California Turfgrass Culture

FORMERLY, SOUTHERN CALIFORNIA TURFGRASS CULTURE

VOL. 17 - NO. 1 JANUARY 1967

Water Requirements as a Function of Clipping Height and Frequency

J. R. Watson [1]

Water requirement is customarily defined as the pounds of water required to produce a pound of dry matter. Such a definition takes into account the influence of a number of factors, including species, fertility, aeration and evapotranspiration.

There is, unfortunately, a paucity of documented information dealing with water requirements as affected by clipping height and frequency. It seems likely that evaporation and transpiration will be greater on a closely clipped turfgrass area such as a putting green. If such is the case, then water requirements will be affected by clipping height and frequency.

Although there may be little information dealing with water requirements as affected by clipping height and frequency, there is information to show that clipping height has a direct effect on root development. Juska and associates at Michigan State and at Beltsville, Maryland; Davis at Ohio; and Madison at the University of California all have shown there is a reduction in toot growth as a result of decreasing heights of cut. This, obviously, has a direct effect on watering practices. In addition, watering practices - frequency, rate of application and amount - on turfgrass areas are a function of a number of factors, including the kind of grass, the soil, climate (length of growing season, distribution and amount of rainfall and evapotranspiration), the degree of growth and color required to meet the demands of play or other use, the capacity of the irrigation system, and the availability of labor.

Pertinent to a discussion of watering practices as a function of clipping height and frequency is a shortreview of the role of water in plant growth, of the influence of soil properties on root growth and the effect of mowing on grasses.

WATER and PLANT GROWTH

Water is essential to plant growth and activity, and is involved either directly or indirectly in all phases of the care and management of turfgrass. Necessary for germination, cellular development, tissue growth, food manufacture (photosynthesis), temperature control and resistance to pressure, water acts both as a solvent and as a carrier of plant food materials. Nutrients dissolved in the soil are taken in through the roots and then carried to all parts of the grass plant in water as is the food manufactured in the leaves.

Water transpired by the leaves serves as a temperature regulator for the plant, and water within the cells of the grass leaves may help counteract the effects of traffic. Plant cells filled with water are said to be turgid, a condition that helps leaves resist foot and vehicular traffic. Damage may result when pressure is applied to grass in a state of wilt, a condition that exists when cells do not contain enough water and are said to be flaccid.

MOWING PRACTICES

First, good mowing practices are one of the more important factors contributing to appearance - especially a well-groomed appearance - of any turfgrass area.

Secondly, because of the regularity of the mowing process, grass cutting is the major time-consuming operation in the maintenance program.

Third, the manner in which turfgrass is mowed will greatly influence its health, vigor, density, degree of weed invasion and longevity. Since mowing is one of the factors limiting or controlling the adaptability or suitability of a given grass for turf-purposes, and, since mowing practices must conform to the specific demands created by the use for which the turf is grown, it becomes one of the major management concerns of the turfgrass supervisor.

To be suitable for turf production, a grass plant must be able to grow and persist in its environment and to stand up to the demands made on it by golfers, players or other users. Unless a grass is able to survive under these demands, it must be replaced, or maintenance practices must be modified. Otherwise, use must be restricted.

CONTINUED

[1] Director, Agronomy Division, Toro Manufacturing Corporation, Minneapolis, Minnesota.

For those concerned with the production of turfgrass, restriction of use always should be considered a last resort. The primary objective of the supervisor and grower is to produce high quality turfgrass suitable for use or play, irrespective of environmental adversity.

More often than not, practices which are desirable for good grass growth have to be modified extensively to meet turfgrass requirements for use ot play.

Management practices, including mowing, severely limit the number of grasses that may be used to produce satisfactory turfgrass. Only a few (25 - 30) out of the more than 1100 species known to grow in the United States qualify. Consequently, growth habits and characteristics are important considerations in the selection of a grass for turf purposes.

GROWTH HABITS AND CHARACTERISTICS OF GRASS

On the basis of growth type, grasses may be classified into three general groups. Bunch-type grasses, such as ryegrass and chewings fescue, produce new shoots which grow inside the sheaths of the previous stem growth. Stoloniferous grasses, such as bentgtass, spread by runners ot stolons which develop from shoots that push through the sheath and run along the surface of the ground, rooting at the nodes (joints). Kentucky bluegrass, a rhizomatous type of grass, develops shoots at the underground nodes. Some grasses, such as bermudagrass and zoysiagrass, spread by both rhizomes and stolons. There ate also intermediate types with decumbent stems which root at the nodes, such as crabgrass and nimblewill.

The grass leaf, because of its shape, intercepts a maximum of the sunlight essential for photosynthesis (food manufacture). A reduction in the plant leaf area exposed to sunlight reduces the plant's capacity to carry on this vital function.

The ability of grasses to withstand frequent and relatively close cutting is related to certain peculiarities of the grass family. Grasses exhibit basal growth, as opposed to terminal growth found in most other plants. Basal growth means simply that growth initiates at the base rather than at the tip of the blade or stem. From a practical standpoint, this means that normal and frequent mowing does not cut off the growing areas of the grass leaf. Removal of too much leaf surface at any one cutting may, however, destroy some of the growing points. For this reason, as well as for appearance's sake, grass should be mowed often enough so that never more than one-third (1/3) of the leaf surface need be removed at any one clipping.

To compensate for the reduction in root growth produced ot caused by clipping, soil environment and management practices – fertilizing, watering, cultivating and programs of disease, insect and weed control – must be balanced one against the other and applied more intensively and with greater care. Development and maintenance of good soil properties is essential to satisfactory production of turfgrass.

SOIL PROPERTIES AND ROOT GROWTH

Soil as the medium for turfgrass growth must provide support for the plant, serve as a storehouse for nutrients, supply oxygen, and act as a reservoir for moisture. The texture (size of soil particle), structure (arrangement of soil particles), and porosity (percentages of soil volume not occupied by solid particles) of a soil are the basic physical factors which control the movement of water into the soil (infiltration), through the soil (percolation) and out of the soil (drainage). Texture, sttuctute and porosity, along with organic matter content, determine the water-holding capacity and control the air-water relationships of the soil; hence, have a direct influence on root growth and development.

TEXTURE

Texture is a most important characteristic of soils because it describes, in part, the physical qualities with respect to porosity, coarseness or fineness of the soil, soil aeration, speed of water movement in the soil, moisture storage capacity and, in a general way, the inherent fertility of the soil. Sandy soils are often loose, porous, droughty and low in fertility; whereas, clay soils may be hard when dry or plastic when wet and poorly aerated, but high in moisture retention and possibility high in fertility.

Clays have a higher total porosity than sands. Clays have a large number of small pores which contribute to a high water-holding capacity and slow drainage. Sands, on the other hand, have a small number of small pores with, therefore, a low water-holding capacity and rapid drainage.

Compaction of soil refers to a condition in which aggregation is reduced or absent; the soil is dense, the number of large pores reduced. Degree of compaction at or near the surface is of special importance as far as movement of water into the soil is concerned. A thin layer of compacted soil materially reduces the rate of infiltration. Fortunately, since most of the compaction on turfgrass areas occurs within the upper two-inch layer of soil, the condition may be temporarily alleviated mechanically.

Drainage, or the removal of excess water from a soil, is of two types – surface and internal. Surface drainage is accomplished through grading and contouring of surface areas. Internal drainage is a function of the physical soil properties and has an important bearing on root growth and development. On most turfgrass areas, one is usually able to apply water if soil moisture becomes limiting. During periods of heavy rainfall, in too many cases, rapid percolation with subsequent removal of the excess water does not take place. This is particularly true of many green and tee areas. Unless soils are adequately drained, many problems associated with saturated soils will arise.

WATERING PRACTICES

Frequency of water application. Supplemental irrigation is always necessary if turfgrass areas are expected to remain green throughout the growing season. The frequency of irrigation is governed by the water-holding capacity of the soil and the rate at which the available water is depleted. For the most vigorous and healthy growth, watering should begin when approximately 40 to 60 percent of the available water has been depleted. Most plants show a marked growth response when soil moisture is maintained between this level and field capacity. Assuming equal depth of rooting, sandy type soils will have to be watered more frequently than will loams or clays. Climatic conditions, such as high wind movement, intense sunlight, low humidity and temperatures, all contribute to high water-use rates.

The amount of water to apply at any one time will depend upon how much is present in the soil when irrigation is started, the water-holding capacity and the drainage characteristics of the soil. Enough water should be applied to insure that the entire root zone will be wetted. Too, on natural soils (as opposed to those modified for intensive use), sufficient water should be applied to maintain contact with sub-soil moisture and to assure percolation, especially in arid and semi-arid regions. Continuous contact between the upper and lower levels of moisture will avoid a dry layer through which roots cannot penetrate. Application of too much water at one time is serious when the soil is poorly drained and the excess cannot be removed within a reasonable period of time.

Water should never be applied at a rate faster than it can be absorbed by the soil. Sprinklers that do not adequately disperse water, or sprinklers that deliver a large volume of water within a concentrated area, cause surface runoff. Whenever water is applied at a rate faster than it can be absorbed by a given soil, the water is being wasted. The sound watering program calls for sprinklers that apply moisture slowly enough to permit ready absorption. To improve materially the infiltration tate of water, conditions, such as compaction, should be corrected by cultivation (aerification) or spiking.

Once surface runoff is evident, sprinklers should be turned off. If the soil has not been wet to the desired depth – this may be determined by probing and examining the depth of penetration – then the sprinklers may be turned on again at the end of 30 minutes to an hour, depending on the permeability of the soil.

In summary, water practices are a function of clipping height and frequency because of the relationship between clipping height and root development.

To use water properly requires an understanding of the fundamental role water plays in plant growth; of the effects climate and weather have on growth rates, how they influence water-use rates and choice of grass. Good watering practices demand a knowledge of the basic physical and chemical soil properties, how they effect watet absorption, storage and drainage as well as the frequency, rate and manner in which water must be applied. Further, proper use of water means correlating such basic information with the requirements for play, and programming a watering schedule to fit the existing irrigation facilities so as to make the most efficient use of them and the available labor force.

BIBLIOGRAPHY

1. *BEARD, JAMES B. and DANIEL, WILLIAM H., "Effect of Temperature and Cutting on the Growth of Creeping Bentgrass (Agrostis palustris Huds. Roots", Agronomy Journal, May-June, 1965.*

2. *DAVIS, R. R., "The Effect of Other Species and Mowing Height on Persistence of Lawn Grasses". Agronomy Journal, November, 1958.*

3. *HAGAN, ROBERT M., "Water Requirements of Turfgrasses", Proceedings of the Eighth Annual- Texas Turfgrass Conference, January 18 – 20, 1954.*

4. *JUSKA, F. V., and HANSON, A. A., "Effects of Interval and Height of Mowing on Growth of Merion and Common Kentucky Bluegrass (Poa pratensis L.)", Agronomy Journal, November-December, 1961.*

5. *JUSKA, F. V.. TYSON, J., and HARRISON, C. M., "The Competitive Relationship of Merion Bluegrass as Influenced by Various Mixtures, Cutting Heights, and Levels of Nitrogen", Agronomy Journal, November, 1955.*

6. *MADISON, JOHN H., "Mowing of Turfgrass, 11. Responses of Three Species of Grass", Agronomy Journal, May-June, 1962.*

7. *McBEE, GEORGE G., "Effects of Mowing Heights on Texture of Bermudagrass* Turf", *Texas A &M University, Department of Soil and Crop Science Technical Report No. 10, 1966.*

8. *MORGAN, WAYNE C., "New Irrigation and Aerification Methods': California Turfgrass Culture, April, 1965.*

9. *PRUITT, W. O., "Evapotranspiration – A Guide to Irrigation", California Turfgrass Culture, October, 1964.*

10. *RICHARDS, S. J. and WEEKS, L. V., "Evapotranspiration for Turf Measured with Automatic Irrigation Equipment", California Turfgrass Culture, July, 1963.*

Response of Plants to Their Environment

Victor B. Youngner
University of California, Riverside

Plants, in fact all living organisms, respond to their environment in many ways. In a sense every change occurring in the life of a plant is a response to environment. Factors such as light, temperature, moisture, nutrients and many more, act upon the hereditary background of the plant to induce specific responses. All plants do not react in the same way to the same set of environmental conditions. Species and varieties or even individual plants of a variety will often react quite differently.

During the millions of years since plants appeared on the earth many evolutionary changes within the plant kingdom have taken place. These changes arose through heritable variations resulting from mutations, gene recombination, interspecific hybridization and polyploidy. Some few of these variations were advantageous, permitting the plants carrying them to grow and reproduce themselves better than others under the environment in which they were found. These plants multiplied and soon became dominant. Many variations were not favorable to survival and reproduction. Such variations were eventually eliminated from a population as plants carrying them produced few or no progeny. This, in simple terms, is natural selection; a selection among individuals for the ability to reproduce themselves.

It is through this process that our higher plants have arisen and our numerous genera, species and varieties developed during the history of life on this earth. It is in this manner that our warm season and cool season grasses have come into being. Natural selection should not be thought of as a process which occurred in the past only and has now ended, for it is a dynamic one still taking place today. Man, however, consciously and unconsciously complicates this simple picture by selecting or propagating many variants which in nature would not survive. The plant breeder selects naturally occurring heritable changes or manipulates his material by hybridization ot induction of mutations and polyploidy to produce the changes he desires.

Golf course superintendents, by their turf management practices, may be affecting a natural selection process. For example, Poa annua in greens is a big problem to most superintendents. By frequent close mowing of their greens they are selecting for types of Poa annua peculiarly adapted to those conditions – types which would have poor survival value under most other conditions. These are highly perennial, dense prostrate, sparse flowering and sometimes sterile strains. A single plant of this type may spread year after year until it covers many square feet of area. The perennial nature and prostrate growth habit are advantageous characteristics under these conditions while the low fertility is of little consequence. These strains are not able to compete with the taller-growing heavy-seed producing types in different environments; for example, a fairway, field or orchard, and are rarely found in such places.

Seaside bentgrass, Agrostis palustris, is not a pure strain but is a complex mixture of numerous variants. Golf greens planted to Seaside bentgrass will develop a mottled appearance after a few years. This is caused by single plants, genetically better adapted ***to the*** particular environment of that green, spreading and overcoming other more poorly adapted plants. The dominating individuals will form discrete patches differing from each other in color, leaf width and other characteristics, thus producing the mottling.

Can an individual plant, poorly adapted to conditions in an area, become better adapted after surviving in the area for a few years? For all practical purposes the answer is no. The genotype of the plant will not be changed, hence it cannot become better adapted. There are such adaptations as the hardening of plants to cold by the gradually lowering temperatures in autumn or by changes in nutrition, but these are purely physiological changes in the plant tissue of a temporary nature. Only as we go from generation to generation with the associated recombination of genetic material in each generation can we have any true adaptation; a natural selection of those plants best able to grow and reproduce.

Thus it can be seen that the response of plants to their environment is controlled by the genetic makeup of each individual. The more uniform the genotypes of a population of a species the more alike will be the behavior of all individuals under any given environment.

In modern agriculture many factors of the plant's environment are modified to permit better growth of crops. Such practices as cultivation, irrigation and fertilization are attempts to create a better environment for the crop plants. There are other environmental factors, particularly those of climate, which cannot be easily changed. Species and varieties adapted to a specific climate must be carefully selected for success.

It is well known that all plants have certain minimum, optimum and maximum temperatures for growth. Bermudagrass, Cynodon dactylon, for example, ceases growth at approximately 50° F If exposed constantly to 40-45° F or less and to bright sunlight, bermuda will become dormant and lose its green color. However, if day temperatures are 70-75°F, bermuda will continue to grow even if the temperature at night drops to near freezing. The maximum temperature for bermuda is not known but must be quite high.

Kentucky bluegrass, Poa pratensis, will grow at 40° F or less but will stop growing and become dormant if exposed to approximately 90° F for a prolonged period. The optimum temperature for bluegrass top growth is 70-75°F, but a soil temperature of about 60° F appears most favorable for root growth.

Many plants make their best growth under a rhythm of alternating cool nights and warm days rather than constantly warm days and nights. Seeds of many plants also germinate best with this alternation of temperatures.

Another aspect of the temperature requirement of plants is less well known or understood. This is a need for a certain amount of exposure to cold or chilling. In recent years in southern California many deciduous fruit and shade trees have suffered from a delayed foliation in the spring, resulting in numerous dead twigs and branches and poor fruit production. These trees require winter chilling, exposure to moderately low temperatures for a time during their dormant period, to permit the buds to break in the spring. If there has not been sufficient cold, breaking of buds is delayed, often until well into summer, and many may never open. Years ago when these trees were planted, winters were normally cold enough to promote good foliation. However, Kimball* has shown by study of weather records that the southern California climate has been gradually warming over the past several decades. Frequently now winters are not sufficiently cold to give the trees the chilling they require. The result has been the loss of many fruit, shade and street trees.

Kentucky bluegrass often does not produce a dense vigorous growth in coastal southern California. This poor growth is surprising since temperatures are well within the favorable range for growth during most of the year. In contrast in the Mojave Desert, where summer day temperatures may be very high, bluegrass grows well and persists for years if adequate irrigation water is provided.

Two features of the desert climate different from that of the coastal region may be responsible for superior bluegrass growth in the desert. Diurnal temperature fluctuations are great in the desert but of only a few degrees along the coast. The comparatively cool nights in the desert perhaps have a more important effect on the grass growth than do the hot days. Second, desert winter temperatures are low. Various studies have shown that cold winter temperatures may stimulate better development of new shoots in the spring, resulting in a dense vigorous sod year after year.

The cold winter temperatures may also have the effect of keeping fungus disease levels low, especially when followed by summers of very low humidity.

One other effect of cold winter temperatures of considerable biological and agricultural importance is vernalization. Many cool season grasses; bluegrasses, fescues, bentgrasses and others will not flower and produce seed unless first given sufficient chilling. Within limits, the greater the chilling the greater will be the production of flowering shoots. It is obvious that this reaction is of great importance to anyone producing seeds of these plants. Seed production fields must be located in areas where sufficient cold is assured every year.

On the other hand, someone in the bentgrass stolon production business could reduce production costs by locating fields in areas of mild winters. Few or no seed heads would be produced so labor of removal to prevent contamination would be practically eliminated,

Three aspects of light are important for plant growth and development. These are light intensity, light duration (photoperiod) and light quality (wave length or color). Of these light intensity and photoperiod are most important in practical culture of plants.

The common measures of light intensity are the lux and the foot-candle. One lux is the light intensity received at one meter distance from a standard candle. The foot-candle is the light intensity at one foot from a standard candle. In terms of foot-candles full sunlight will range from 10,000 to 12,000 foot-candles.

Light is the source of energy for photosynthesis, the chemical process by which plants produce carbohydrates from water and air. Most plants have evolved leaf arrangements which can efficiently catch the available sunlight. Individual leaves in full sun may use only 25% or less of the light falling upon them. However, since one leaf may shade another quite high light intensities may be required for maximum photosynthesis by the whole plant.

Grasses require high intensity light for maximum growth and are highly efficient in catching the light available to them. The numerous overlapping leaves in a dense stand of grass will reduce the light reaching the soil surface to very small percent of that at the level of the grass leaves. Often the lower leaves will receive so little light that they turn yellow and eventually die.

Red fescues, Zoysia and St. Augustinegrass will produce a fairly dense turf with a minimum light intensity of 1,500 ft. candles. Bermudagrass will require at least 2,500 to 3,000 ft. candles to produce as dense a growth. These intensities are adequate only at the optimum growing temperatures. At higher temperatures the minimum light intensity will be correspondingly higher.

Day length or photoperiod, the duration of the light period, produces a number of highly important responses in many plants. One of the most important and intensively

*Kimball, M. H., University of California, Los Angeles. Unpublished data.

studied is that of flowering. Some species or varieties flower only when the length of day or photoperiod is greater than a certain number of hours. These are called long-day plants. Others will flower only when the photoperiod is less than a certain critical number of hours. These are the short-day plants. Some plants flower at any day length and are referred to as day-neutral.

The first experiments demonstrating this reaction of plants to photoperiod were performed around 1920. More recent experiments have shown that this is actually a response to the length of the dark period or night. However, since this distinction is primarily of academic interest, the common terms such as day length, long-day, short-day, etc. have been retained.

Some of our popular flowers are short-day plants, for example, chrysanthemums and poinsettias. Chrysanthemums for cut flowers are now produced throughout the year by the simple technique of regulating the day length with artificial lights or black cloth shades as desired.

The Zoysia grasses are also short-day plants, hence produce a stubble-free turf throughout the summer. However, this day length requirement may be one of the reasons for the limited production of seed as warm temperatures are also required for good seed set.

Well-known long-day plants are Kentucky bluegrass, tall fescue, red fescue, bentgrasses and perennial ryegrass. These perennial grasses must have a period of chilling (vernalization) prior to the long days before they will flower well. Some grasses require a sequence of cold temperature, short days and long days, in that order, before flowers will be produced.

Poa annua, annual bluegrass, on the other hand, is a day-neutral plant, hence it flowers throughout the month when temperatures are favorable. This may be one of the most important factors responsible for the worldwide distribution of this species. Bermudagrass also is essentially day neutral, flowering whenever temperatures are satisfactory.

Flowering is not the only response of plants to day length. Most of our grasses increase in vegetative growth with the increase in day length up to a maximum of about 16 hours. At this point growth levels off and at greater day lengths may even decrease. In the grasses we have studied, root growth in respect to day length follows the same pattern as top growth.

One aspect of this growth response of considerable importance is stolon development. Stolon growth on bents, bermuda, zoysia and dichondra is very slight under short days. Not until day lengths exceed approximately 12 hours is there rapid stolon growth. Then the growth rate appears to increase with increasing day length up to 16 to 17 hours. We can take advantage of this response by establishing these grasses in the spring and early summer. The stolon growth rate then will be at a maximum and coverage will be most quickly obtained.

We have discussed here only a few aspects of the many environmental factors affecting plant growth and development. The subject is an extremely complex one involving not only many more factors but the interaction of all of them. We tend to over simplify by saying that a given aspect of plant development is in response to a single specific feature of the environment for example, day length. In truth this is not so for while this feature may be a key factor, the actual plant response may be conditioned and modified by the influence of many other factors.

Fertilizer Material Solubility

The following solubility table will be useful in determining methods and rates of application. This same table will be of help in preparation of starter solutions and foliar sprays. It may be necessary to use hot water to dissolve some of these chemicals.

SECONDARY NUTRIENTS:

Material	Approx. parts Soluble in 100 ports in cold water*
Borax	5
Calcium chloride	60
Copper oxide	insoluble
Copper sulfate	22
Ferrous sulfate	29
Magnesium sulfate	71
Manganese sulfate	105
Sodium chloride	36
Sodium molybdate	56
Zinc sulfate	75

PRIMARY NUTRIENTS:

Materi al	Approx. ports Soluble in 100 parts of cold water*
Ammonium nitrate	118
Ammonium sulfate	71
Calcium cyanamide	decomposes
Calcium nitrate	102
Diammonium phosphate	43
Monoammonium phosphate	23
Nitrate of soda	73
Potassium chloride	35
Potassium nitrate	13
Potassium sulfate	12
Superphosphate, single	2
Superphosphate, treble	4
Urea	78

*A gallon of water weighs about 8-1/3 pounds.

While some forms of fertilizing materials and agricultural minerals are not completely soluble, it has been found that they will move in suspension. One exception to this would be sprinkler irrigation application. Partly soluble material might tend to wear out and possibly clog the jets.

Here is how you use the table:

Example (a) Solubility of ammonium nitrate in water:
8.33 lbs. (weight of 1 gal. water)
118 (parts of ammonium nitrate soluble in 100 parts of water)

$\frac{118}{100}$ 1.18 factor

8.33 x 1.18 = 9.8 lbs. ammonium nitrate in 1 gal. water

Example (b) Solubility of potassium nitrate in water:
8.33 Ibs. (weight of 1 gal. water)
13 (parts of potassium nitrate soluble in water)

$\frac{13}{100}$ = .13 factor

8.33 x .13 = 1.08 lbs. potassium nitrate soluble in 1 gal. water

MAJOR OR MACRONUTRIENTS

Essential elements used in relatively large amounts.

Mostly from Air and Water	From Soil Solids	
Carbon (C)	Nitrogen (N)	Calcium (Ca)
Hydrogen (H)	Phosphorus (P)	Magnesium (Mg)
Oxygen (0)	Potassium (K)	Sulphur (S)

MINOR OR MICRONUTRIENTS

Essential elements used in relatively small amounts.

From Soil Solids	
Iron (Fe)	Copper (Cu)
Zinc (Zn)	Boron (B)
Manganese (Mn)	Chlorine (Cl)
Molybdenum (MO)	

Ordinarily from 94 to 99.5 percent of fresh plant tissue is made up of carbon, hydrogen, and oxygen. Plant growth, except in cases of drought, cold weather, poor drainage, unfavorable soil-and-water relations, or disease is not seriously retarded by a lack of carbon, hydrogen or oxygen. It is the nutrient elements obtained from the soil that usually limit crop development.

Plant growth may be retarded by lack of the macronutrients because these elements are actually lacking in the soil, because they become available too slowly, or because they are not adequately balanced by other nutrients. Sometimes all three conditions are limiting.

Nitrogen, phosphorus and potassium are called the “fertilizer elements” as they are commonly supplied to the soil as manures or as commercial fertilizers.

Because the micronutrients sometimes referred to as “trace” elements, are used by plants in very small amounts does not mean they are less essential than the macronutrients. They are all fundamentally just as important.

Except for iron, trace elements are found sparingly in most soils and their availability in a form for plant use is often very low. The three general soil situations where micronutrients are most apt to be a problem are:

(1) Sandy Soils,
(2) Organic Soils
(3) Very Alkaline Soils

(pH above 7 is known as alkaline).

This is due to the relatively small quantities of micronutrients in sands and organic soils and to the low availability of most of these elements under very alkaline conditions.

DISCLAIMER:

To simplify information in newsletters it is sometimes necessary to use trade names of products. No endorsement of named products is intended nor is criticism implied of similar products that are not mentioned.

(This article adapted from “Western Fertilizer Handbook” by R. H. Sciaroni, University of California Agricultural Extension Service).

Plant Nutrients and Fertilizer Materials

CHEMICAL FERTILIZERS:

KIND	% NITROGEN (N)	% PHOSPHORUS (P)	% POTASH (K)	APPROXIMATE POUNDS REQUIRED TO SUPPLY 1 LB. OF ACTUAL ELEMENT
Nitrogen Materials –				
Ammonium sulfate	20.5	–	–	5
Ammonium nitrate	32.5	–	–	3.5
Calcium nitrate	15.5	–	–	6.5
Amophos 16 - 20	16	8.5 – 9.0	–	6.25
Urea	45	–	–	2.2
Urea-formaldehyde	38	–	–	2.65
Phosphate Materials –				
Superphosphate - single		7.8 – 8.7	—	12
Superphosphate – double		18 - 20		5
Superphosphate – triple		18 - 20		5
Potassium Materials –				
Potassium chloride		–	51.5	2
Potassium sulfate		–	44.0	2.3

BULKY ORGANIC FERTILIZERS

KIND	AVG. % NITROGEN	AVG. % P_2O_5	AVG.% K_2O	% DRY ORGANIC MATTER	ONE TON PROVIDES APPROX. LBS. N	LBS. P	LBS. K	LBS. DRY ORGANIC MATTER	AVG. NO. CU. FT. PER TON	CU. FT. TO MAKE 1 LB, NITROGEN
Dairy manure - wet	0.5	0.3	0.7	25	10	6	14	500	45	4.5
Dairy manure - dry	1.0	0.5	1.8	40	20	10	36	800	65	3.25
Feedlot steer manure	2.2	1.0	2.2	69	44	20	44	1,380	70	1.59
Poultry droppings	4.1	3.1	1.6	73	82	62	32	1,160	55	0.67
Poultry No. 1	2.0	1.9	1.16	52	40	37	23	1,100	60	1.5
Hog manure	2.2	2.1	1.0	62	44	42	20	600	59	2.8
Rabbit manure	2.0	1.3	1.2	60	40	26	24	1,000	70	1.75
Alfalfa hay	2.5	0.6	2.0	83	50	10	40	1,660	–	–
Bean straw (lima)	1.3	0.25	1.3	83	26	6	26	1,660	–	–
Cereal straw	0.6	0.3	1.6	85	12	6	32	1.700	175	14.6

CALIFORNIA TURFGRASS CULTURE
Deportment of Agronomy, University of California
Riverside, Califomia 92502
Editor, Dr. Victor B. Youngner

CALIFORNIA TURFGRASS CULTURE is sponsored by the Federoted Turfgross Council of Califomia and is financed by the regionol councils ond other turfgross organizations of the state. The Federated Council consists of officers and directors of the regionol councils. Subscription to this publication is through membership in one of the councils listed below.

SOUTHERN CALIFORNIA TURFCRASS COUNCIL
P.O. Box 429, Orange, Colif.

President .... John J. McQuade
First Vice President .... Richard Eichner
Second Vice President .... Robert Scofield
Secretary .... Borry Clark
Treasurer .... H. Hamilton Williams

NORTHERN CALIFORNIA TURFGRASS COUNCIL

President .... George Bell
Vice President .... C. R. Stoib
120 Montgomery St., San Francisco, California 94104
Secretary-Treasurer .... Don Nishinoko

CENTRAL CALIFORNIA TURFGRASS COUNCIL

President .... James D. Watson
Secretary .... Lewis LeValley
Fresno State College, Fresno, Calif.