California Turfgrass Culture

FORMERLY, SOUTHERN CALIFORNIA TURFGRASS CULTURE

APRIL 1962 VOLUME 12 - NUMBER 2

Progress Report on the Bermudagrass Mite and the Fruit Fly

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Two new turfgrass pests have caused considerable damage in Southern California since 1958. These are the bermudagrass mite, *Aceria neocynodonis* Keifer, and the frit fly, *Oscinella frit* (Linn.).

The bermudagrass mite is in the family *Eriophyidae* and is related to the bud mites and the rust mites. These mites are microscopic in size and have only two pairs of legs instead of the usual four pairs. The bermudagrass mite lives in the terminal leaf sheaths and its feeding causes stunting, a witches-broom effect (many shoots from the same node), general decline, and eventual death of the stolon. It was first observed and recorded from Phoenix, Arizona, in 1959, and subsequently in Yuma and several locations in Southern California in 1960. Later surveys showed it to be wide-spread throughout Southern California - from the Colorado River to the coast. Damage has varied from light or almost negligible to almost total destruction of the grass.

The bermudagrass mite infests the new hybrids as well as the common bermudagrass, *Cynodon dactylon*. Observations indicate that hybrids closest to *C. dactylon*, such as U-3 and Ormond, are more susceptible to damage than those closest to *C. transvaalensis,* such as Tifgreen and Sunturf.

Observations and experiments conducted during 1961 indicate that proper cultural practices will be as important as insecticides in control. The build-up of "thatch" resulting in poor water penetration and aeration not only weakens the grass but may make it more susceptible to damage by the mites. Under such conditions the grass will not respond to applications of insecticides since unfavorable conditions for growth still exist. While damage has been observed where thatch was not a factor, many cases of severe damage were associated with a heavy thatch.

Various insecticides were tested in 1961 and the most effective materials were Diazinon and Eradex at five pounds of actual insecticide per acre. (Of these two, only Diazinon is available as the manufacture of Eradex has been discontinued). Wettable sulfur and Dithane Z-78 gave an initial reduction but mite populations rapidly built up again. Materials that did not give satisfactory control included chlorobenzilate, Niagara 9044, dimethoate, and Zectran.

Another experiment was conducted to determine the effect of cultural practices in control where a heavy thatch was involved. The grass in plots that were vertically mowed, aerated and fertilized responded about as well as plots that received an application of Diazinon in addition to vertical mowing, aeration and fertilization. The grass came back vigorously and no real differences were observed until about sixmonths after treatmentwhen signs of mite infestation began to appear in the plots that did not receive the Diazinon. In contrast, the check plots that received no treatment of any kind never did recover.

It should not be inferred from the above results that thatch removal, aeration and fertilization will entirely eliminate the need for insecticide treatments. The results do indicate, though, the importance of proper cultural practices in control and also that the number of insecticide treatments may be reduced by good management. Further experiments along this line in cooperation with Wayne Morgan, Farm Advisor in Los Angeles County, are planned for 1962.

The frit fly has been present in California for many years but is a new pest in the sense that damage to turf has occurred in Southern California only since 1959. Damage so far has been mainly restricted to golf greens, and bluegrass and bents appear to be the most susceptible grasses. It has been found breeding in bermudagrass, however, so it is likely that all grasses are attacked although the damage may not be evident.

The frit fly is a very small, black, fly. The tiny maggots, or larvae, tunnel in the stems near the surface of the soil causing the upper portion of the plant to turn brown and die. Symptoms of damage on golf greens are quite characteristic. Damage appears first on the collars and moves in toward the center of the green. The high or upper sections are usually the first to show injury, and observations indicate that greens with a high organic matter content may be more susceptible.

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No controlled experiments have been conducted due to the difficulty of setting up experimental plots with untreated check plots on golf greens. The writers suggested Diatinon in 1959 on the basis of its effectiveness against flies in general, and at five pounds per acre Diazinon appears to be more effective than other materials that have been used such as DDT, malathion, chlordane and dieldrin. It should be noted that Diazinon at five pounds of the active material per acre also gives good control of lawn moths. In 1961, one golf course had good results with a program that consisted of monthly applications but alternating the more expensive Diazinon with a DDT-toxaphene spray.

In areas susceptible to frit fly damage treatments should begin not later than the first part of April, and in certain areas may be necessary in March. In previous years the earliest damage reported to the writers occurred in April, but this year in the China Lake area treatments were necessary in early March.

Studies of the frit fly are continuing and Farm Advisor Wesley Humphrey of Orange County is taking weekly samples of the fly population on a golf course in that county. It is hoped that the results of this study will provide information that will permit more accurate timing of treatments.

Budgeting Your Fertilizer Needs for Turfgrass

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Most park, school and recreation districts, and many golf courses require maintenance personnel to anticipate turfgrass fertilizer needs on a yearly basis. A carefully planned feeding program is necessary to provide a turf that will fulfill the requirements for which it was planted with a minimum amount of money spent on fertilizer.

NITROGEN. Nitrogen is the limiting nutrient in most turf areas. Visual inspection will disclose the yellow characteristics of nitrogen-deficient grass where the nitrogen supply is low. Immediate response can be observed when 3/4 to 1 pound of actual nitrogen is applied per 1000 square feet.

A minimum requirement of nitrogen for parks, schools, cemeteries, football fields, and fairways of golf courses over a 12 month period is about three pounds per 1000 square feet. This might best be applied in four applications – two in the Spring (April and June) and two in the Fall (September and November). An individual application rate of 3/4 pound nitrogen per 1000 square feet will meet the yearly requirement of three pounds. This is a general recommendation. The timing of applications will vary due to different soils, areas, and climate.

A rate of six pounds of actual nitrogen per 1000 square feet per 12 months may be recommended where greater growth is desired. Applications may be made at the rate of one pound actual nitrogen per 1000 square feet every four to six weeks over a six to nine month period during the growing period. Some turf areas are being fed up to nine pounds of actual nitrogen over the 12 month period.

Rates of twelve, eighteen and sometimes twenty-four pounds of actual nitrogen will be needed on the greens of golf courses over a 12 month period. The rate will depend on the demand of the members or players as well as the soil and climatic conditions. Heavy play will cause conditions that call for high rates of nitrogen.

Knowledge of the characteristics of nitrogen fertilizers will be most valuable to the manager or superintendent in planning his budget for the year. Ammonium sulfate may meet all needs of some turf areas. Ammonium nitrate is a little less acid-forming but contains no sulfur. If acidity is a problem, calcium nitrate may be the best source of nitrogen. The ureas, urea-forms, natural organics,, and many other nitrogen sources may fit into the overall fertilization program. Organics may be combined with inorganics to get optimum results. The higher cost of nitrogen from organic sources 'should be weighed against their advantages. These include 1) less hazard from "burn" due to over-applications, 2) a longer-lasting supply of nitrogen, 3) less tendency to produce excess flushes of growth, and 4) lower application costs due to less-frequent applications. Normally we recommend inorganic nitrogen sources for those with limited fertilizer budgets.

PHOSPHORUS. The place of phosphorus can be approached from field trials and soil analysis. On turf previously fertilized with phosphorus, it will be found in the first inch of soil. It does not move. Many soils already contain an adequate supply of phosphorus. Excess phosphorus should be avoided.

IRON. Iron (ferrous sulphate) at the rate of 3 oz. per 1000 square feet should be applied if needed. Make tests on several small plots. Many turf areas in Santa Clara and Alameda Counties respond in thirty minutes where a deficiency exists.

POTASSIUM. No potassium (potash) deficiency has been recognized on turf in the above mentioned counties. Many field tests have been tried with negative results.

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However, there is always a chance of finding potash need due to high fertility requirements.

SULPHUR. Sulphur is deficient in many areas of these counties. Enough sulphur is in ammonium sulphate to meet the requirements.

No other elements have demonstrated their deficiencies in this county.

SIMPLE FIELD TEST RECOMMENDED

The following field exploration test on turf using nitrogen, phosphorus (P_2O_4) potash, and sulphur, can he laid out on any area where the fertilizer need is questioned. Such a plot will eliminate soil sampling and give actual field results. Each fertilizer is applied to an area 80' x 20'. This provides sixteen individual 20' x 20' plots, covering all possible combinations of the four elements. Use the fertilizer materials and rates listed below. Do not substitute other fertilizers as they may contain more than the single nutrient being studied.

	N	O	S	NS	
P	NP	P	PS	NSP	20'
O	N	O	S	NS	20'
K	NK	K	KS	NKS	20'
PK	NPK	PK	PKS	PNKS	20'

80'

FERTILIZER SOURCES AND RATES

N - Nitrogen. Rate: 5 lb. N per 20' x 80' plot (135 lb. per acres)

Use one material only

1. ammonium nitrate - 15 lbs. (33% N)
2. calcium nitrate - 32 lbs. (16% N)
3. urea (Uramon) - 11 lbs. (45% N)

P - Phosphorus. Rate: 8 lb. P_2O_4 per 20' x 80' plot (200 lb. per acre).

1. treble superphosphate - 19 lbs. (42% P_2O_4)

K - Potassium. Rate: 6 lb. K_2O per 20' x 80' plot (150 lb. per acre)

1. muriate of potash (KCL) - 10 lbs. (60% K_2O)

S - Sulphur. Rate: 15 lb. S per 20' x 80' plot (400 lb. per acre)

Use one material only

1. sulphur - 15 lb. (98% S)
2. gypsum - 100 lb. (15-18%S)

O - No fertilizer added.

A calendar record is recommended for the manager to have detailed information on how much, what kind, and location. Detailed map of turf area as to square feet and traffic wear must be recorded.

Selecting the level of nitrogen feeding one desires, the additional types of nitrogen fertilizers needed to achieve optimum plant growth, other elements that have been shown to be deficient in any area must be considered over the twelve month period.

CALIFORNIA TURFGRASS CULTURE is sponsored by the Federated Turfgrass Council of California and is currently financed by the Southern California Golf Association. Communications should be sent to the editor, Dr. Victor B. Youngner, Deportment of Floriculture and Ornamental Horticulture, 300 Veteran Avenue, University of California, Los Angeles 24, California. The Federated Council consists of the officers of the three regional councils. Subscription to this publication is through membership in one of the regional councils listed below:

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Metal Ammonium Phosphates

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REPRINTED FROM CALIFORNIA AGRICULTURE, FEBRUARY 1962

Compounds of limited solubility offer a unique approach to controlled availability of nitrogen fertilizers – now being achieved by means of various metal ammonium phosphates. Nearly all compounds of ammonium or nitrate – the principal fertilizer nitrogen sources – are highly soluble and are immediately available to plants when placed in soils. Urea nitrogen is also soluble and is usually rapidly decomposed to ammonium in soils. Nitrate nitrogen is not absorbed by soils and is subject to leaching loss in deeply percolating water. Ammonium nitrogen is absorbed by soils but is largely converted to the nitrate form in a matter of one to three weeks in many soils.

Complex organic forms of nitrogen may have very limited solubility but are made available by means of micro-biological transformation to simpler forms. In

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Observations on Turfgrass Aeration and Vertical-Mowing

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Early in May of 1961, a request was received from a memorial park in the Burbank area for help on turfgrass irrigation.

The hillside area was being sprinkler irrigated every day for approximately 30 minutes. The weather usually had been cool and overcast, but even under these conditions, along with the daily application of water, many acres of turf were already showing symptoms of dying from insufficient moisture.

Close examination of the area revealed that a matted layer of thatch over 3/4" thick had developed. Efforts were made to examine the root system in the decomposed granite soil. In almost all cases it was impossible to insert the soil auger beyond a depth of one inch. This was as deep as any roots had developed.

Sprinklers were turned on for 15 minutes. Examination of the turf showed the water had barely penetrated into the thatch layer. Again the sprinklers were turned on, this time for 30 minutes. Even after 45 minutes of water application, in 5 out of 6 cores taken with a soil auger, the water had hardly infiltrated beyond the thatch.

Test plots of aeration, vertical-mowing and aeration and vertical-mowing together were established immediately. The remainder of the area was aerated twice.

Results of the aeration, both in the test area and throughout the rest of the section, showed water infiltration to an average depth of from 12" to 15" with substantially less water being used. With this increased water infiltration, it was possible to reduce irrigation to 20 and 25 minutes every other day, even in the heat of summer.

In the test area where vertical-mowing only was tried, the results were unsatisfactory because the mixture of cool season grasses had so many roots growing in its own thatch, and so few in the soil. When enough of the matted thatch was removed to show significant increases in water infiltration, the turf was very slow to recover.

More trials of aeration and a combination of aeration and vertical mowing were established in turfgrass areas at the Court of Freedom, Forest Lawn Memorial Park, Glendale. This site was selected because each area had its own irrigation system. The soils were all identical because they were mixed in place; 1/2 adobe soil from decomposed shale and 1/2 washed plaster sand.

The tests were begun on July 26 and were followed until October 17. The heavy common bermuda grass turf had been completely renovated early in March the same year.

Plots were established as follows:

Aeration and Vertical Mowing 3	Aeration 2	Check 1

Tensiometers were installed at depths of 4" and 12" in each plot. Instructions were to allow each instrument to reach 70, or near to it, before applying water. Since the upper tensiometer was located in a zone where the majority of the roots were located, when the tensiometer reached the given reading at the upper depth, but the other instrument indicated a wetter condition at the lower depth, only enough water was applied to wet the upper soils. When the deeper tensiometer showed that the soil had partially dried to allow better aeration condition, then longer water sets were used to reach the lower soil zone.

Results of these trials are as shown below:

Total Water Applied (in total number of minutes of application)	693	670	1,133
Number of Applications	24	23	32
Plot Number	3	2	1

These figures show that aeration alone resulted in a reduction of over 40 per cent in water used, with almost 1/3 fewer applications. Participants in this experiment feel that the aeration, vertical-mowing plot should have been below 500 minutes of water used, in less than 20 applications, but a faulty sprinkler was creating a dry area that was requiring water before the upper tensiometer reading reached 70.

Another important result of these trials was indicated from the lower tensiometer readings. The check plot required a significantly longer water set to reach the lower instrument than did the other plots. The aerated plot would show a rising and lowering of readings between irrigations, but the aeration and vertically-mowed plot showed a consistently lower reading of below 10, indicating the soil still was being kept excessively wet.

Trials consisting of vertical-mowing and aeration and vertical-mowing were conducted at Will Rogers State Park in Santa Monica. This was in cooperation with Mr. Stan Spaulding of the Department of Floriculture and

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Ornamental Horticulture at UCLA. No tensiometers were used on the common bermuda grass polo field, but cores of soils taken showed that only the thatch and mat were wet following an irrigation. The vertically-mowed plot had water reaching four inches into the root zone, while the combined tillage operation resulted in water infiltration to a depth of 15 inches.

Other significant observations received from these and other trials were the greater effectiveness of fertilizer as strikingly evidenced from placing bands of fertilizer across both treated and untreated plots, faster and easier mowing, and a substantial reduction in crabgrass from these treatments.

While testing tensiometers in golf greens, indications were that frequency of aeration may play a significant role in the uptake of water by plants. One green that received from 5 to 6 aerations a year was able to have water withheld until a reading of above 60 was reached. Greens that were aerated only twice a year required that water be applied at readings between 20 and 30. Another green that was very wet, with poor aeration, showed wilting of the grass when tensiometer readings were still below 10.

Trials have been established this year at five locations to further study the effects aeration and vertical-mowing have on the frequency and length of irrigations needed to grow a healthy and beautiful turfgrass.

Three golf courses and one bowling green are planning cooperative trials with the Agricultural Extension Service in Los Angeles County this year to obtain indicators of how frequency of aeration affects the use of water by turfgrasses. Similar greens at these places will be aerated 2, 3, and 4 times a year.

At three bowling greens with creeping bent grasses, tests are planned for determining the best frequency of vertical-mowing for controlling thatch. This will be once a month versus twice a month. Tensiometers will be used at all locations to indicate water availability and depth of infiltration.

Life Cycle of Crabgrass in California

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Crabgrass, *Digitaria sanguinalis* and *D. ischaumum* may have a quite different life cycle in subtropical California from that of other parts of the United States. This difference must be considered when planning a control program and when selecting the chemicals to be used.

Both species are abundant in California. While usually an infested area will be primarily one species or the other, it is not unusual to find the two inapproximately equal numbers in a turf area. Fortunately, the behavior and control of the two species appears to be similar so it is not necessary to differentiate between them in a turf.

Crabgrass seed may germinate in the warmer parts of the state throughout the year. In sheltered locations or areas with a southern exposure numerous seedlings may be found even in December and January. Heavy general crabgrass seed germination in Los Angeles and areas of similar climate will begin in late January to early March depending on the weather. In areas of colder winter weather this germination period will be correspondingly later. Seeds will continue to germinate throughout the spring and summer.

The young seedlings grow rather slowly during the spring months and often will not progress beyond the two to four leaf stages until mid-May. After that time, with warm soils and long days, growth proceeds at an accelerated rate.

During June and July the crabgrass plants produce numerous tillers or shoots. Many of these shoots will lie on the surface of the ground and form new roots at the nodes, developing new plants much as do the stolons of bermudagrass or bentgrass. A single seedling may thus form a plant from one to two feet in diameter which will smother or shade out the turfgrasses beneath it.

Flowering of plants from spring germinated seed will commence in late July or August. Only three to four weeks from flowering may be required for the development of mature seed. This new seed is dormant and will not germinate for several months.

Normally with the maturation of the seeds and the onset of cool fall weather, crabgrass plants develop a deep purple pigmentation and slowly die. However, studies have shown that some plants may survive the winter in a dormant or semi-dormant state to produce new growth and often a second crop of seed in the spring or early summer. Plants from late summer germinating seed which have not produced a fall seed crop may survive the winter with very little die-back. Usually, however, plants will appear to be dead by mid-winter even though there may still be life in the plant stems. A few seemingly dead plants will produce new leaves with the rising temperatures of spring. All regrowth on these plants appears only at the rooted nodes of the procumbent

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shoots. Regrowth has not been observed coming from the main crown of the old plant.

This behavior of crabgrass has been observed only in mild climate areas of the state. Wherever frosts are common, survival of this type is doubtful.

Relating chemical control to these observations, it is clear that pre-emergence herbicides should be applied before the end of January for best control. Pre-emergence herbicides which also have a seedling or early post emergence toxicity will be especially valuable because of the possible germination of seed at any time throughout the winter. Since seedling growth is slow in the spring, such an herbicide may also have a much later final date for successful application.

Optimum time for application of post emergence herbicides would appear to be about late May. Plants still will be quite small at this time and will not be competing excessively with the turfgrasses. At the same time a large portion of the season's crabgrass will have germinated. Therefore a minimum amount of herbicide should be required to obtain a high degree of control. Delaying control measures until later in the season will not only require more chemical but will have allowed the rapidly growing crabgrass to lower the turf quality.

In the mild climate areas control with pre-emergence herbicides may be more difficult because of the winter survival of old plants.

Properties of Coated Fertilizer Materials

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REPRINTED FROM CALIFORNIA AGRICULTURE, JANUARY 1962

The rate of release of highly soluble inorganic fertilizers can be controlled by enclosing the fertilizer granule in a coating membrane. Factors which affect that rate under growing conditions were studied to gain a better understanding of the mechanism involved. The rate of release remains nearly constant until about two thirds of the fertilizer has been released; thereafter the rate drops off. After the first few days or weeks the rate may increase slightly.

The thickness of the coating material regulates the rate of release. The table gives a comparison of three different membrane thicknesses in an elution study with coated potassium chloride. Initially the release rate was highest with the thinnest coat. This caused rapid exhaustion of the salt within the granule, and within a few weeks the rate of nutrient supply dropped below that observed with the thicket coatings.

POTASSIUM RELEASED FROM POTASSIUM CHLORIDE FERTILIZERS WITH COATINGS OF DIFFERENT THICKNESSES

Thickness of coating	First week %	Third week %	Sixth week %	Ninth week %
Light	58.2	8.0	3.8	1.1
Medium	46.8	10.2	4.9	1.5
Heavy	12.8	7.8	10.3	6.0

From a 10:10:10 fertilizer, the initial release of nitrogen ions, nitrate, and ammonium was more rapid than that of potassium or phosphates.

External conditions

Coated fertilizers can be used under any soil conditions of acidity or alkalinity. Two elution experiments showed no definite effect of the hydrogen-ion concentration on release rate. In general, the release curves were almost identical in solutions at pH values of 4, 6, or 8 and also in soils which ranged from very acid to very alkaline.

Raising the temperature from 10 to 20°C roughly doubled the release rate. The temperature effect was smaller between 20 and 30°C. Since the growth rate of plants is increased at higher temperatures, nutrient supply and growth rate may thus change in the same direction.

A buildup of external salt concentration has little effect on the rate of release of coated fertilizers. Apparently the solution inside a granule is saturated, and biologically tolerable salt concentrations of the external solution have little effect on the concentration difference between the two sides of the membrane.

Microbial attack was not required for release of minerals through the coating. Probably the high internal salt concentration prevents attack by micro-organisms until after most of the salts have been leached out. In one test, the rates of release from granules were even slightly lower under sterile than under non-sterile conditions. But this may have been caused by the effect on membrane permeability of the formaldehyde solution used to prevent microbial activity.

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Placement of fertilizer

Leaching experiments with soil columns indicate that the yield of potassium and phosphorus is 30 to 50 per cent lower when the coated material is placed as top-dressing than when it is incorporated uniformly through the soil. However, the release curves under the two conditions are similar, and top-dressing is considered a suitable method for the application of coated materials.

Diffusion mechanism

At first look, there appear to be some discrepancies in the explanation of diffusion as a mechanism of salt release, because the temperature coefficient with coated granules is too high for a diffusion process and the rate of release by diffusion should not increase after a few days. However, the membranes do not necessarily remain rigid but may actually expand somewhat in course of time, and this expansion may be affected by temperature. Expansion would enlarge the pores of the membranes and facilitate diffusion. Visual inspection of the granules confirms such a change in the coating, because the initially jagged granules become nearly spherical after exposure to moisture.

METAL AMMONIUM PHOSPHATES (FROM PAGE 11)

contrast, the metal ammonium phosphates dissolve to a limited extent and provide a certain amount of nitrogen, phosphate and the metal ion to the solution. Theoretically, the product of the ammonium, phosphate, and metal ion concentrations equals a constant. When saturation is reached, no more metal ammonium phosphate dissolves. However, if a plant root removes ammonium ions from a solution in equilibrium with a metal ammonium phosphate, more of the mineral dissolves tending to replace the ammonium which had been removed. The fact that the mineral tends to establish equilibrium with the solution surrounding it gives rise to some involved reactions in soils, but under most conditions the metal ammonium phosphates are effective, long lasting, sources of nitrogen.

Metal ions

Metal ions which may be precipitated with ammonium and phosphate to form slightly soluble compounds include magnesium, ferrous iron, manganese, zinc and copper. The compounds are also of interest as sources of the metals to plants and as sources of phosphate. As long-lasting sources of nitrogen, the magnesium and ferrous forms are of interest since the zinc, manganese or copper compounds are apt to supply excessive quantities of the metals when used as sources of nitrogen.

Nitrogen runs about 8 per cent for the magnesium and 7 per cent for the ferrous materials, while phosphorus (P_2O_5) contents are about 40 and 35 per cent, respectively. The ratio of nitrogen to phosphorus would usually be unfavorable for prolonged repeated use, thus interest in the materials will focus in those applications where a single or few applications would be made. Logical use areas would include potted flowering plants or canned nursery stock, new landscape installations and forest plantings. The need for long lasting nitrogen fertilizers for nursery production was stressed in a previous article in this series.

At saturation of magnesium ammonium phosphate and at pH values of 7 to 8, approximately 15 parts per million of nitrogen are in solution. As compared to a nutrient solution this is a relatively low concentration of nitrogen but if it is continuously maintained it is adequate to sustain good plant growth.

Particle size of the fertilizer influences the rate at which solution takes place, although the amounts in solution at saturation are not influenced much by particle size. In a comparison of powder and 5 mesh granules of magnesium ammonium phosphate, the amount of nitrogen coming into solution from powder during the first 30 minutes was about 15 times as great as that from the granules. Within six hours the amounts dissolved were about the same, although the solution was only about one-half saturated. The duration of nitrogen supply from similar applications was longer from granular materials than from powder, in turfgrass cropping trials.

Rates of application

While particle size has a marked effect on duration of fertilizer supply from metal ammonium phosphates, rates of application must also be considered. Maximum rates which may be applied safely to an average planting without injury are not well defined because of the properties already discussed. Since nitrification in soils removes the ammonium ion from solution, more mineral dissolves as nitrification takes place. Thus if no leaching occurs, moderate levels of soluble salts in soils may develop after large incorporations, especially of powder. In general, however, the hazard of fertilizer burn from a large application is low. As much as 2,000 pounds of nitrogen per acre from powdered magnesium ammonium phosphate was applied to turfgrass prior to planting without injury.

As indicated above, the duration of a supply of nitrogen from metal ammonium phosphate will depend on particle size and amount supplied. When 175 pounds per acre of nitrogen from powdered magnesium phosphate was used in sand to produce corn, under heavy irrigation, the mineral was essentially all consumed in about three months time. Under similar conditions, large granules have lasted in excess of six months.

By using golf-ball size pellets in the holes made for planting woody landscape materials or trees, it appears reasonable that substantial amounts of nitrogen could be supplied for periods of a pear or two or more – offering a practical use for these materials. Freeway landscaping, for example, is often done in soils of low fertility with high labor costs for fertilization after planting. Fertilizer

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materials of exceptionally long duration would be advantageous in such cases.

Several soil conditions affect the rate or extent to which the metal ammonium phosphates will "dissolve." Incubation studies have shown that soil moisture levels have an effect on the amount of nitrogen dissolving. In the range from the permanent wilting percentage to the field capacity, there is a tendency for increased solution with an increase in moisture content of the soil. In a given period of time the amount of magnesium ammonium phosphate dissolving at field capacity in a soil was about twice that going into solution when soil moisture was near the permanent wilting percentage. This is probably due to more rapid diffusion of soluble products at higher moisture levels which means the fertilizer is equilibrating with a larger volume of water.

As previously mentioned, nitrification permits more of the metal ammonium phosphate to dissolve. As soils become more acid there is a tendency for an increase in the amount of nitrogen dissolving but the effect is not large. Increasing temperature accelerates the rate at which solution takes place, but in the temperature range in which plants grow the total solubilityis not influenced very much.

CONTROLLING GOPHERS WITH POISON AND TRAPS

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Controlling gophers is normally a year round job; however, the best and most effective time for an all out campaign is in the late fall after the first rains of the season have softened the ground. At this time it is easier to locate the burrows for the purpose of placing poison baits or traps. Also there is an obvious advantage of controlling the adults before the young make their appearance in the spring.

Poisoning and trapping are the two methods most commonly used to control gophers. Gassing the burrows with methyl bromide, gopher "bombs" ot engine exhausts is usually not effective. Gophers may plug the runway when they detect the gas and it is difficult to maintain a a lethal concentration of gas in the burrows that are very often long and close to the surface of the ground.

Poisoning is more economical than trapping and should be used where large numbers of gophers are to be destroyed. Trapping should be used to follow-up a poisoning program on large areas and to catch gophers on small areas and home properties.

Gophers can be effectively controlled by poisoning with strychnine vegetable baits. The recommended vegetables in order of their preference are sweet potatoes, carrots and parsnips. To prepare the baits, dust 1/8 ounce of strychnine-alkaloid over two quarts of baits cut 1/2" square and 2-1/2 inches long, and stir until the poison is evenly distributed. Strychnine-alkaloid may be obtained at cost from the County Agricultural Commissioner.

The baits can best be put in the runway by using a special probe that may be made by any welding shop. Directions for making a probe may be obtained from the Farm Advisor's office or the County Agricultural Commissioner.

It is important that the hole made in the burrow by the probe be closed after the bait is placed.

If a probe is not available, or the soil is too dry and hard to use a probe, the main runway may be located with a shovel and a bait placed 12 inches or more back in each opening which is then tightly closed with soil. Baits are more likely to be taken when placed in the runway with a probe than when the runways are dug out with a shovel. When retreating an area, it is advisable to change baits. Gophers remaining after two treatments with vegetable baits probably will have to be trapped.

Traps are very effective when properly set in active runways. There are two types of traps in general use, the wooden box trap and the wire trap. Gophers are readily caught in either of the two types, but the box trap is easier to set and is usually more effective for a novice to use.

Success with the box trap is dependent on proper setting. The freshest mound should be selected. By digging carefully into the mound the plugged lateral runway can be located and dug out until the end of the plugged portion is reached. The area in front of the open hole is then cleared away with a trowel so the front of the trap will fit tightly against the opening and the wire choker loop will be level with or below the bottom of the runway when the choker loop is in the set position. After the trap is placed firmly in position in front of the hole it should be completely covered on top, sides and end so little or no light enters the trap.

If in the process of locating the open lateral runway, the main runway is broken into, then it will be necessary to set two traps, one in each of the open ends of the main runway.

There are several variations of the wire trap, the most common one is known as the Macabee. This trap should be set in the main runways and not in the laterals leading to the surface mounds. The main runways can be located by digging with a shovel near the freshest surface mound. After locating the main runway, clear a space so that a trap can be set in each direction. With a long handle spoon, clear the runway, disturbing it as little as possible. Set the treadle of the trap so it will be sprung with a light touch. Place the traps, jaws forward, well back in the holes and press down firmly so the trap will not move when the gopher pushes against it. After the traps are in place the open holes should be closed with a clod or clump of grass and then covered with dirt so little or no light enters the burrow.

A trap should be attached to a stake or other object to prevent dogs or wild predators from carrying away the caught gopher and the trap. Traps not sprung in 24 hours should be moved to a new location.