DSMA spray, two applications or more per year, to control nutsedge. This kind of treatment will also probably require two or more years.

The major unanswered question regarding the use of selective herbicides, especially 2,4-D and dicamba, is what happens to the bluegrass and bermudagrass. Recent research at another institution has shown very clearly that a lot of undesirable things happen to the roots of these turfgrasses even though above-ground effects are not noticeable. These unnoticed "side" or actually "under (ground)" effects caused by herbicides probably account for a lot of the so-called "summer injury" and other problems that we often cannot explain.

For best control of nutsedge, or in fact any weed, herbicides should be applied when the plants are making their most rapid growth. Adequate soil moisture is one of the most critical factors involved. One of the best times to apply herbicides is several days after a heavy rain or irrigation.

We do not recommend any of the chemical control measures mentioned above for nutsedge control except soil fumigation with a temporary soil sterilant such as methyl bromide. However, some of the other treatments may warrant experimental trials in areas where nutsedge is becoming a real problem. If we have more hot dry summers like the two or three just passed, nutsedge will probably continue to increase.

—*The Agronomist*

Vol. 3, No. 10, Page 1, Oct. 1966

POA ANNUA — "THE FAILURE GRASS"

W. H. Daniel, Department of Agronomy, Purdue University, Lafayette, Indiana urges replacement of *Poa Annua* in greens, tees and fairways. To accomplish this he advocates planning a five step program similar to that which he outlined in the August 1, 1966 edition of the "Midwest Turf Newsletter."

Plan a Five Step Program

1. *Plan the switch — when — start early fall or early spring to restrict and replace *Poa annua*. Where — 9 fairways, 18 fairways, 1 or even 1/2, or just 1,000 square feet, but get a start. How fast — there is time, just begin divided applications to develop a toxicity level in one calendar year.*
2. *Introduce the Desired.* It takes repeated overseeding and time, so start in early fall with light and repeated seedings to take advantage of open space and weather changes. *What?* A blend of bluegrass preferred, but the same techniques apply to a blend of bentgrasses. Choose these selections best adapted and available. Merion, Windsor, Delta, Park, Newport, and Common are available. Prato, Cougar, Delft, etc., may be offered, and new dwarf varieties are needed. Tolerance to disease and close cutting, plus spread, are desired. Don't wait for new varieties not now available — just upgrade with these later. *Use light seed rates — Use 20-40 lbs./A, even*

less if slit or trench seeded. Then repeat 3-4 weeks later and again late next winter and early next fall. This totals four times or chances for introduction.

3. *Restrict the competition of *Poa annua*.* Neburon and several pre-emergents could be used. With Neburon older *Poa annua* can be killed under ideal conditions — at 4#A/A in mid-April. Then, only existing perennial desired grass is available for summer use — so careful first use in small plots is suggested. With Pre-San or Betasan, Benefin, Dacthal, Zytren, Bandane, Azuk, etc., the dosage for prevention of *Poa annua* seedlings will also stop desired grass seedlings. Thus their use is limited to areas where desired grass is already well established and where existing *Poa annua* is killed by drought or chemicals as combined cleanup — then — prevent program. So, that leaves the arsenicals — which can selectively restrict and kill old *Poa* and prevent new competition by rootzone toxicity. Lead or calcium, or any arsenate could work, but calcium arsenate is the most economical, selective and widely used. The principle of selectivity is that roots will take up arsenic, but leaves won't translocate arsenic — so plant growth is restricted.
4. *Promote the Desired — Keep it growing —*
 - a. By irrigation — Green leaves make energy for new growth — so save a crop of leaves and increase spread.
 - b. By disease reduction — Maybe four sprays per year can avoid loss during severe disease periods.
 - c. By wear distribution — Move wear pattern, if possible. Extra aerifying and watering can save grass.
 - d. By spot repair — Plugs, reseeding and mulching of critical spots makes a big difference in developing uniformity.
 - e. By ample nutrition — Match nitrogen and irrigation to keep the rhizomes growing.
 - f. By renovation — Thatch control — Vertical grooving, aerifying help make room for new growth close to the ground and also dilute thatch with soil.
5. *Stay on the program — Make a plan.*
 - a. for fertilizer — use ample N and one-half as much K, but No P until *Poa annua* is under control — then use very little P at any time.
 - b. build arsenic in divided applications — consider repeat applications of 4#F/1000 sq. ft. — target 12-16#F/1000 sq. ft. in 1 year
 - c. maintain arsenic toxicity — by light annual applications 2#F/1000/yr.

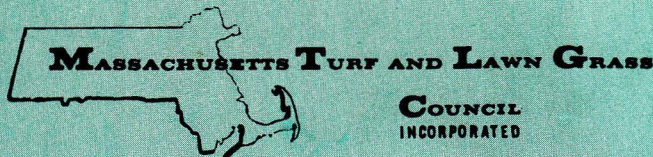
Dr. Daniel further suggests that the reader refer to *Midwest Turf Leaflet No. 29 — "Bluegrass Fairways? Yes, If!"* October 1964, before attempting to remove *Poa annua*.

ADVANTAGES OF BUYING BLUE TAG CERTIFIED SEED (OR SOD)

When there is a choice between certified and uncertified seed or sod my advice is to choose the *certified* material every time. Sometimes there is no choice because the crop in question may not merit certification nor qualify for the high standards.

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FROM



RFD #2, HADLEY, MASS. 01035

TURF BULLETIN

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standards for mechanical purity and, most important, genetic identity. The slightly higher cost for certified stock represents only part of the extra costs incurred by the grower and processor.

Though the tag on certified stock the user can trace back to the original grower in case there is any question concerning the planting material.

Uncertified stock carries no guarantee of genetic identity. Seeds of other varieties which are so similar as to escape visual detection legally can be sold under the popular variety name. *The loser is the user.* He has no recourse and can claim damages from no one.

It would seem that the slight extra cost of certified material is a small price to pay for satisfaction and protection. **KEEP ALL TAGS!**

—Fred V. Grau

Golfdom, Vol. 40, No. 10, Oct.-Nov., 1966

No Shortcuts For A Good Lawn

CHARLES M. DRAGE
*Extension Horticulturist
Colorado State University*

You can't make "shortcuts" and have a good healthy lawn. Bluegrass must have enough leaf surface to provide food to support the plant and develop a strong root system. Mowing your grass too short can lead to problems.

Bluegrass should be mowed 1½ to 2½ inches above the soil. The higher you mow, the stronger the grass will be.

If it is necessary to mow lower than this, more frequent watering, extra fertilizer and more intense management will be required, the lawn expert says. If bluegrass is mowed lower than 1¼ inches, troubles and perhaps failures can be expected.

Grass normally cut at 1½ inches should be mowed before it reaches 2 inches. As a general rule, not more than one-third of the green-leaf area of the grass should be removed at one time.

If grass is permitted to grow taller than the usual height, cut it back to its regular height gradually, not at one clipping. And keep your mower sharp.

—Seed World

Vol. 99, No. 3, Page 22, Sept. 9, 1966

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