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SELECTING THE LEVEL OF TURFGRASS MAINTENANCE

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The lawn is a vital feature of any home or grounds area. The turf area can be maintained at one of a number of different levels, depending on the grass variety selected, quality of lawn desired, interest of the owner, time, and money available. There are four vital principles for the maintenance of any lawn area:

1. Select adapted grasses of the desired quality for the specific environmental and soil condition. A mixture of desirable perennial grasses offers distinct advantages over an individual turfgrass species since a wide range of conditions usually exist in the home lawn. Shade, sandy soil pockets, and exposed subsoil from excavations are conditions which require specific grasses.

   The following is offered as a quide in selecting a lawn mixture for meeting these varied requirements. Quality turfgrass mixtures which fall within the percentage ranges listed are available or may be purchased individually and mixed. Percentages are given on a weight basis.

   A. Sunny areas of medium to low maintenance:
      Kentucky Bluegrass (Common, Delta, Park).....70 to 40%
      Creeping Red Fescue (Pennlawn, Common, Rainier).....30 to 60%

   B. Sunny areas of high maintenance:
      Merion Kentucky Bluegrass.....20 to 10%
      Kentucky Bluegrass (Newport, Common, Delta, Park)...50 to 30%
      Creeping Red Fescue (Pennlawn, Common, Rainier).....30 to 60%

   C. Moist, shaded areas:
      Kentucky Bluegrass (Common, Delta, Park).....20 to 30%
      Creeping Red Fescue (Pennlawn, Common, Rainier).....70 to 40%
      Roughstalk Bluegrass.....10 to 30%

   Use the higher percentages of red fescue under shady conditions or on light sandy soils. Add 15 to 25% ryegrass to the mixture under the following adverse conditions:

   A. Seeding at poor time of year such as mid-summer.

   B. Sloping areas subject to erosion.

   C. During droughty periods when the area cannot be irrigated or mulched.

   Bentgrass, redtop, tall fescue and timothy should not be used in lawn seed mixtures where a high quality turf is desired. They eventually produce a patchy and otherwise undesirable appearance. These grasses cannot be selectively removed from the desirable grasses with herbicides now available. As a result, they can become the most undesirable of turfgrass weeds

2. Insure proper soil conditions, including adequate surface and internal drainage. This step should be accomplished at the time of lawn establishment.

3. Employ proper mowing height and frequency. For bluegrasses and red fescues, mow at 1 1/2 to 2 inches. Also, mow frequently enough so that no more than 1/3 to 1/2 of the leaf area is removed at any one time. Mowing too close or not frequently enough will result in a shortened and weak root system. A restricted root system increases susceptibility to drought and disease attacks.

Now available is a growth inhibitor called maleic hydrazide. Its use on quality lawn turfs is of doubtful value since its primary action on turf is the inhibition of seedhead formation. It does not control growth to the extent that is desired in a quality lawn. If mowing is practiced following an application of maleic hydrazide a severe thinning of stand may result. Also, if the lawn is severely injured from either disease or some other adverse condition, it would be incapable of actively growing and repairing the injured area. Because of these undesirable features, maleic hydrazide would be more applicable to low maintenance areas, such as slopes and roadsides, than to quality lawn turfs.

4. Fertilize to meet the minimum requirements of the grass. This usually means a minimum of two fertilizations per year in early spring and early fall. Phosphorous and potassium should be applied once per year in the form of a complete carrier. A 3-1-2 or 4-1-2 ratio of N-P-K is generally adequate. The creeping red fescues require 1 to 3 pounds of actual nitrogen per thousand square feet per year; the common Kentucky bluegrasses 2 to 4 pounds, and Merion Kentucky bluegrass and creeping bentgrass 6 to 8 pounds of nitrogen. The higher rates should be utilized where clippings are removed, heavy irrigation is practiced, or on light sandy soils.

In addition to these four primary steps, there are nine other steps which can be taken to improve lawn quality. It is the turf grower's choice as to which level of maintenance he wishes to employ.

5. Irrigate to prevent wilting and to maintain a green turf. Deep infrequent watering to a soil depth of six inches is preferred rather than light, frequent waterings. Investigations have shown that the more frequent waterings result in a thinner turf of reduced quality.

6. Control most broadleafed weeds with 2,4-D (2,4dichlorophenoxyacetic acid). The exceptions are white clover, chickweed, and henbit, which can be controlled with 2,4,5-TP (2-(2,4,5-trichlorophenoxy) propionic acid). Care should be taken to avoid injury to susceptible planting.

7. Control annual weedy grasses such as crabgrass, foxtail, barnyardgrass and sedge, either pre-emergence or post-emergence. Where a severe infestation of weedy grasses occurs, it is best to apply a post-emergence herbicide, such as DMA or AMA, then, verticut the area to remove dead grass, fertilize, and overseed with desirable perennial grass species. A pre-emergence herbicide can be applied the following spring after the preferred grasses are established.

8. Control insects such as June beetle grubs, sod webworms, Japanese beetle grubs, and ants. If grubs are severe in the area, insect control would become one of the primary maintenance factors.

9. Remove clippings, especially under high maintenance conditions. In the past, it has been suggested that clippings be returned if at all possible. However, with the advent of more vigorous grass varieties, higher fertility levels, and increases in irrigation, the amount of clippings being returned is much greater. In fact, it is exceeding the rate of decay, thus resulting in an accumulation of material in the lower regions of the turf vegetation. This is not desirable as will be brought out under item 10.

10. Remove thatch by mechanical renovation. Thatch is defined as a tightly intermingled layer of living and dead stems, leaves, and roots of grasses which develop between the layer of green vegetation and the soil surface. The higher rates of nitrogen fertilization, development of more vigorous grass varieties increase in watering, and Michigan's relatively cool climate for midsummer growth have contributed to the current prominence of the thatch problem.

Thatch accumulating to a depth of more than one-half inch creates the following undesirable conditions which result in deterioration of the turf.

1. Greatly enhances the micro-environment for disease activity, including leafspot, stripe smut, powdery mildew, and Fursarium rosium.

2. Elevates the grass crowns above the soil to the extent that drought resistance is reduced.

3. A tight thatch or mat can greatly inhibit aeration and water movement into the soil.

Thatch has only recently become a problem in lawns and is not widely known or recognized as yet. Rather, the lawn owner notes a disease or drought condition.

To determine the degree of thatching present, cut a pie-shaped wedge, two inches deep, remove the plug, and make an examination of the vertical cross-section. Superficial examinations from the surface are not effective in determining the amount of thatch which is present.

Thatch can be mechanically removed by one of several vertical renovation machines which have recently become available. These machines can be obtained on a rental basis for home use. There are two basic types involving either knives or tines mounted vertically on a reel which removes the thatch by a cutting or pulling action. Under heavy thatch conditions, it may be necessary to go over the area several times.

11. Eradicate weedy perennial grasses by sterilization or use of grass killers. Included in this category are: tall fescue, timothy, redtop, bentgrass, and quackgrass. If all lawns surrounding the one where control is being contemplated contain bentgrass, it would be of no use to sterilize or use grass killers on this area, since the bentgrass would readily reinvade the area from surrounding lawns. In this case, the only choice is to use Silvex (2,4,5-TP) two to three times per year to keep the bentgrass under control and reduce its degree of infestation. In general, bentgrass cannot be eradicated by use of Silvex.

12. Correct compacted soil conditions by hand or mechanical aerification. This is needed primarily on heavy soils or traffic areas. It should be pointed out that the action of aerification is a removal of cores and not just a spiking or punching operation.

13. Apply fungicide for the prevention or control of disease. Currently, a disease which is of particular concern is powdery mildew. It attacks the Kentucky bluegrasses, especially in wet, heavy shade areas. Where grass growth is being limited by powdery mildew, the fungicides, Karathane or Actidione-Thiram will give good control. Also, on areas having a past history of snow mold injury control practices may be considered.

MANAGEMENT OF BENTGRASS PUTTING GREENS

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Selection of a maintenance program for putting greens is governed by the grass variety, soil type, micro-environment and operating funds available. General recommendations usually fail to provide a set program or guide fitting all conditions.

The following discussion is presented as a basis from which an appropriate program can be developed for specific situations:

MOWING

Close cutting favors the most satisfactory putting surface. A cutting height in the range of 3/16 to 1/4 inch reduces the problems of "matting" and soft spongy turf which often occurs with a higher cut. It may be necessary to raise the height of cut 1/16 inch during the hot July and August weather. Clippings should always be removed.

Daily mowing is necessary to maintain the highest quality putting surface, otherwise mat formation is encouraged and coarse textured greens result. The mower must be sharp and properly adjusted. The direction of cut should be changed each time the green is mowed, using at least four different directions. Continuous mowing in one direction encourages the formation of grain. Undesirable, spongy, grainy or stemmy conditions can be corrected by brush or comb attachments available for the mower.

FERTILIZATION

Rates depend on topdressing practices, sand content of underlying soil, irrigation program and the climate. The normal annual nitrogen requirement of bentgrasses is between 6 and 8 pounds of elemental N per 1,000 square feet. A complete fertilizer containing nitrogen (N), phosphorous (P) and potassium (K) should be applied at least once and preferably twice a year in spring and fall. A soil test will indicate the P and K needs.

A light application of soluble nitrogen in early spring encourages the growth of bentgrass and enables this grass to compete more favorably with Poa annua. The fall use of an organic nitrogen fertilizer results in slower nitrogen release in cool weather, permitting the grass to harden off for the best winter survival.

Where excessive cup wear is experienced, a light application of potassium greatly improves wear tolerance. If chlorosis (yellowing) of grass persists, even when nitrogen fertilization is adequate, spray ferrous sulphate at 1 to 1 1/2 ounces of ferrous sulphate with 5 to 6 gallons of water per 1,000 square feet.

SOIL PH

An application of lime should be made when the soil falls below pH 6.0. Agricultural ground limestone is the safest and easiest form to apply to correct soil acidity. If soil magnesium levels are low use dolomitic limestone. Where the pH is excessively high (above 7.5) it may be lowered by the use of an acid producing fertilizer such as ammonium sulfate.

WATERING

One of the most vital factors in putting green management is watering. Deep, infrequent watering promotes deep root penetration. Overwatering should be avoided since it encourages shallow rooting. Early morning watering is preferable. Daytime syringing must be practiced during hot, windy weather on greens having a shallow root system to avoid loss of turf from wilting. Wilt can even occur when adequate soil moisture is present if the root system is so limited that loss of water by transpiration exceeds uptake by the roots.

TOP-DRESSING

The light application of a prepared soil mix to the green can be utilized to improve an uneven surface, to control mat formation, to inoculate with micro-organisms and, in some instances, to modify soil conditions. Topdressing should not be practiced as a set program but used only when conditions warrant. Spring and/or fall topdressing may be applied depending upon conditions. Rates of topdressing may vary from 1/4 to 1/2 cubic yard per 1,000 square feet. It is important that composition of the topdressing be similar to the existing soil so that no "layering" problems develop.

AERIFICATION

The removal of soil cores for the purpose of correcting surface compaction serves to improve soil aeration, water movement, rooting and thatch decay. Aerifier cores may be removed or broken up and returned as a topdressing. The amount of aerification should be modified according to the degree of soil compaction.

VERTICUTTING

The use of vertically mounted blades which cut into the turf thus removing excess vegetation can be utilized in two primary ways as a:

(a) light combing action to reduce grain and stemminess.
(b) deep renovating action to remove excessive thatch.

SPIKING

Spiking should be utilized judiciously to reduce localized compaction problems or dry spots when aerification is not possible.

SELECTED TURFGRASS VARIETY EVALUATIONS

by
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Winterkill and Drought Tolerance

The winter of 1964-65 provided an excellent opportunity for winterkill observations under field conditions. This was especially true at the northern Michigan experimental plots (Traverse City). Winterkill comparisons of eight Kentucky bluegrass varieties are shown in Table 1. Of this group, only two exhibited significant injury. Both are experimental selections that are not now commercially available. Brabantia, a selection from the Netherlands, was nearly 50% thinned by low temperature kill, while K 5 (47) exhibited 11.5% thinning. The K 5 (47) readily recovered from this injury, while Brabantia continued to show thinning well into the summer growing season. All six commercially available bluegrass varieties showed nominal winter injury, ranging from 3 to 5.5 per cent.

Table 1. 1965 Winterkill and Drought Evaluations of Eight Kentucky Bluegrass Varieties. Traverse City, Michigan (91% sand). Planted May 16, 1963.

Variety	Percent Winterkill	Drought Tolerance 8/19**	Drought Recovery 9/16**
Cougar	5.0	4.0	4.0
K 5 (47)*	11.5	6.3	5.0
Park	5.5	7.0	6.0
Merion	4.5	7.5	6.3
Delta	4.0	7.5	6.5
Common	4.0	7.5	6.5
Brabantia*	47.0	7.5	6.5
Newport	3.0	8.0	7.0

* Experimental Selection
** 1- Best; 9- Poorest

The red fescues proved highly susceptible to low temperature injury, as shown in Table 2. The experimental selection Highlight from the Netherlands, proved the most winter hardy of the eight red fescues under evaluation. Also showing good hardiness were Pennlawn, common chewings, and, to a lesser extent Illahee red fescue. The latter three showed thinning ranging from 10 to 17 percent. The other four red fescues, Rainier, common creeping, MSU-47-FR, and Olds, exhibited serious injury ranging from 40 to 67 percent loss of turf. The greater susceptibility of the red fescues to low temperature injury has not been widely recognized in the past. However, there does appear to be a range of tolerances within the red fescue varieties with Pennlawn, common chewing's and Illahee, in that order, being the preferred grasses in areas where low temperature injury is of concern.

Table 2. 1965 Winterkill and Drought Evaluation of Eight Red Fescue Varieties. Traverse City, Michigan (91% sand). Planted May 16, 1963.

Variety	Percent Winterkill	Drought Tolerance 8/19**	Drought Recovery 9/14**
Pennlawn	10.5	7.0	4.3
Illahee	17.5	6.8	5.0
Rainier	51.5	6.8	5.3
Common Creeping	40.5	7.8	6.3
MSU-47-FR*	49.0	6.8	6.3
Olds	66.5	7.3	6.5
Common Chewing's	14.0	7.8	6.8
Highlight*	2.0	8.8	7.3

The experimental plots at Traverse City were established in May of 1963 on a site with 91% sand. The experimental design permitted two replications to be maintained under irrigation and two without supplemental irrigation. These irrigation differentials were not initiated until the spring of 1965 after maximum uniformity of stand was achieved. By mid-August of 1965 the unirrigated series was almost completely brown with the exception of a few plots. The data presented (Tables 1 and 2) include a rating made on August 19 at the time of peak drought injury and then on September 14 after the grasses were well along toward recovery.

The comparative drought tolerance of nine Kentucky bluegrass varieties is shown in Table 1. All varieties were severely thinned by mid-August. Cougar, a selection from Washington State, proved to be superior in drought tolerance and recovery. K 5 (47) also ranked well in terms of drought recovery, followed by Park and Merion. Although recognized as a high management grass, Merion did exhibit a fair ability to recovery from drought.

All eight red fescue varieties showed a similar degree of browning during peak drought stress. However, certain varieties had a much better ability to recover from drought. Outstanding drought recovery was Pennlawn followed in order by Illahee and Rainier. The other five red fescue varieties were inferior in terms of drought recovery.

Four years of red fescue variety and performance data at East Lansing has shown no great superiority of any of the commercially available red fescue varieties (Table 3). However, the data obtained at Traverse City in 1965 concerning relative tolerance to winterkill and drought indicate that Pennlawn is definitely superior to the other red fescue varieties in these two important characteristics. Based on these observations Pennlawn appears to be the preferred variety for use in red fescue turfs.

Table 3. Four Year Performance of Nine Red Fescue Varieties, East Lansing, Michigan. Planted July 11, 1962.

Variety	Turf Quality Rating** (1-Best; 9-Poorest)			
	1962	1963	1964	1965
S-59*	2.0	2.1	1.4	1.6
Highlight*	1.8	3.2	1.6	1.8
MSU-47-FR*	5.0	2.9	2.2	2.0
Pennlawn	3.3	3.7	2.0	2.6
Rainier	3.3	3.7	2.5	2.7
Olds	3.5	4.8	2.9	2.9
Illahee	3.4	4.2	3.3	3.7
Common Chewing's	2.7	4.6	3.4	3.8
Common Creeping	5.6	4.1	3.7	4.0

* Experimental Selection
** Average of monthly ratings

SELECTING A TURF FERTILIZATION PROGRAM

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A vigorous attactive turf requires adequate fertilization. Selecting the most desirable fertilization program for a specific turf involves many factors including soil test, species of grass, time of year, clipping removal, irrigation level, soil testure, cost of fertilizer and its application, the general maintenance level desired by the grower, etc.

NITROGEN

Turfgrasses are most responsive to nitrogen, although phosphorus and potassium must be supplied. There is no simple soil test for nitrogen, but the annual requirements for several species have been determined as shown in Table 1.

Table 1. Annual Nitrogen Requirements for Michigan Turfgrasses

Species of Grass	Pounds of Nitrogen Per 1000 Sq. Ft.	Pounds of Nitrogen Per Acre
Merion bluegrass	6 - 8	260 - 350
Bentgrasses		
Common Kentucky bluegrasses	2 - 4	85 - 175
Red fescues	1 - 3	40 - 130

Frequent irrigation, especially on sandy soils, may require increasing these levels 20 to 40 percent. These rates may also need to be increased 20 to 40 percent if clippings are removed. Personal judgement must be used in evaluating the nitrogen needs as the objective is to maintain desirable color and vigor in a quality turf.

Nitrogen fertilizers are of three general types - soluble, antural organic, and ureaform. Each type has certain advantages and disadvantages. The soluble nitrogen carriers are readily available to the plant after application, but because they possess salt type properties care must be taken in application during active growth periods to prevent burning. Some of these carriers possess acidifying properties which can result in markedly increasing soil acidity with continued use. Ammonium sulfate is particularly acidifying to the soil, while ammonium nitrate, urea, and ureaform are less effective in this respect. Carriers such as calcium nitrate and sodium nitrate have a basic effect; that is they can cause soil acidity to decrease. The soluble nitrogen carriers require more frequent application than others but they are usually much less expensive per pound of actual nitrogen. Some examples of each type of nitrogen carrier are shown in Table 2.

Table 2. Examples of some nitrogen turf fertilizers.

Nitrogen Carrier	Analysis	Pounds needed for one pound of nitrogen
Soluble carriers		
Ammonium nitrate	33-0-0	3.0
Ammonium sulfate	21-0-0	4.8
Urea *	45-0-0	2.2
Calcium nitrate	17-0-0	5.9
Sodium nitrate	16-0-0	6.2
Natural organics		
Activated sewage sludge	5-4-0	20.0
Dried blod	12-1-1	8.3
Soybean meal	7-1-2	14.3
Fish scraps	7-6-0	14.3
Ureaform	38-0-0	2.6

*Urea is sometimes considered an organic nitrogen carrier but it reacts very similar to the soluble carriers in the soil, and therefore, is classified here as a soluble nitrogen material.

The nitrogen in natural organic carriers is combined in the organic compounds. Soil microorganisms must break down the organic structure to release the nitrogen so it can be taken up by the roots. These microorganisms are not very active when soil temperatures are below 55-60°F. This temperature dependence limits the release of nitrogen from the organic carriers during cool seasons. As a result it may be necessary to use soluble nitrogen for quick response at these times. Since the natural organics are not soluble, leaching and burning problems are reduced and fewer applications will be required per year. However, the cost per pound of nitrogen may be three or more times that for soluble materials. The rate of release of nitrogen from the organic carriers is quite variable so the user should be familiar with the product.

Continued, exclusive use of natural organic nitrogen carriers which contain appreciable quantities of phosphorus (activated sewage sludge, for example) may lead to a buildup of available phosphorus in the soil to levels which may be undesirable. Where soil phosphorus tests are high these carriers should not be used as the main source of nitrogen.

The ureaforms are synthetically prepared nitrogen materials providing slow release properties. The advantages and disadvantages are similar to those for the natural organic carriers. A minimum of two applications have been found desirable in Michigan and supplemental soluble nitrogen may be necessary in early spring. It can be applied at any time during the year - at recommended rates - without danger of burning the foliage. Continued use of ureaform nitrogen would suggest a buildup of slowly available nitrogen especially after the first two or three years. However studies up to five years duration have indicated that ureaform has been about 50% as effective per pound of nitrogen compared to certain other nitrogen carriers. In other words, two pounds of nitrogen as ureaform has given the same response on turf as has one pound of nitrogen from other carriers. Freedom from frequent application may offset the disadvantages of cost and lower efficiency, however.

Phosphorus and Potassium

Phosphorus and potassium applications should be based upon soil tests. When soil test results are determined by procedures used in the Michigan State University Soil Testing Laboratory, Tables 3 and 4 will serve as guides for determination of the desired rates.

Table 3. Annual Phosphate Applications Based on Soil Test.

Soil Test (Lbs. P/Acre)	Pounds phosphate (P_2O_5) Recommended		
	General Turf		High Maintenance Turf*
	Per 1000 sq. ft.	Per Acre	Per 1000 sq. ft.
Less than 25 (low)	2	80	4
25-40 (medium)	1	40	2
40-70 (High)	0	0	1
More than 70 (very high)	0	0	0

* High maintenance turf would include golf greens.

Table 4. Annual Potash Applications Based on Soil Test.

Soil Test (Lbs. K/Acre)	Pounds Potash (K_2O) Recommended		
	General Turf		High Maintenance Turf*
	Per 1000 sq. ft.	Per Acre	Per 1000 sq. ft.
Less than 50 (low)	3	120	5
50-150 (medium)	1	40	3
150-250 (high)	0	0	2
More than 250 (very high)	0	0	0

*Especially for sandy soils with high irrigation rates.

Complete Fertilizers

Fertilizers containing nitrogen, phosphate, and potash are called complete fertilizers. Popular complete fertilizers for turf include 15-5-10 or 16-4-8. The first number corresponds to the percent nitrogen, the second number to percent available P_2O_5 (phosphate or phosphoric acid) and the third number to percent soluble K_2O (potash). The above fertilizers would possess 3-1-2 and 4-1-2 ratios, respectively.

In determining which fertilizer one should use when all three nutrients are needed, the suggestions outlined in Tables 1 through 4 should be considered. The proper fertilizer can then be selected on the basis of the ratio which most closely resembles the recommended nutrients. Consider a recommendation which calls for four pounds of nitrogen, one pound of P_2O_5 and two pounds of K_2O per 1000 square feet per year. This gives a ratio of 4-1-2, which should be easily matched by a commercial turf fertilizer. A 16-4-8 fertilizer analysis, applied at the rate of 25 pounds would probably be divided into <u>at least</u> two applications per year for general turf. Some other examples which can be used as guides are given in Table 5.

Table 5. Some Examples of Fertilizer Selections Based on Soil Tests.

Annual application Pounds Per 1000 Sq. Ft. N	P_2O_5	K_2O	Ratio	Possible Fertilizer Analysis	Fertilizer Needed Pounds/1000 Sq.Ft.
4	1	2	4-1-2	16-4-8	25
				20-5-10	20
8	2	2	4-1-1	16-4-4	50
				12-3-3	67
6	2	3	3-1-2	15-5-10	30
				12-4-6	50
4	0	0	1-0-0	33-0-0	12
				38-0-0	20*
2	0	1	2-1-1	20-10-10	10
				16-8-8	12.5

* Based on 50% efficiency of ureaform nitrogen carriers.

For small turf areas where the ration does not work similar to a commercially available fertilizer, one which has a similar ration is acceptable for convenience. As an example, consider the case shown in the last line of Table 5 where the ratio of N-P_2O_5-K_2O is approximately 2-1-1.

For larger turf areas where greater amounts of fertilizer will be needed, it may be profitable to use only nitrogen and phosphorus on soils testing low in phosphorus and high in potassium. Superphosphate (0-20-0 or 0-45-0) may be used to provide phosphorus, while nitrogen may be applied in the form of one of the nitrogen carriers shown in Table 2. Five pounds of 0-20-0 or 2 1/4 pounds of 0-45-0 provide one pound of P_2O_5.

Muriate of potash (potassium chloride, 0-0-60) can be used for providing potassium on soils testing high in phosphorus and low in potassium. One and 2/3 pounds of 0-0-60 would be needed to provide one pound of K_2O. The phosphate and potash carriers mentioned above are the most commonly used straight fertilizers, but there are many other sources which are commercially available.

General Pointers

When soil tests are not available as a basis for selection of the proper fertilizer one may use a fertilizer with one of the following rations: 4-1-2, 4-1-1, 3-1-2, or 3-1-1. The rate of application should be based on the percent nitrogen in the fertilizer and the nitrogen requirements of the species of grass being grown. On newly established turf higher levels of phosphate and potash may be desired. On older established turf areas which have received regular fertilization in the past, higher nitrogen ration fertilizers should be acceptable.

Beware of buying fertilizers advertized as containing slow release organic nitrogen in which the primary nitrogen source is urea. Urea does possess an organic type structure but it reacts very similar to the soluble nitrogen carriers in the soil as pointed out in Table 2. As a result it does not provide slow release of the nitrogen by comparison to most other organic carriers. Although it can technically be called organic nitrogen, slow release properties should not be expected. Most companies list the major forms of nitrogen present in their product. Look for this list on the fertilizer bag.

Salt type fertilizers should be applied with special care during active growing periods, since these fertilizers can cause burning of the leaf tissue. This problem occurs especially when the leaves are wet. Immediately after application these fertilizers should be washed off the leaves and into the soil by watering with a coarse spray.

Timing of fertilizer application is very important in maintaining a quality turf. Sufficient nitrogen should be present during the periods of vigorous top growth and rhizome development in spring and fall. This allows the grass to compete with weeds and fill in open spots thinned by disease or drouth injury. On the other hand, a high soil nitrogen level results in a young plant which is quite succulent. In this condition the plant is more susceptible to drought or cold injury. Reducing the nitrogen level in the soil allows the plant to become more mature, often called being hardened, and it will be less subject to injury from cold or drouth. If July and early August nitrogen applications are necessary the amounts should just provide nitrogen enough for maintainence during these periods. Fall applications should be made in late August through September 15. It is generally not wise to fertilize after October 1, unless the turf is severely nitrogen deficient. In the upper peninsula and other parts of the state where the growing season is shorter, fall applications should be made about 15 days earlier than those mentioned above.

A combination of nitrogen carriers is often used to reduce the number of applications required. For example, under general turf conditions two applications could be used - spring and fall. The spring application may be half soluble nitrogen to provide a readily available source of nitrogen, and half ureaform or other slow release nitrogen material, providing available nitrogen during the summer months.

The number of nitrogen applications required during the year is a matter of personal judgment for the turf under consideration. Attempts have been made to apply all the nitrogen in one annual application. This is not recommended for most turf, expecially the higher maintenance turf, because of the possibilities of over-stimulation and resultant thinning of the grass brought on by high amounts of nitroge in one application. This is most critical when using the soluble, readily available nitrogen carriers.

The question of foliar feeding of turf is often raised. The grass leaf is capal of absorbing nutrients applied on its surface, but only limited amounts can be taken up by the plant from one application. As a result a fertilization program using foliar feeding exclusively would require very frequent application at least once a w for true foliar feeding to allow absorption of adequate amounts of nutrients. Cost of fertilizer application may become a prohibitive factor in such a program. In most cases fertilizers applied in the liquid form are actually applied as a drench where most of the fertilizer rolls off the leaves with the water into the soil. The nutrients can then be absorbed by the roots of the plant. Regardless of whether the fertilizer is applied in the liquid or dry form, when equal rates of application are used, the application must be followed by watering to wash the salts off the leaves. This will prevent burning of the leaves by soluble salt-type fertilizers.

Micronutrients

Under conditions of extremely high phosphorus tests (above 320 lbs. P per acre) or quite alkaline soils (pH 8.0 or higher) the grass may be observed to remain a yellowish or brownish color even after fertilizing with nitrogen and watering. This chlorosis condition may be an indication of iron deficiency. Spray every 2 weeks with 1 1/2 to 2 ounce of ferrous sulfate dissolved in 5 gallons of water per 1000

square feet of turf. Do not get the material on clothes, walks or buildings as it will discolor them. The chelated iron compounds may also be used effectively for control of iron deficiency. Follow the manufacturers recommendations when using chelates.

Deficiencies of micronutrients other than iron have not been generally recognized in turf under field conditions. The conditions of high pH and high soil phosphorus tests are known to induce deficiencies of manganese, zinc or copper in other crops but these observations have not been reported on grass in Michigan.