Fertilizers and Their Contribution to Roadsides

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The basic question faced by those interested in highways is not whether to use fertilizer, but how much fertilizer to use. Certainly the constant increase in the use of nutrients to produce more crops on field soils on farms offers a guide. Obviously, adequate amounts of nutrients should be applied on exposed subsoils when highways are built. Even maximum rates of fertilizer used would be a minor part of total expenditure for road development. This is fortunate, but fertilizer's contribution need not be ignored. The value of utilizing mulch, seed, and fertilizer effectively has been appreciated not only by the highway user, but by the contractor-builder as well.

EARLY TURF COVER ESSENTIAL

What can be more expensive than to build culverts, stream channels and diversion ditches to exacting specifications, then have them a double loss as they fill with eroded soil which was needed at the initial site? The cost of repairing a washout or failure, even after one heavy rain, may exceed the original cost of establishment. Roadsides, which may vary from 1 to 5 percent of the total cost in highway construction, need good turf for early erosion control and engineering protection. Maximum fertilization should be encouraged to produce quickly good roadside turf which may serve as long term ground cover.

NEED FOR FERTILIZATION

Fertilization saves time in developing better ground cover by assuring adequate nutrients. In general, the higher the fertility, the better the cover, and the fewer the weeds infesting the area. Current road-building practices require large quantities of soil to be moved in making cuts, overpass, embankements, fills and ditches. This exposes some subsoil which is much less fertile than the topsoil. Yet, even the original topsoil may not be fertile. For example, of the 36 soil groups in Indiana, soil tests show 40 percent are low in phosphorus and 47 percent low in potassium.

In the building of new roads, the original topsoil, unless stockpiled, is not present on the final graded surface. On most projects, only the topsoil salvaged on the project is ample for reapplication to critical areas and this, after spreading, is often blended into subsoil rather than left as a separate layer. Topsoil is not applied on steep cut slopes on some projects because slumping and slipping may occur whenever topsoil is saturated with water. The scraping, hauling, stockpiling, and respreading of topsoil is costly, ranging from $0.50 to $5.50 per cu yd (4 in. of topsoil is approximately 500 cu yd per acre). Heavy and repeated use of fertilizer would be a money-saving alternative. But, in deficient subsoils a favorable root-zone supply of nutrients, particularly nitrogen, is imperative for satisfactory turf. A safe principle is to provide an adequate supply of nutrients for the least fertile soil in the state, county or soil group concerned.

NEEDED NUTRIENTS

Plants contain over 35 chemical elements. Many of these are called trace, or minor elements, because so little is used or needed. Others are used in larger amounts, and often are present in adequate supply. These include sulphur, magnesium, calcium. Commercial fertilizers may carry some of the above, but primarily they supply the three most needed elements—nitrogen, phosphorus, and potassium.

Nitrogen

Nearly all soils are deficient in nitrogen supply for desired grass establishment. Semi-annual applications are best. Nitrogen encourages fast growth, a dark color, leafy growth, and a dense ground cover. Its absence produces yellowing, sparse cover, and poor growth after germination. Nitrogen is subject to rapid utilization by plants and is not retained well in the soil. Leaching, plant use, and soil micro-organisms may quickly reduce its availability.

Phosphorus

Wherever phosphorus is deficient, it is most needed mixed into the rootzone before planting. Within each seed there is enough phosphorus to get a seedling started, but young plants need phosphorus to develop new cells and to grow rapidly. Seedbed preparation offers the best opportunity for adequate phosphorus incorporation because roots expand rapidly into soil areas having more than minimum phosphorus.

Potassium

Potassium is used in large quantities as a balancing and regulating element in plants. Also, it is leached and fixed gradually in the soil, so potassium needs replenishment at regular intervals.

FERTILIZERS

The label may read 20-5-5, 15-15-15, 12-6-6, etc. The first figure always refers to the percentage of nitrogen (N) by weight in the fertilizer formulation; the second is the amount of phosphorus (P_2O_5), and the third is the percentage of potash (K_2O).

Fertilizer is bought in actual pounds of these nutrients. High analysis fertilizers cost more per ton, but less tonnage is required, so handling cost may be lower. For example 2 tons of 15-15-15 equals 3 tons of 10-10-10 in amount of nutrient supply. Many combinations of mixed fertilizers are on the market as solids or liquids for a variety of application requirements. In Indiana, for example, over 50 companies produce fertilizer, of which over 40 distribute a 1:1:1 ratio fertilizer, such as 12-12-12.

Generally, a pound of available plant food is equally efficient whether used in a dry or liquid form. With hydroseeding methods, water is used as a medium for applying fertilizers and seed in a rapid and efficient manner.

Amount to Use

The key values are the total pounds per acre of each element required. Where fertilizer is worked into the rootzone, or when a mulch is used, then loam soils can utilize and store for plant use at least 100 lb per acre each of N - P_2O_5 - K_2O. This would be equivalent to about 20 lb per 1,000 sq ft, 180 lb per 1,000 sq yd, or 870 lb per acre of 12-12-12, or its equivalent. Even for sandy or gravelly soils with low nutrient holding capacity, use of one-half this amount is minimum. On exposed cut slopes in Georgia, Hendrickson had best results with 200 lb N - 400 lb P_2O_5 - 200 lb K_2O per acre in slope erosion plantings.

The increasing availability of ureaforms (UF), a source of long-lasting controlled-release nitrogen, and their incorporation into mixed fertilizers,offers the possibility of much higher application rates for initial seedbed fertilization. This would reduce the severe need for supplemental nitrogen feeding soon after seedling emergence and would improve turf cover. Research by DeFrance in Rhode Island, Musser in Pennsylvania, Daniel in Indiana, and elsewhere, has shown that ureaform nitrogen is ideally suited for seedbed use in that a single heavy application carries the grass on to established sod. Since longer nitrogen release and steadier feeding is expected, rates of 300 - 100 - 100 lb per acre would be standard.

Many turf fertilizers are being offered on the market with approximately 50 percent of nitrogen as UF. For these, rates of 200 - 100 - 100 lb per acre are suggested. In Rhode Island, DeFrance used 350 - 175 -175 lb in complete fertilizer which contained more than 50 percent of the nitrogen as ureaforms. In surface applications on slopes where mixing is impractical, under sod, or where hydraulic fertilization and seeding, plus mulching is used, a suggested standard is 100 lb each of N, P_2O_5 and K_2O as a seedbed application.

Acid Soils Need Lime

Lime, to be most effective, is best mixed into the surface soil. Calcium in lime serves as a nutrient, changes the soil to a desirable pH for plant growth, improves the physical conditions of the soil, and regulates the release of other elements essential for plant growth. Many soils do not need lime, so a soil test should always be secured to determine the desired rate. Since the interpretation of the tests is based on research within each state, soil samples should be sent to a laboratory in the area. Agricultural limestone is widely available. For convenience and handling ease with hydraulic equipment, hydrated lime (75 percent as many pounds as agricultural lime) may be spread, but separately from fertilizers.

Mulches

Mulching protects the investment in grading, seeding, and fertilizing. With the improvement in machinery for mulch applications, plus asphaltic binding, mulching for quick and more uniform turf establishment has become standard. Mulch assists in reducing freezing and thawing and the detrimental effects of weather variations on seeding establishment and early survival. It permits much more latitude in the time of grade stabilization and seeding with assurance of successful results.

In Connecticut, 5 oz/sq/yd open mesh burlap is used as mulch on waterways. In the Midwest, sod is often used in ditches. In Florida, damaged "tobacco cloth" is pegged down as mulch on steep slopes. Use of hay or straw mulch at rates varying from 1 to 2 tons per acre is common, depending upon application equipment. Ohio permits four mulching methods, but favors 1.25 in. loose mulch (1.25 tons dry straw) sprayed with 100 gal of a specified asphalt emulsion as the straw leaves the mulch blower. In general, the use of mulch requires, and also permits, a much heavier use of fertilization.

Maintenance of Good Turf

Plant usage, fixation in the soil, leaching, and erosion make annual fertilization after planting desirable on grass sods. On slopes where legumes, such as crown vetch, predominate, only P and K would be used

if cover is thin. An application of fertilizer at seeding time is not enough to keep turf dense year after year. Nitrogen is the most needed in maintenance, and a complete fertilizer high in N, such as 20-5-5, 15-5-5, 12-6-6, or 16-8-8, should be most efficient.

TABLE 1

SUGGESTED MAINTENANCE FEEDING WITH NITROGEN SOURCES

	Actual N per Acre per Application x No. Applications		
Relative Rate of Use	All Soluble, lb	1/2 Org. or UF, lb	All Org. or UF, lb
Light	20 x 2	60 x 1	80 x 1
Medium	40 x 2	80[1] x 2	160 x 1
Heavy	80 x 2	100 x 2	240 x 1

[1]Equal to 500 lb of 16-8-8, or its equivalent.

CONCLUSIONS

Grass grown on properly limed and fertilized soils reduces erosion, develops a sod quicker and can crowd out weeds. It will be longer lived and can carry a heavier load without breaking down, under emergency traffic use, as well as recover more rapidly from traffic effects.

ACKNOWLEDGMENTS

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Discussion

Iurka: Do you have studies on the economics of using fertilizers?

Daniel: Of course, ureaforms cost more. The urea combined with formaldehyde means two chemicals involved, plus manufacturing. Likewise, organic forms of nitrogen cost more per pound of available nitrogen. However, all the major companies now incorporate one or the other in their better turf fertilizers, and thanks to these we are recommending much higher rates of nitrogen fertilizer for continued growth than considered favorable previously.

Deakin: Can you tell sometime about hydrated lime versus ground lime? How should they be used and where?

Daniel: Hydrated lime requires only three-fourths as many pounds as ground limestone. When hydrated lime is used in hydro-spreaders other products should not be mixed in the same tank. However, application can be made to the surface soil in sequence immediately. Even where lime need is well established, soil tests are recommended prior to lime use. As an alternate potash fertilizer and lime should be applied based on the most needy soil in the area under contract.

Rabbitt: Is there any advantage in applying fertilizer in two applications by discing in the P and K first and then adding the N later?

Daniel: Using a complete fertilizer will accomplish equal benefit for the available phosphorus in the soil solution will be adequate, even with surface applications, to maintain adequate growth. Actually nitrogen need is so much greater than phosphorus and potash that we are cautious to be sure it is included in adequate quantity along with phosphorus and potash additions to seedbed.