California Turfgrass Culture
FORMERLY, SOUTHERN CALIFORNIA TURFGRASS CULTURE

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WHAT WE SHOULD KNOW ABOUT NITROGEN FERTILIZERS FOR TURFGRASS

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Nitrogen is one of the 16 elements required by plants and one of the six elements required in large quantities from the soil. Of these six, it is by all odds the element most likely to become deficient in southern California. The other five elements required in large quantities – phosphorus, potassium, calcium, magnesium and sulfur – are often either in good supply in the soil or are present in substantial quantities in irrigation water in southern California.

Undoubtedly, significant amounts of sulfur are also available from the atmosphere near industrial centers. Phosphorus deficient soils are not uncommon but since phosphorus accumulates in soils, it is often present in turfgrass areas which have been receiving phosphorus fertilizers for a number of years. It should not be assumed that one should not be concerned about levels of the five major nutrients other than nitrogen but it must be emphasized that nitrogen levels should be the principal concern of fertilizer programs in turfgrass areas.

Nitrogen is present in igneous rocks to the extent of about 70 to 80 parts per million. Some 10 pounds of combined nitrogen per acre per year is brought down in rainwater. The amount of nitrogen from this source varies considerably. In nature combined nitrogen is made available to higher plants by virtue of the ability of various micro-organisms to utilize gaseous nitrogen which is plentiful in the atmosphere. It has been claimed that some nitrogen is fixed by photochemical reactions with cellulose or other materials but the importance of these proposals awaits evaluation. When nitrogen is utilized by plants or micro-organisms, it is converted into various complex forms which are ultimately returned to the soil and after microbial transformation find their way into the soil humus or well decomposed organic matter. The nitrogen content of soil organic matter is about 5 or 6 per cent and in general about 1 to 2 per cent of this organic nitrogen is mineralized per year. Organic matter is a means of storing nitrogen in non-leachable forms in soils. The process of mineralization of organic nitrogen involves the conversion of complex forms of nitrogen to amines and then to ammonia, nitrites and nitrate by micro-organisms. In most well areated soils nearly all the soluble nitrogen is present as nitrate. Nitrate is not absorbed by soils and thus is subject to leaching. When ammonium fertilizers are added to soils and soil temperature and moisture conditions are favorable, they are usually nearly all converted to nitrate in about 10 days to three weeks. The ammonium ion, while it exists as such, is absorbed by clay and does not leach as readily as does nitrate.

As emphasized above turfgrass areas nearly always respond to fertilizer nitrogen. The quality of turf desired often dictates the amount of nitrogen to be used. In general turfgrass areas can be divided into two groups: the very high quality turf areas such as putting greens where no reasonable expense is spared to maintain quality and the average areas such as lawns, parks, and cemeteries where standards of acceptability are lower and often variable. Suggested nitrogen management programs are discussed below.

Nitrogen fertilizers are available in a wide range of forms whose properties and price are quite variable. Nitrogen in large lots in the common inorganic forms costs from about 20 cents per pound to less than 10 cents per pound. The use of aqua-ammonia, one of the cheapest sources of nitrogen, is not usually convenient on turfgrass. Organic nitrogen sources vary greatly in price but often cost 65 cents per pound of nitrogen or more.

Among the important side effects resulting from the use of nitrogen fertilizers is an effect on the soil reaction or pH. Ammonium fertilizers are acidulating whereas nitrate fertilizers by virtue of the metallic base they supply tend to maintain the soil pH unchanged. The following tabulation indicates the acidulating tendency of various fertilizers.

	Pounds of lime ($CaCO_3$) required to neutralize the acid produced per unit of nitrogen (20 pounds of N.)
Ammonium sulfate	143
Calcium nitrate	8
Urea	71
Milorganite	45

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Thus, if ammonium fertilizers are being used in large quantities care should be taken to prevent the soil from becoming overly acid with prolonged use.

The hazard of a fertilizer burn resulting from an over application is a matter of concern to turfmen. Indeed one of the advantages of the organic fertilizers is the relative safety from a fertilizer burn. Among the soluble nitrogen sources considerable differences exist among them regarding burning hazard from a given nitrogen application. The salinity hazard produced by various fertilizers relative to urea is listed below.

Salinity produced by various fertilizers relative to urea (comparable N basis).

Urea	1.0
Ammonium nitrate	1.9
Ammonium sulfate	2.0
Calcium nitrate	2.4

As indicated in the above tabulation about twice as much nitrogen can be applied safely from urea as from ammonium nitrate or ammonium sulfate.

Organic sources of nitrogen are valued for turf for several reasons:

1. There is a large safety factor against burn which might result from over-application. 2. The mineralization of the nitrogen requires several days to weeks and hence the tendency for large flushes of growth resulting from large quantities of available nitrogen is reduced. 3. The nitrogen supply tends to last somewhat longer, and 4. Extensive use of some materials such as sewage sludge for prolonged periods under many conditions has been generally very satisfactory.

Most organic nitrogen fertilizers do not yield nitrogen in large quantities for as long a period as is commonly believed. Figure 1 from Clark, Gaddy and Jacob* shows that in general the bulk of the nitrogen which would become available in 31/2 months from organic sources is released during a three week period under favorable conditions and secondly that about one half or more may not be mineralized at all in the 3 1/2 month period. 0.J. Noer** found that about 36% of the nitrogen in activated sewage sludge was released in a 9 week period.

Within the last five years the use of urea formaldehyde for turfgrass has received much publicity. This material is a synthetic fertilizer which combines many of the favorable characteristics of the natural organic sources. Figures 2 and 3 taken from data by Arimeger et al.‡ show the recovery of nitrogen and growth of perennial ryegrass on plots fertilized with 100 pounds per acre of nitrogen from three sources as compared to control plots not receiving nitrogen. Attention is called to the general similarity between the curves in the two figures. It is apparent, as one would expect, that the availability of urea exceeds that of Milorganite and a flush of growth results. Milorganite, on the other hand, has high immediate availability as compared to urea -formaldehyde. This is well corroborated by field observations with U-F materials which often give a disappointing response when applied at rates of two pounds of nitrogen per 1000 square feet. The longer lasting effects of urea-formaldehyde as compared to Milorganite are clearly demonstrated in both Figure 2 and 3. These and other data not discussed indicate the maximum rate of mineralization of Milorganite occurs during the first three weeks under favorable circumstances while the maximum rate of mineralization of urea-formaldehyde probably occurs during the second to the fifth week. Figure 2 suggests that the absolute release of nitrogen from Milorganite and urea-formaldehyde in the period from the 4th to 7th week after application are about equal and thereafter the release from U-F is greater. It should be borne in mind that the data presented in Figure 2 and 3 are in relation to a control which was nitrogen deficient. It should not be necessarily implied that a single application of urea-formaldehyde will supply ample nitrogen for four months, for example.

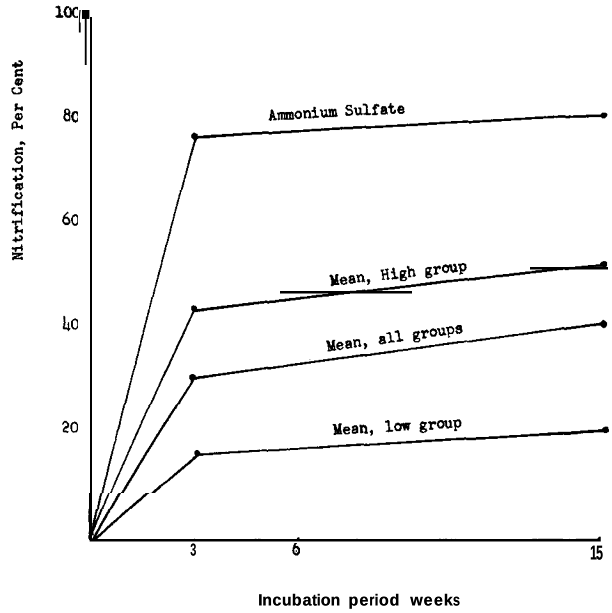

Figure 1

NITRIFICATION OF AMMONIUM SULFATE AND SAMPLES OF WATER INSOLUABLE NITROGEN FROM VARIOUS ORGANIC FERTILIZERS.

Agronomy Jour. 43:57-61. 1951.

*** Jour. Amer. Soc. Agron. 18:953-962. 1926*

‡ *Jour. Amer. Soc. of Agron. 40:342-356. 1948.*

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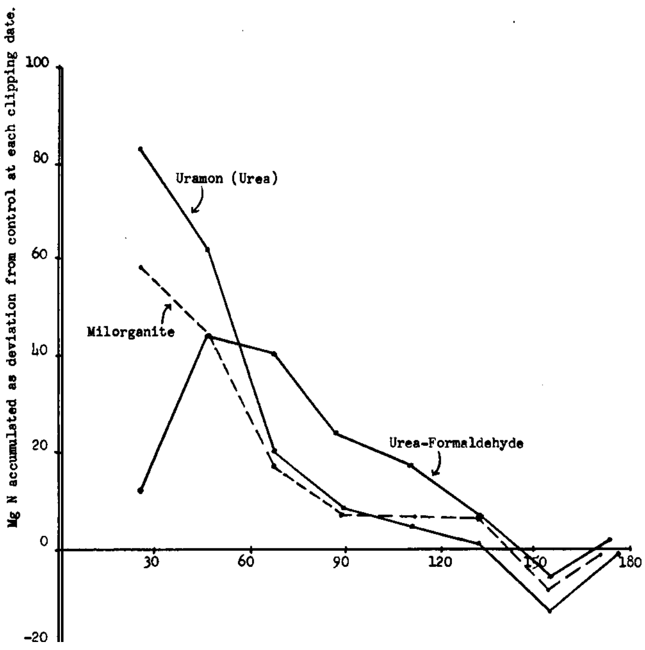

Figure 2

RECOVERY OF N BY PERENNIAL RYEGRASS FROM THREE SOURCES. NITROGEN WAS APPLIED TO SOIL SURFACE AT THE RATE OF 100 POUNDS PER ACRE. (Recalculated from Table 5, Armiger, et al.)

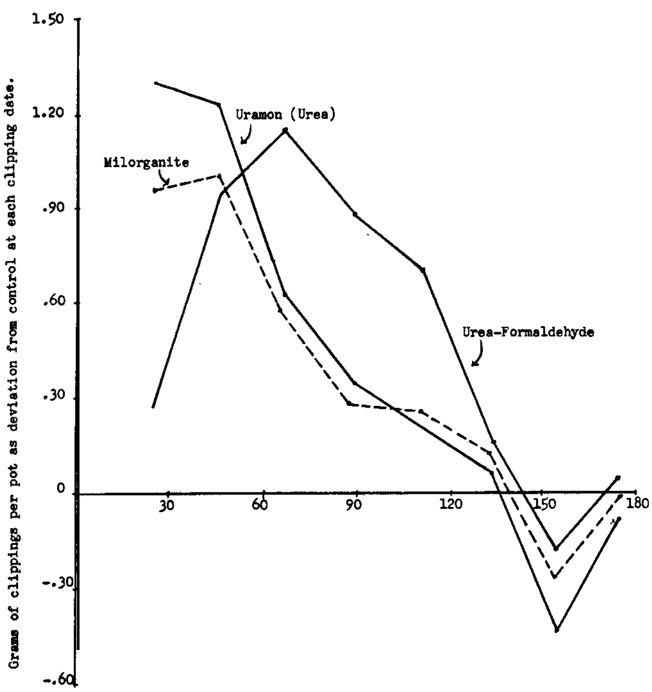

Figure 3

CLIPPINGS OF PERENNIAL RYEGRASS REMOVED PER POT FROM THREE N SOURCES AS COMPARED TO CONTROL NOT RECEIVING NITROGEN (Recalculated from Table 5, Armiger, et al.)

Before discussing the most advantageous ways in which nitrogen materials of immediate, intermediate and slow availability can be used on turfgrass, additional data on the availability of nitrogen from "residual" U-F is desirable. "Residual" nitrogen is arbitrarily defined as that not mineralized under favorable conditions during approximately a 6 week period. Figure 4† shows the relationship between insoluble "residual" nitrogen from U-F and yield of corn. The soil nitrogen was essentially all derived from applications of Urea-formaldehyde made seven or more weeks prior to the study and subsequently leached several times before cropping to corn. The significant point is that the amount of growth was closely related to the amount of "residual" nitrogen in the soil derived from U-F. In other words, if sufficient "residual" nitrogen from U-F is present in the soil, an adequate and relatively uniform and prolonged supply of nitrogen could be expected to be mineralized.

The response of grasses to nitrogen fertilization is complex and not yet fully understood. Troughton†† summarizing this subject says: "In general, it appears

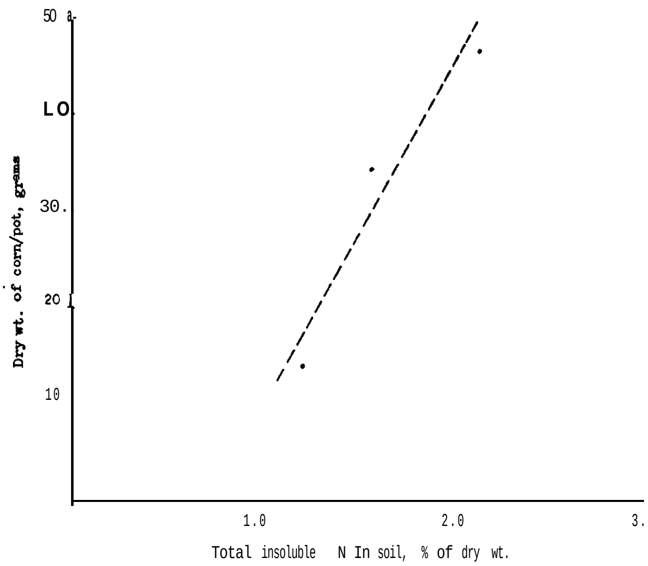

Figure 4

RELATIONSHIP BETWEEN YIELD OF CORN AND TOTAL INSOLUBLE NITROGEN IN SOIL. THE NITROGEN IN SOIL WAS DERIVED FROM "URAMITE" WHICH HAD BEEN APPLIED 7 WEEKS PRIOR. DURING THIS INTERVAL THE SOIL HAD BEEN THOROUGHLY LEACHED SEVERAL TIMES.

† *Unpublished data from Thomas G. Byrne, UCLA.*

†† *Troughton, Arthur. 1957. The underground Organs of Herbage Grasses. Bull. No. 44. Commonwealth Bureau of Pastures and Field Crops. Commonwealth Agriculture Bureau, Farnham Royal, Bucks, England.*

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that plants grown in conditions where available nitrogen was a factor limiting growth have a well developed root system but a poorly developed shoot system. Plants grown with an excess of nitrogen exhibit the opposite relative development." In as much as the roots of grass are the principal organs of food storage by the plant turfgrass research workers generally agree that large flushes of growth produced by heavy fertilization which result in a wide shoot: root ratio ate not desirable. Thus, a steady and moderate supply of nitrogen to turfgrass is generally considered to constitute the ideal fertilizer program.

The optimum temperatures for the growth of grass varies greatly. A critical discussion of literature on temperature and nutrition is beyond the scope of this discussion. In southern California where mixtures of cool and warm season grasses ate grown in the temperate regions near the coast, year round fertilization is desirable. In areas where warm season grasses such as bermuda are grown, late fall fertilization is desirable since this often extends considerably the period the grass remains green.

Regarding programs with different fertilizer materials for highest quality turf such as putting greens, optimum programs with immediately available fertilizers require frequent, light applications. The plots at Virginia Country Club indicate that three quarters of a pound of nitrogen per 1000 square feet every two weeks is desirable. Observations extending over several years time are desirable however to ascertain possible long-term effects. A material of intermediate availability such as Milorganite greatly minimize the possibility of an undesirably large flush of growth from an over application of nitrogen. Continued use of Milorganite gradually builds up small reserves of residual nitrogen so that a somewhat longer carry-over can be demonstrated as compared to plots on which soluble nitrogen had been used. However, the lasting ability of Milorganite is not sufficiently greater than soluble sources so that the periods between applications can be markedly extended. On putting greens the frequency of application of Milorganite should be every three to five weeks at rates which would supply 18 to 24 pounds of nitrogen per 1000 square feet per year.

The Urea-formaldehyde materials ate not all alike in their relative nitrogen availability. However, on the basis of laboratory and small plot work it appears that the longer lasting of these materials offer the possibility of relatively infrequent fertilization while supplying nitrogen at a relatively steady rate. Perhaps three months between applications is a reasonable frequency of application. It would appear that such a program would be successful only after building up the reserve of "residual" nitrogen in the soil by relatively heavy and frequent applications for a period of nine months or a year. Thus monthly applications of about 4 pounds of nitrogen per 1000 square feet for about nine months should preceed a gradual lengthening of the interval between applications to about three months. Presumably, total application rates should be about 24 pounds of nitrogen per 1000 square feet per year after the initial "build-up" period is completed.

The principal drawback to the practice of frequent light fertilization of putting greens and other high quality turfgrass areas has been the labor cost involved. This can be circumvented by the use of devices which apply fertilizers in the irrigation water. Those who are thinking ahead to automatic or semi-automatic irrigation of greens might also give consideration to installation of equipment which will also permit fertilization in the irrigation water. At the present time most greens are hand-watered. The author has seen an inexpensive, simple Venturi asperator used effectively for applying either soluble or solid (in suspension) fertilizers to greens that are hand-watered. The apparatus consisted of a thirty gallon steel drum with simple plumbing connections which permit the attachment of a hose for filling the tank and an outlet to which a hose could be attached. A three-quarter inch Venturi asperator is attached in the main flow line for withdrawing the solution or suspension from the tank. A schematic representation of the apparatus is shown in Figure 5. In use, the quantity of fertilizer to be applied to a green is placed in the drum, water introduced and the material applied during the hand-watering of the green. The empty drum is easily transported from one location to another.

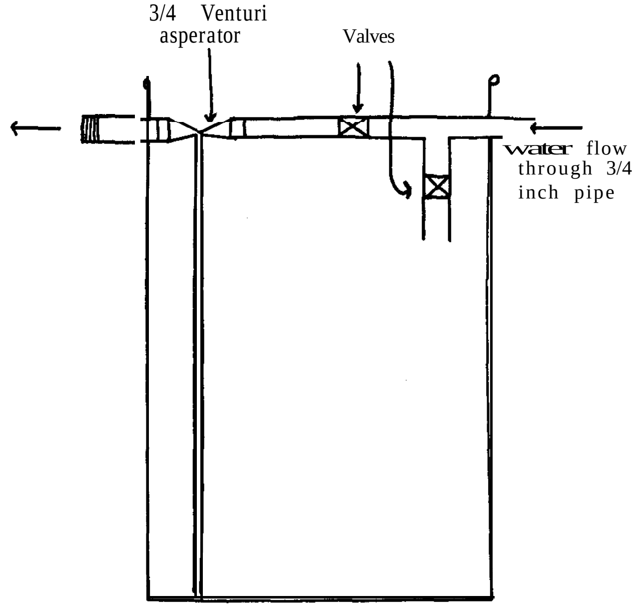

Figure 5

SCHEMATIC REPRESENTATION OF ARRANGEMENT OF A STEEL DRUM WITH PLUMBING ATTACHMENTS FOR OPERATING A VENTURI ASPERATOR TO APPLYING FERTILIZER ON SMALL AREAS.

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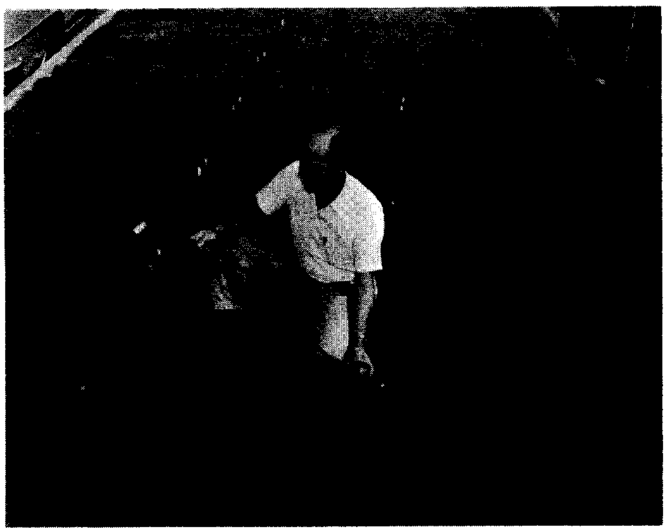
Fertilization of turfgrass areas that are not so highly groomed as putting greens is not so demanding and the fertilization program to be followed is often dictated by the quality of turfgrass desired. Since'the greater the nitrogen application the greater the mowing required, this expense should also be considered in setting up a program. Thus, for parks, cemeteries, lawns, etc., only very general suggestions will be made regarding nitrogen fertilization programs.

On home lawns and similar areas 6 to 8 pounds of nitrogen per 1000 square feet per year will produce turfgrass of average quality. Applications should be made about every six weeks throughout the year in southern California. In areas where warm season grass are used alone and where the grass becomes dormant in winter, fertilization need not be made when grass is completely dormant. Fall fertilization and early spring fertilization often shortens the dormant period.

On larger recreation turfgrass areas or cemeteries fertilization practices again will vary considerably depending on requirements and economic considerations. The application of 35 pounds of nitrogen per acre in March, again in June or July and again during the first 15 days of October is suggested as a sample program. On large scale applications price and application convenience are important considerations.

Summary

The properties of various fertilizer materials in relation to turfgrass fertilization are discussed and several sample programs are suggested.



0. R. LUNT

RECOMMENDATIONS REVISED FOR TURFGRASS AND DICHONDRA PESTS IN SOUTHERN CALIFORNIA

Southern California Turfgrass Culture
Volume 9, Number 2, April, 1959

Experimental work at the end of 1959 indicates revision of the recommendations for control of lawn moths and cutworms on page 13.

LAWN MOTHS:

Increase dosage of D.D.T., chlordane or toxaphene sprays to 3 oz. of actual insecticide per 1000 feet.

Delete Aldrin, dieldrin and heptachlor sprays.

CUTWORMS:

Increase dosage of D.D.T. or toxaphene sprays to 4 oz. of actual insecticide per 1000 square feet.

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HOW TO FIGURE YOUR FERTILIZER COSTS

Richard G. Maire

University of California Agricultural Extension Service

The program states that I'm to cover the problem of "How to Figure Your Costs." After delving into the subject, it became more and more difficult to arrive at any average or normal situation to base figures upon. It is impossible to give any specific recommendations – each golf course, park, or cemetery has its own peculiarities in relation to the many variables that enter into good turf management. As a result, since each of you are familiar with your own particular set of conditions, we will briefly discuss how to compute the cost of various fertilizer materials, and you can take it from there according to what you feel your individual needs require.

To begin with, let us first determine the cost of N, P_2O_5, and K_2O in fertilizer containing only one element – and in this way find our cheapest form of each.

Let us start with ammonium sulphate. As you all know, it carries a guaranteed analysis of 21% N. Cost will vary, but the average runs $57/tori, and in 20 ton or truckload lots approximately $54/tori. Twenty-one percent N of course means we have 21 pounds available N/100 pounds material, giving us 420 pounds N/ton. Figuring a ton at the $54 price, our N in ammonium sulphate would cost us 12.8 cents per pound.

Taking the cheapest form of phosphorus, which would be treble super, with an analysis of 45% phosphorus and an approximate cost of $86.50/ton by truck load, our phosphorus would cost us 9.6¢ per pound.

Figuring the same for potash, muriate of potash being the cheapest form with an analysis varying from 60-63% K_2O, at a cost of $5O/ton by truck load, our K_2O would cost us about 4¢/pound.

MIXED FERTILIZERS

Many of you find it more convenient to use a mixed fertilizer. It is only natural that our materials will cost more in this form because of the cost of preparing a mix by the manufacturer. It is a little more difficult to figure the cost of the various elements in a mix because of the added advantages – reduction in application cost due to all elements being applied in one application, and conditioning materials present supplying other plant foods, such as Ca, Mg, Fe, S, etc. These advantages have an intangible value which is hard to estimate in dollars and cents.

Taking only our three major elements into consideration, the following procedure can be used to compute the cost of each element.

Let us take a 10-10-5 mix. This means we have 10 pounds of N, 10 pounds of P_2O_5, and 5 pounds of K_2O per 100 pounds of material. To get cost per pound of N, we must first figure cost per pound disregarding the other elements. 10-10-15 costs approximately $61/ton, which means our N would cost 30½¢ per pound. However, to get a true value, we must figure the value of K_2O and P_2O_5 and subtract these values from the cost of the N.

Using the cost of P_2O_5 per pound in treble super as our value of the phosphorus in 10-10-5 mix, we would have a 1-1-1/2 ratio of N, P_2O_5, and K_2O which means .096¢ and 2¢ should be subtracted from the cost of N alone, giving us a true value of the N in a 10-10-5 mix at approximately 19¢ per pound. The same procedure should be used to determine P_2O_5 and K_2O.

ORGANICS

When you start figuring your cost of elements in the urea type fertilizers or the organic fertilizers, you will find your cost per pound of elements is considerably higher than your simple form or even your mixes. If N, P and K were the whole story, it would be simple to determine a program, but so many intangible values figure into the use of organic fertilizers that it is up to you as a turf manager to determine if the added cost per element is compensated by other values to warrant its use.

Advantages of organic fertilizers include several factors. The lower number of applications and elimination of the necessity of watering in of the material save many hours of labor. The residual effects of organics give longer lasting benefits. Organics reduce the danger of damage from the burning to a minimum, and there is value in the organic material incorporated in the soil. All these things are difficult to evaluate exactly, but we know the value is there. Each turf manager must weigh these factors, and adopt a program most efficient, economical, and practical to meet his needs.

APPLICATION OF FERTILIZER IN IRRIGATION WATER

The use of proportioners or injectors to apply fertilizer through irrigation water is a practice that is becoming more common all the time. Liquid feeding on golf greens particularly has great possibilities. It gives better control – more frequency of applications, more uniform distribution, and the cost of distributing dry is eliminated.

The fertilizer that you use must be determined by the conditions which exist in your particular situation.

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**Part of a talk presented at the 1959 Southern California Turfgrass Institute.*

University of California
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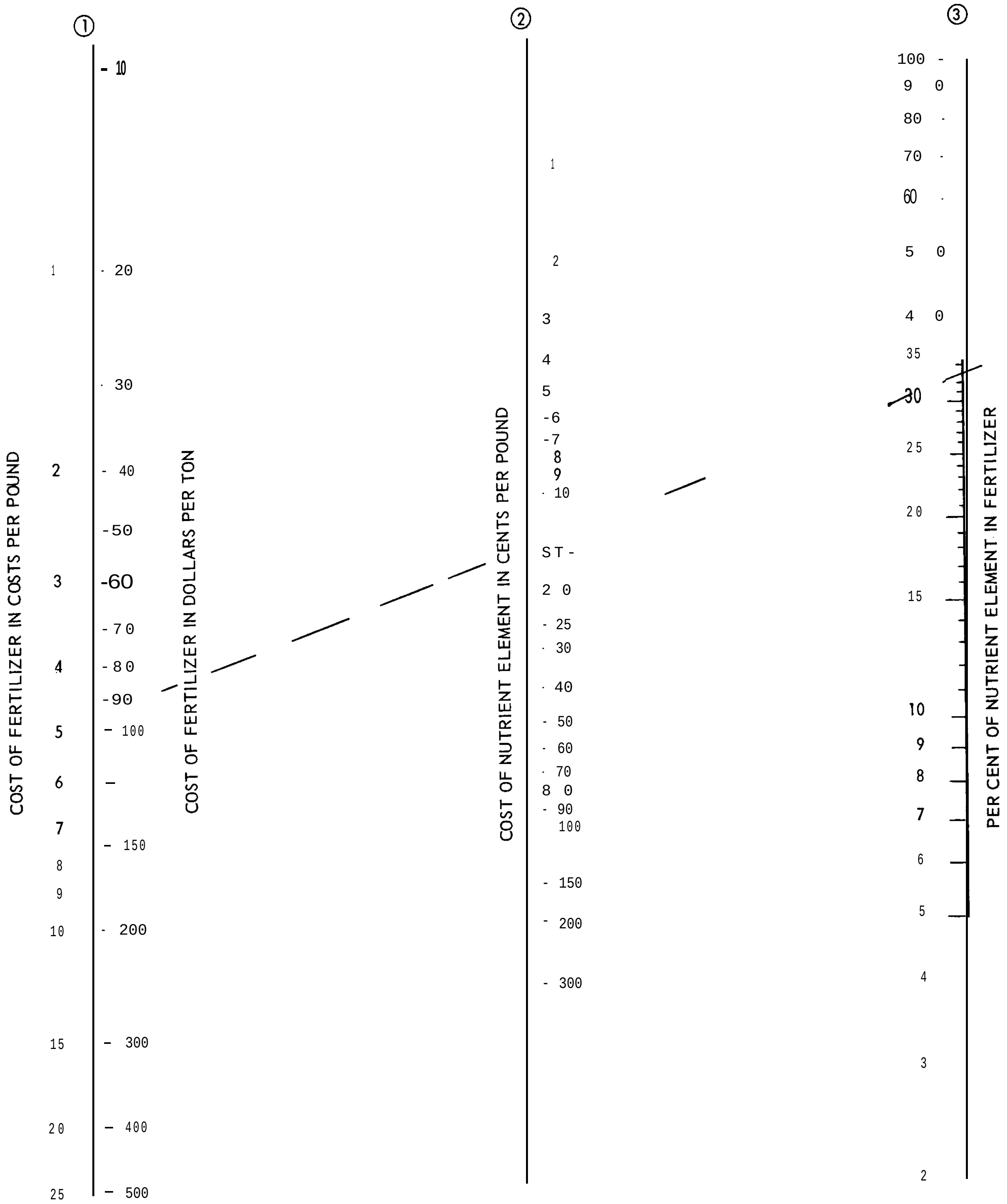
Los Angeles County

COST PER UNIT OF NUTRIENT ELEMENT



In order to calculate the cost per pound of nutrient element, it is necessary to know the cost per ton (or per pound) of the fertilizer to be used and the per cent of nutrient element in the fertilizer. Example: Compare cost per unit of nitrogen for ammonium nitrate 33% at $95 per ton and ammonium sulfate at 21% and $80 per ton. Locate $95 per ton on Scale 1 and 33% on Scale 3. Connect these values. Answer read on Scale 2 is 14.4 cents per pound. Locate $80 per ton on Scale 1 and 21% on Scale 3. Connect these values. Answer read on Scale 2 is 19 cents per pound. Wayne C. Morgan, Farm Advisor.

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The simple material containing any one element are the cheapest source dollar-wise of your three major elements. However, remember this is only part of the story. You can use these costs as a springboard to determine the advisability of paying more for N or P_2O_5, plus get the value of the other intangible features of the mixed and organic fertilizers. I'm certain I have not presented anything new or startling to most of you here, but I hope maybe it will help you to evaluate your own operations and determine if you are using the most efficient, economical and practical practices for your turf area.

NEW DICHONDRA PUBLICATION

A new University of California Agricultural Extension Service Publication, Dichondra as a Ground Cover, is now available. The folder, written by M.H. Kimball and V.B. Youngner, covers planting, management, weed control and disease and insect control. It may be obtained by writing to your local Agricultural Extension Service (Farm Advisor's office).

NEWPORT KENTUCKY BLUEGRASS

The recent introduction of the Newport Strain of Kentucky bluegrass has created much interest in the turfgrass industry. Many inquiries have been received by the Department of Floriculture and Ornamental Horticulture about this new variety.

The place that Newport Kentucky bluegrass may take in turfgrass culture will be known only after a number of years of actual use. Observations of test plots at UCLA for approximately three years have shown this strain to have the following characteristics: The color is a deep blue-green approaching that of Merion Kentucky bluegrass. Growth habit is more upright than Merion but not as much so as common Kentucky bluegrass. Germination time is about the same as Kentucky but full density of turf appears to be achieved in a shorter period. It has a high resistance but not immunity to rust disease which is severe on Merion.

It is believed but not completely proven as yet that Newport is more heat tolerant and mote presistent in California than other strains. The fact that bluegrass is not well adapted to much of Central and Southern California must be kept in mind. There is no indication that Newport will form a permanent turf in this area but it may last one or two years longer than other strains with the possible exception of Merion. Newport is very uniform in color, texture and growth habit presumably because of a high percentage of apomictically developed seed.

The original parent plant of Newport was collected near Newport, Oregon in 1944 by W.E. Lawrence of the Carnegie Institute of Washington. After years devoted to further selection, testing and seed increase, the strain was introduced in 1958.

Newport Kentucky bluegrass appears to be a valuable new turfgrass variety for use wherever bluegrass is adapted.