1978

Spring 1987 Conference Issue

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M. Bryant

Richard Dattner

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Featured in this issue:
- Phosphorus
- Dollar Spot
- Parks for the Year 2000

SPRING 1978 CONFERENCE ISSUE

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The Massachusetts Turf and Lawn Grass Council Incorporated is chartered under the laws of the Commonwealth of Massachusetts as a non-profit corporation. The turf council seeks to foster “Better turf through research and education.”

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Phosphorus and Its Effect on Plant Growth

By Brian M. Silva
University of Massachusetts, Amherst

Phosphorus is invariably classified as one of the macronutrients, but its content in plants is considerably less than that of nitrogen, potassium, and calcium. As a limiting factor, however, phosphorus is more important than calcium, and probably more important than potassium. The need of plants for phosphorus has received particular consideration in the formulation of commercial fertilizers. This element, in the form of superphosphate, was the first to be supplied as a manufactured product. Until fairly recently, the amount of phosphoric acid in mixed fertilizers almost always exceeded that of nitrogen or potassium. Even today the total tonnage of phosphorus, expressed as P₂O₅, is exceeded only by that of nitrogen (4, 5, 9).

Phosphorus, like nitrogen, is directly involved with many vital growth processes in the plant. Phosphorus is involved in a number of physiological functions within the plant including energy transformation where it functions to a great extent in the form of adenosine triphosphate (ATP). The phosphate in several organic linkages may be split off by hydrolysis with a relatively high yield of energy. Phosphate groups that have this property are called high-energy phosphates. By means of enzymes, the high-energy phosphates can be transferred from a source such as adenosine triphosphate to another compound, such as glucose, without dissipation of the energy in transit (4, 7, 8).

Phosphorus is a constituent of nucleic acids, phytin, and phospholipids. Phosphorus is necessary for the assimilation of fats, and apparently it increases the efficiency of the chloroplastic mechanisms. The initial reaction of photosynthesis in which light energy is trapped involves the splitting of water in the presence of adenosine diphosphate, an inorganic phosphate. Phosphorus is also involved in carbohydrate transformations such as the conversion of starch to sugar. Phosphorus in the form of phosphate buffers is important in the maintenance of desirable pH values inside the cell (3, 4, 6, 7, 9).

Phosphorus occurs in large amounts in young tissues in the regions of cell division and also occurs in large quantities in seeds as a constituent of phytin. As a plant matures, phosphorus is transferred to the reproductive portions of the plant and eventually accumulates in the seeds. A good supply of phosphorus has been associated in the past with increased root growth. There exists disagreement on this point (3, 4, 6, 7, 9).

According to Black, the statement that phosphorus stimulates root growth implies that phosphorus has some special effect on the growth of roots that it does not have on the above-ground portion of the plant. In examining this question, it is important to consider what is meant by "root".

If "root" designates the subterranean storage tissue of root crops, the supply of phosphorus does have a special effect. If a root crop is deficient in phosphorus, fertilization with a phosphorus compound usually increases the yield of roots relatively more than that of above-ground parts. This behavior may be accounted for by a theory patterned after a nitrogen-carbohydrate relationship. Translocation of carbohydrates to the roots is limited as long as leaf growth continues. The maximum leaf weight is attained at a later date by phosphorus deficient plants than by phosphorus fertilized plants. Consequently, the translocation of carbohydrates to the storage tissue proceeds for a longer time in the phosphorus fertilized plants than in the phosphorus deficient plants.

On the other hand, if "root" refers to the absorbing roots, as in the turgrases, Black feels that phosphorus does not seem to have any unusual stimulating effect. In fact, treatment of phosphorus deficient plants with phosphate fertilizers ordinarily increases the yield of above-ground parts to a greater extent than the absorbing roots. This effect is illustrated below (4).

![Graph](image)

Other sources maintain that root growth is primarily dependent on ample availability of soil phosphorus. Phosphorus is singled out in regard to the stimulation of root growth and development, and branching (1, 3, 7).

An important clarification must be made in regard to phosphorus and root growth. Phosphorus is involved in certain chromosome functions, so that cell division, which means growth, depends on its availability. A lack of phosphorus will restrict overall growth, which includes root growth, as would deficiencies of other nutrients, improper environmental conditions, and the like. However, a heavy phosphorus fertilization will not increase root growth at the expense of above-ground growth. In the final analysis, adequate available phosphorus should be maintained to foster overall plant growth, which will include the growth of both roots and shoots (1).

Several quantitative effects on plant growth can be attributed to phosphate fertilization. An ample supply of phosphorus promotes rapid plant development and hastens maturity, in this manner counteracting the effects of excess nitrogen application. Corn reaches the stage of tas-

(Continued on Page 4)
seling and silking at an earlier date where the supply of phosphorus has been ample than where it has been deficient. Because of the difference in rates of development, plants deficient in phosphorus mature later compared with plants amply supplied with phosphorus. Seed setting is also enhanced by higher phosphorus levels (3, 4, 5, 6).

The effect of phosphorus fertilization on the time of maturity may be of practical importance with crops that utilize the full growing season, as is true of corn in the northern part of the United States. With other crops in particular environments, earliness of maturity may make possible the harvesting of the crop under relatively favorable weather conditions (4).

Phosphorus is particularly vital during the seedling stage of growth and development of many plants. Thus, phosphorus should be placed near the seeds during planting to assure rapid establishment (3, 7).

The prevalence of fungal root-rots is greater in plants with a deficient supply of phosphorus than in those with an ample supply. This trend is noted particularly with plants in the seedling stage. The effect of phosphorus appears to be exerted not so much through a change in the inherent susceptibility of a particular root to infection as through an increase in the rate of growth and reproduction of new tissue. Optimum phosphorus levels reduce the susceptibility of turfgrasses to seedling damping-off diseases. In such cases an adequate supply of phosphorus may be said to facilitate escape from the diseases rather than to increase resistance to them (3, 4).

The interaction of phosphorus and arsenic in soils is of particular significance in turfgrass weed control. The quantity of arsenic absorbed by the roots decreases as the available phosphorus concentration in the soil increases. Where inorganic arsenicals have been utilized for the control of annual grassy weeds, excessively high available soil phosphorus levels should be avoided in order to achieve adequate weed control at a minimum arsenic level and acceptable cost. A higher available soil phosphorus level requires a higher quantity of arsenic to achieve satisfactory weed control (3).

Phosphorus is readily mobilized in plants, and when a deficiency occurs, the element contained in the older tissues is transferred to the active meristematic regions. However, because of the masked effect that a deficiency of this element has on retarding over-all growth, the striking foliar symptoms which are evidence of a deficiency of certain other nutrients, such as nitrogen and potassium, are seldom observed (8, 9).

In general, symptoms of phosphorus deficiency are not particularly pronounced or specific. If phosphorus is deficient, cell division in plants is retarded and growth is stunted. Phosphorus deficiency produces certain effects that are similar to the effects of nitrogen deficiency. With deficiencies of both elements the stems of plants are thin, leaves are small, and lateral growth is limited (3, 4).

With the turfgrasses the visual symptoms of phosphorus deficiency first appear as a dark green coloration of the lower, older leaves. The plants tend to be spindly and dwarfed but not to the degree associated with nitrogen deficiency. The dark green coloration changes to a dull blue-green as the phosphorus deficiency progresses, with a purple discoloration appearing along the entire margin of the blade as well as in the basal main veins. Merion Kentucky bluegrass does not exhibit the dull blue-green to purplish stage just described for Seaside Creeping bentgrass and Pennlawn Red fescue. Subsequently, the purple discoloration gives way to dull reddish tints appearing first near the leaf tip and then developing down the blade. Necrosis of the older leaf tips occurs in the advanced stages of a phosphorus deficiency and gradually moves to the base of the
In bermudagrass the deficiency initially appears as a dark green color that gradually changes to a pale green color with minimal effects on the shoot growth rate. A phosphorus deficiency causes a reduction in the tillering, shoot growth, and moisture content of ryegrass shoots.

The quantity of phosphorus utilized by turfgrass plants is considerably less than the amount of nitrogen and potassium. Turfgrasses vary in phosphorus absorption. Kentucky bluegrass ranks quite high, whereas carpetgrass and bermudagrass are relatively low (3).

It is generally considered that plants absorb most of their phosphorus as the primary orthophosphate ion, \( \text{H}_2\text{PO}_4^- \). Smaller amounts of the secondary orthophosphate ion, \( \text{HPO}_4^{2-} \), are absorbed. In fact, there are about ten times as many absorption sites on plant roots for \( \text{H}_2\text{PO}_4^- \) as there are for \( \text{HPO}_4^{2-} \). The relative amounts of these two ions, which will be absorbed by plants, are affected by the pH of the medium surrounding the roots. Lower pH values will increase the absorption of the \( \text{H}_2\text{PO}_4^- \) ion, whereas higher pH values will increase absorption of the \( \text{HPO}_4^{2-} \) ion.

The total content of phosphorus in soils is relatively low. Research has determined 0.062 per cent as an average value for the content of phosphorus in the plowed layer of the crop land of the United States, a value considerably smaller than the corresponding figures of 0.14 per cent for nitrogen and 0.83 per cent for potassium. Most of the phosphorus present in the soil is in a form unavailable to plants.

Also, when soluble sources of this element are applied to soils, the phosphorus contained in these sources is often fixed or rendered insoluble or unavailable to higher plants, even under ideal field conditions (4, 5).

The problem of phosphorus availability is exemplified by fertilizer practices under field conditions. As earlier stated, the tonnage of phosphorus-supplying materials used as fertilizers exceeds all others except the nitrogen carriers. The removal of phosphorus from soils by crops, however, is low compared to that of nitrogen and potassium.

In the United States, phosphorus added in fertilizers exceeds that removed by crops by more than 24 per cent. In some areas, notably the Eastern Seaboard states, additions of phosphorus more than triple the removal of this element by crops. Since phosphorus is lost only sparingly by leaching, the inefficient utilization of phosphate fertilizers by plants is obvious (5).

In contrast to certain inorganic combined forms of nitrogen, which are not highly stable in soils and are lost readily by volatilization and leaching, phosphorus is relatively stable in soils and is not lost readily in either way. The high stability (low solubility) of phosphorus in soils is the immediate cause of deficiencies of soil phosphorus for plants (4).

Briefly, the overall phosphorus problem is threefold: there exists a small total amount in soils, such native phosphorus is unavailable to plants, and added soluble phosphates are readily fixed by many different constituents in the soil. Since crop removal is relatively low and world phosphate supplies are huge, the problem of supplying sufficient total phosphorus should not be serious. Increasing the availability of native soil phosphorus and the retardation of fixation are the problems of greatest importance (5, 6).

Phosphorus in the soil can be classified generally as organic or inorganic, depending on the nature of the compounds in which it occurs. The organic fraction is found in humus and other organic materials which may or may not be associated with it. The inorganic fraction occurs in numerous combinations with iron, aluminum, calcium, fluoride, and other elements. These compounds are usually only very slightly soluble in water. Phosphates also react

(Continued on Page 6)
with clays to form generally insoluble clay-phosphate complexes.

The content of inorganic phosphorus in soils is almost always higher than that of organic phosphorus. An exception to this rule would be, of course, the phosphorus contained in predominately organic soils. In addition, the organic phosphorus content of mineral soils is usually higher in the surface horizons than it is in the subsoil because of the accumulation of organic matter in the upper reaches of the soil profile (9).

PHOSPHORUS FIXATION

Most soils have the capability of reacting rapidly with soluble phosphates and reducing their solubility. In a strongly acid mineral soil an appreciable amount of aluminum and smaller but significant amounts of iron and manganese will be present. Reactions with the \( \text{H}_2\text{PO}_4^- \) ions would occur, rendering the phosphorus insoluble and unavailable for plant growth. In most strongly acid soils the concentration of iron and aluminum ions greatly exceeds that of the \( \text{H}_2\text{PO}_4^- \) ions and consequently only minute amounts of the \( \text{H}_2\text{PO}_4^- \) ion remain available for plants under these conditions; most is incorporated into the unavailable form of hydroxy phosphate. The \( \text{H}_2\text{PO}_4^- \) ion also reacts with insoluble hydrous oxides of iron, aluminum, and manganese. The compounds fixed as a result of fixation by iron an aluminum oxides are likely to be hydroxy phosphates, just as in the case of chemical precipitation just described (4, 5, 9).

Another mechanism that has been suggested to explain phosphorus fixation is the reaction of phosphates with silicate clays. This reaction occurs under moderately acid conditions and involves minerals such as kaolinite, montmorillonite, and illite (5, 9).

While phosphorus fixation in acid and neutral soils is largely associated with the presence of iron, aluminum, manganese, and silicate clays, the retention of phosphorus in alkaline soils is the result of an entirely different set of reactions. In alkaline soils, phosphate precipitation is caused mostly by calcium compounds. Such soils are plentifully supplied with exchangeable calcium, and in most cases, with \( \text{CaCO}_3 \). Available phosphates will react with both the calcium ion and its carbonate. The illustration below shows the inorganic fixation of added phosphates at various soil pH values (5, 6, 9).

With insolubility of phosphorus occurring at both extremes of the soil pH range, the question arises as to the range in soil reaction in which minimum fixation occurs. Insoluble phosphates of iron and aluminum will be precipitated in acid soils, and the insoluble phosphates of calcium at pH values greater than 7.0. The facts indicate that maximum phosphate availability to plants is obtained when the soil pH is maintained in the range of 6.0 to 7.0. Even in this range, however, the fact should be emphasized that phosphate availability may still be low and that added soluble phosphates are readily fixed by soils (3, 5, 9).

It is interesting to note the actual quantity of phosphorus which soils are capable of fixing. One Coastal Plain soil was reported to have a phosphate-fixing capacity of 125 tons of 20 per cent superphosphate per acre-furrow slice. Although such values are somewhat higher than usual, they do not overemphasize the problem of phosphate fixation (2).

In addition to pH and related factors, organic matter strikingly affects the availability of inorganic phosphorus. Numerous researchers have reported that humus extracts from soils have increased the solubility of phosphorus. Products of organic decay, such as humus and organic deposits...
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acids, are thought to be effective in forming complexes with iron and aluminum compounds, thus preventing their reaction with phosphorus. This engagement of iron and aluminum reduces inorganic phosphate fixation to a remarkable degree (5, 9).

Of considerable importance in the fixation of added fertilizer phosphates is the degree of phosphorus saturation of the soil or the amount of this element previously fixed by the soil. The practical implications of this relationship are quite important. On soils that have been heavily phosphated for several years it should be possible to reduce the amount of phosphate fertilizer currently applied in the fertilizer and/or to utilize to a greater extent the phosphorus in the soil (9).

The inefficient utilization of applied phosphorus by plants has been a long recognized problem. The small amount of control that can be exerted over phosphate availability seems to be associated with liming, fertilizer placement, and organic matter maintenance. By holding the pH of soils between 6.0 and 7.0, banding or pelletizing phosphate fertilizers to reduce soil contact and the resulting fixation, and maintaining levels of organic matter, the availability of phosphorus to the plant should be increased.

While a great deal of phosphorus will still revert to less available forms, it should be remembered that fixed phosphorus is not lost from the soil and through the years can become slowly available to growing plants. This becomes an important consideration on soils that have been heavily phosphated for years (5, 8, 9).

The phosphorus content is usually highest in the upper portion of the soil profile. Cultivation of established turfs before application of phosphate fertilizer assists in the penetration of a portion of the phosphorus into the root zone rather than just at the soil surface (3).

Phosphorus is quite immobile in the soil and is not leached to any extent since it is immobilized almost immediately when applied to soils. Consequently, there is little possibility that ground water would become polluted from the use of phosphorus fertilizers. Erosion of soil particles, however, can carry phosphates absorbed on soil particles into surface water. This type of contamination occurs naturally as well as a result of erosion from agricultural land.

Erosion is a selective process. The finer particles are removed first and these fine particles are rich in plant nutrients. Research at the University of Wisconsin showed that fine eroded material carried over three times as much phosphorus as the soil itself. Where fertilizers promote a more vigorous plant cover and reduce soil erosion, the danger of enriching surface water with phosphates is reduced (3, 6).

The development of the modern phosphate fertilizer industry began with the demonstration by Liebig in 1840 that the fertilizing value of bones could be increased by treatment with sulfuric acid. Shortly thereafter, in 1842, John Lawes patented a process by which phosphate rock was acidulated with sulfuric acid. Lawes began the commercial production of this material in England in 1843 (9).

The primary source of fertilizer phosphorus in the United States was waste animal bones until the commercial production of phosphate rock began in South Carolina in 1867. South Carolina supplied practically the entire domestic output of mineral phosphate until phosphate mining began in Florida in 1888. Due to the highgrade of rock and the vast extent of the deposits, Florida soon became the leading source of fertilizer phosphate, a position it still holds today. Mining from deposits in the Western States has accounted for an increasing share of the phosphorus market in recent years (7).

The basic phosphate compound contained in all commercially important deposits of phosphate is apatite. If the phosphorus contained therein is to be rendered easily available to plants the apatite bond must be broken. This can be accomplished by treatment with heat or acid. The greatest tonnage of fertilizer phosphate materials is manufactured by treating phosphate rock with acid rather than with heat. The acids most commonly used are sulfuric, phosphoric, and nitric.

Sulfuric acid is basic to the fertilizer industry. It is used in the manufacture of ordinary superphosphate as well as in the production of phosphoric acid. Phosphoric acid is a basic ingredient in the production of triple superphosphate and the ammonium phosphates.

Ordinary superphosphate contains 7 to 9 per cent available phosphorus, the lowest content of any of the important sources of fertilizer phosphorus. Triple or concentrated...
superphosphate contains 19 to 23 per cent available phosphorus. The ammonium phosphates, produced by reacting ammonia with phosphoric acid, are completely water soluble and represent that group of fertilizer phosphates most rapidly increasing in popularity in the United States and abroad (9).

SUMMARY
Phosphorus is the second most critical plant nutrient. Phosphorus is essential to several processes in plants, but two roles illustrate the truly indispensable nature of this element. Phosphorus is a major constituent of chromosomes in the cell nucleus and is an essential component of energy transfer within cellular tissue.

In the final analysis maintaining sufficient available phosphorus in the soil requires a two-fold program; the addition of phosphorus containing fertilizers, and the regulation to some degree of the fixation and release of the added and native phosphates. Bearing in mind the ideas presented here, a turfgrass manager can do much to prevent the occurrence of phosphorus deficiency.

REFERENCES

Dollar Spot Fungicide Control Trial — 1977
By J. Troll and M. Bryant

The efficacy of several test fungicides was compared to that of standard chemicals for the control of Dollar Spot, Sclerotinia homoeocarpa. Chemicals were applied at several rates on two different sites to determine their significant effects on the control of the disease.

Test site one was a 40'x35' area of Emerald creeping bentgrass established in 1975 on a silt loam on the University of Massachusetts South Deerfield Station. Because of the dependency upon natural infection of turf by the fungus, it was decided to carry out a second fungicide trial on an older stand of bentgrass. Test site two was a 40'x36' area consisting of 40'x12' strips of Emerald, Seaside and PennCross creeping bentgrass.

Both sites were mowed twice weekly at 0.25 inch. To enhance fungus infection only 1.25 lbs. of nitrogen per 1000 sq. ft. were applied by July on each of the two areas with additional increments of nitrogen applied in August and September. Both bentgrass rates received applications of Trex-san bent for the control of broadleaf weeds and applications of Diazinon for insect control. In addition the test areas were topdressed with a sandy loam soil in May and verti-cut and topdressed in late August.

Each test site was divided into 56 randomized 5'x5' plots. There were 17 treatments, each replicated 3 times, plus 5 controls. The chemical treatments were initiated using a pressurized sprayer on May 25, 1977, and re-applied approximately every two weeks until August 9; The next application was made on August 30. Results are shown in Tables 1 and 2.

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TUESDAY, FEBRUARY 28

—Morning—

8:30 - 1:00 PM Registration—Lobby· Plaza Entrance

9:00 - 12:45 PM Industrial Show opens
Snack bar available
Exhibition Hall

—Afternoon—

GENERAL SESSION Banquet Room
Chairman: Dr. Joseph Troll
University of Massachusetts

1:00 Welcome
Dr. Allen V. Barker, Chairman
Department of Plant and Soil Sciences
University of Massachusetts

1:15 Effective Use of Golf Course Maintenance Buildings
Mr. Fred Scheyhing, Jr., Supt.
Mount Kisco Country Club
Mount Kisco, N.Y.

1:45 Photography
Mr. James Gilligan, Supt.
The Bedens Brook Club
Skillman, N.J.

2:15 Mosquito Control on the Golf Course
Mr. Fred Cheney, Supt.
Wentworth Fairways
Portsmouth, N.H.

3:00 Break

3:15 Turf Management with Less than Minimum of Water
Mr. William Spence, Supt.
Pebble Beach and Spy Glass Hill Clubs
Pebble Beach, California

3:45 Short Cuts in Golf Course Maintenance
Mr. Paul Voykin, Supt.
Briarwood Country Club
Deerfield, Illinois

4:30 - 6:30 PM Industrial Show open.
Cocktails available.
Exhibition Hall

4:45 Annual Meeting
Massachusetts Turf and Lawn Grass Council
Banquet Hall

WEDNESDAY, MARCH 1

GOLF COURSE SESSION Banquet Room
Chairman: Professor John M. Zak
University of Massachusetts

—Morning—

9:00 Chronic Organo-Phosphate Poisoning
Mr. Alan Bebka
TechniTurf
South Berlin

9:45 Water—An Exhaustible Resource
Mr. James R. Watson, Vice President
The Toro Company
Minneapolis, Minnesota
10:15  Budgeting in These Times
Mr. Robert Williams, Supt.
Bob O’Link Golf Club
Highland Park, Illinois

11:00  Industrial Show open.

—Afternoon—

2:00  Maintaining the Superintendent’s Image through Good PR
Mr. Palmer Maples, Education Director
GCSAA
Lawrence, Kansas

2:30  Nostalgic Look at 25 Years in the Turf Industry
Mr. Robert Miller
Lake Shore Equipment & Supply Co.
Wilmington, Delaware

3:15  Contemporary Approach to Thatch and its Impact
Dr. Kirk A. Hurto
University of Massachusetts

3:45  Using Glyphosate to Renovate Fairways
W. Thomas Kelleher, Asst. Supt. Grounds
Hercules Country Club
Wilmington, Delaware

4:30 - 6:30 PM  Industrial Show open.

—Evening—

7:00  Banquet and Winter School Graduation
Banquet Hall
—Speaker: Mr. Russ Burgess
ESP in Action

WEDNESDAY, MARCH 1

ALTERNATE SESSION
College Rooms

—Morning—

Chairman: Mr. Charles Mruk
Hercules, Inc.

9:00  General Turf Problems
Mr. Stanley Papanos, Agronomist
Cadwell and Jones
Coventry, Connecticut

9:45  Commercial Aspects of Tree and Turf Care
Dr. Roger Funk
Director of Research
The Davey Tree Expert Company
Kent, Ohio

10:30  Athletic Field Maintenance—Other than Golf Courses
Mr. William Hoopes, Manager
O. M. Scott and Sons
Marysville, Ohio

11:00  Industrial Show open.

—Afternoon—

2:00  Production of Woody Ornamental Plants
Dr. Roy L. Flannery
Rutgers University
New Brunswick, N.J.

2:45  Cemetery Tree Care
Mr. Irwin Benken, Supt.
Gate of Heaven Cemetery
Cincinnati, Ohio

3:30  Grounds Maintenance at Walt Disney World
Mr. Tony Virginia, Grounds Manager
Walt Disney World
Lake Buena Vista, Florida

4:30 - 6:30 PM  Industrial Show open.

THURSDAY, MARCH 2

8:30 - 10:00 AM  Industrial Show open.

GOLF COURSE SESSION
Banquet Hall

Chairman: Dr. Joseph Troll
University of Massachusetts

10:00 - 10:30  Some Current Thoughts on Poa annua Control
Dr. Thomas Watschke
Pennsylvania State University
University Park, PA

10:30  Golf Course and the Environment
Mr. R. Tek Nickerson
Eco-Logistics
Ms. Jeanne Shelburn
Landscape Architect
Cos Cob, Connecticut

11:15  Production of Northern and Southern Grasses in the Carolinas
Dr. William Gilbert
North Carolina State University
Raleigh, North Carolina

12:00  Are Your Management Programs Ready for 1978?
Mr. Stanley Zontek, Eastern Director
USGA Green Section
Highland Park, New Jersey

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Cooperative Extension Service, University of Massachusetts, United States Department of Agriculture and County Extension Services cooperating.

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Ferrous sulphate (FeSO₄·7H₂O) (20% Fe) was applied in a tank mix with each of the Acti-dione products. Both rates of Acti-dione TGF applied to plots on both sites on 5/25, 6/13 and 6/24 included the above ferrous sulphate formulation. The 7/12, 7/27, 8/9 and 8/30 applications to these plots consisted of single packaged Acti-dione TGF ferrous sulphate.

Mycelium of the dollar spot causal organism was observed mornings on the grass plots in late May and early June but damage to the turf did not occur until mid-June. It was expected that damage to turf in test site two by the dollar spot organism would occur at an earlier date and be more severe than damage to turf in test site one, but the opposite occurred. A possible explanation of this occurrence is the Emerald creeping bentgrass grown in our environment is highly susceptible to dollar spot. When the fungicides were applied on a somewhat bi-weekly basis most of them kept the disease in check (Tables 1 and 2). Also it appeared that nearly all of the chemicals applied at the double rate resulted in less disease. Test compounds El 222 and RP 26019 controlled the disease but both rates of El 222 caused turf discoloring. None of the other chemicals was phytotoxic. Both rates of single packaged Acti-dione TGF ferrous sulphate gave excellent control of dollar spot and were not phytotoxic. The Acti-dione formulations, tank mixed with ferrous sulphate, resulted in better disease control than those applied with iron. Ferrous sulphate not only has fungicidal properties but may improve turfgrass color and finish by enhancing plant chlorophyll production. However, turf plots that received applications at Acti-dione TGF mixed with ferrous sulphate and tank mixed Acti-dione Thiram plus iron applied at the higher rate had good color and turfgrass finish but the latter chemical produced more concentrated results. In addition, RP 26019 at 1.5 oz. and Dacron 2787 flowable applied at the 8 oz. rate improved turf color and finish. Failure to apply the fungicides on a bi-weekly basis (8/9 to 8/30), resulted in increased infection and injury to turf in both test sites. But it should be pointed out that the infection and injury in the control plots more than doubled during that interim. Also several of the fungicides, mainly those applied at the higher rates in test site one, either reduced the inoculum potential or possibly their residue held the disease somewhat in check for 3 weeks after the last application.

We wish to thank Upjohn, Eli Lilly, DuPont, Diamond Shamrock, and Rhodia companies for their contribution to these trials.
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Parks for the Year 2000

Increasing urbanization and decreasing resources will demand more innovative park designs in the years ahead.

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The Bicentennial festivities are over, and we are entering our third century as a nation. This seems an appropriate time to look at some of the most important factors which are certain to affect the planning, design and operation of park and recreation facilities over the next 100 years.

Several trends seem likely to influence the way we live. Each has implications for the way we will use our leisure time. The kinds of park and recreation facilities we design must reflect these changes.

Some trends are in conflict. For example, the conservation movement conflicts with our continuing urbanization.

Competition for diminishing land and resources and the choices for its use among the varied interest groups will become even more difficult in the future. Persons responsible for the planning, design and operation of recreation facilities will not only need to plan ahead to provide the types of recreation needed, they must make better use of the resources available.

Changing population

The post-war ‘baby boom’ periods are behind us. The average age of our population is on a steady rise. This trend brings with it an equally steady growth in the numbers of older, retired and semi-retired persons.

As a result, we are witnessing an increased interest in activities which can be enjoyed by older adults. These include walking, tennis, swimming, boating and nature-related activities.

An increasing proportion of our population receives a college education. The combination of better educated people and the increased numbers of older persons will create a demand for a variety of cultural activities. These can be successfully presented in a park setting.

A recent example of such a facility is ArtPark, a project of the New York State Parks & Recreation Commission. Located in Lewiston, N.Y., near Niagara Falls, ArtPark has a full program of performing and visual arts—theater, dance, concerts, poetry, painting, sculpture, crafts. Participation is encouraged through a series of workshops and visiting artists-in-residence. The park’s cultural events, performed in a natural setting, have proved extremely popular.

A summer cultural program in Chataqua, N.Y., probably the first of its kind in our country, has flourished for over 75 years. It provides the same formula of varied cultural and educational activities in a beautiful setting as does ArtPark. The two are less than three hours driving time apart.

Although their proportional numbers remain fairly constant, the handicapped are becoming increasingly mobile. Justifiably, they are demanding access to recreation facilities. The removal of barriers, wherever practical, is a long neglected consideration in recreation planning.

Continuing urbanization

The population of our largest cities has declined somewhat. However, medium and smaller cities and suburban communities continue to grow at a significant rate. Most of our people now live in urban areas. Their proportion of the total population will increase.

The older city centers are increasingly home to the poor and elderly. The lower tax base in these areas has often meant poorly maintained and understaffed park and recreation systems. Most state and federal parks are largely inaccessible to central city residents.

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Some recent developments indicate an increased awareness of the needs of city dwellers by both federal and state governments. The National Park Service, with its Gateway National Seashore for the New York-New Jersey harbor, provides one such example. Gateway will serve New York City, Newark and other metropolitan area communities. It will be accessible by subway and bus as well as by car. The park will preserve and protect forever miles of ocean beach and salt-water marsh from the pressures of development.

In addition, New York State recently completed its first state park within New York City. Roberto Clemente State Park provides swimming, playing fields and indoor recreation on the banks of the Harlem River. A proposed park, at Sherman Creek across the river, would complement these facilities and provide tennis, boating and picnic areas.

Mass transit's role
A simple way to make distant existing parks more accessible is to provide inexpensive mass transportation to the facilities. A bus service (or boat ride such as that provided by the Harlem River Day Line) can let persons without access to cars get to parks. The trip can be a pleasant experience in itself. And mass transit conserves precious energy.

Most of us realize that we will have to pay more for all of life's necessities — food, fuel, housing, medical care. The rest of the world will compete with us for dwindling resources. This means there will be less money to spend on recreation.

As a result, the popularity of such less expensive activities as hiking, biking, camping, and canoeing should increase. Also, the demand for more recreational facilities closer to home — picnic grounds, boating lakes, bike paths, hiking trails — will be on the rise.

 Provision of special trains, buses or boats could bring a number of parks within convenient reach. It would also save energy and reduce the traffic load which burdens many recreation facilities.

Adapting mass transit vehicles to carry bicycles and backpacks is relatively simple. It would certainly decrease the dependence on private autos. In addition, vehicles run-

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**Planning for young adults**

The number of young adults has not increased dramatically, but the activities they participate in has. To accommodate these needs, community recreation programs of the future will have to provide facilities for jogging, hiking, bicycling, boating, camping, physical fitness and adult education.

Here are some recent statistics that will have a definite influence on providing for young adult needs. Surveys indicate that the sharpest rise in recreation participation occurs when individuals earn $3000-$7000. Participation continues to climb with median family income in the $7000-$10,000 range, and then declines somewhat.

The higher a person's education level, the greater will be his rate of participation in recreation. And the number of people with college educations is on a steady increase.

Use of cars, bicycles and boats influences recreation participation. The mobility factor can be measured by determining the number of registered passenger cars and the number of residents of driving age.

The younger the population grouping, the more likely will be the demand on recreation facilities for competitive sports and group activities. The grouping between the ages 25-26 demands family facilities and activities such as picnicking, swimming, boating, arts and crafts.

Abandoned railroad rights-of-way offer an excellent opportunity to cities and counties for meeting hiking, biking and jogging trail needs. Development costs are lower since the railroad bed is established. Safety for the cyclist or jogger is increased.

The Burke-Gilman Trail in Seattle is an example of how a city can realize these benefits. The city acquired 7.2 miles of abandoned railroad right-of-way. This corridor winds through a variety of areas. It provides connections to three city parks and the University of Washington campus. Views of Lake Washington and the Cascade Mountains are plentiful.

Natural screening with trees and shrubs buffers adjoining property owners from the trail and the trail from noise.

Trail surface and configuration is a 10-foot-wide asphalt path with a 4-foot-wide crushed rock path adjoining it. According to the architect, Edward MacLeod & Associates of Seattle, the single-width asphalt path predominates because it:

- Accommodates maintenance vehicles.
- More easily handles peak commuter traffic to the university.
- Provides for side-by-side recreational bicycling.

A Florida city considers such activities as these important in its adult program — astrology, contract bridge, chess, china painting, golf, oil painting, photography, piano and voice, sculpture, Spanish, Yoga, automotive tips for women, creative playwriting, East Indian dance, exercise, square dancing, stocks and bonds and tennis.

It will be noted that several of these activities fall under the heading of adult education. With the number of do-it-yourselfers on the rise, this segment of a recreational program must receive strong support. There is a major difference, however, between what is usually referred to as adult education and recreational education.

Self-improvement or the acquisition of new skill or knowledge, often to achieve an economic or social advantage, prompts many people to enroll in adult education classes. The enjoyment or satisfaction to be gained from participation in the same type of activity explains why others choose to take part in it as recreation. The recreation planner must keep these differences in mind when looking at adult programs of the future.
ning on batteries or liquified natural gas are a pollution-free transporation mode currently used in parks.

Rehabilitation and reuse

Increased costs of new construction suggest that the rehabilitation of existing facilities might prove more practical and cost-efficient than building an entirely new facility. Even the reuse of abandoned structures for recreational purposes is possible. Old train stations, trolley barns and generating plants are a few buildings with a lot of potential for recreational pursuits.

Parks and recreation departments are often at the end of the line when it comes to allocating civic resources. Wise management of what already exists, and innovation in developing new, practical recreation places, are essential.

Our natural and man-made environment, as well as our personal health and well-being, are fragile resources. How they are protected and nurtured have wide implications for recreation.

We must also factor in the renewed interest in physical and emotional fitness. Jogging tracks or trails, physical fitness courses and bicycle paths can usually be incorporated in existing parks with minimum effort.

Interest in conservation and nature suggests the preservation of unspoiled areas in cities. The same applies to less accessible wilderness areas.

Even Manhattan has an area preserved in its original state — Inwood Hill Park. A sensitively designed system of trail markers and identification of plants and Indian dwelling places has enhanced the park’s value without disturbing its fragile ecology. Every community has a similar type of natural resource that could benefit from intelligent preservation.

Our built environment also needs preservation. It offers great potential for recreation.

In Lower Manhattan, the South Street Seaport has grown from a few donated boats to one of the city’s most popular recreation places. The seaport covers several acres of historical waterfront. It has sparked the rehabilitation of many nearby blocks of historical structures.

Almost a dozen vessels ranging from ferry boats to

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Planning for the elderly

About 400,000 citizens reach the age of 65 each year. On this basis, there will be an estimated 28 million older people living in the United States by the year 2000.

This burgeoning retirement-age population creates a challenge of first magnitude for parks and recreation departments. Latest Census Bureau figures show that although the number of births has declined, life expectancy has risen to a new high of 72.5 years.

Because of this rapid growth, a senior citizens recreational center is being recognized as more of a necessity than the teen-age center. Special indoor and outdoor facilities, somewhat removed from areas used by children in a public park, will become more in demand. Organized programs, conducted in large measure by the seniors themselves, are indicated, with some professional oversight.

The Bureau of Outdoor Recreation of the Department of Interior conducted a survey to identify and classify by age group the annual number of participants in a variety of outdoor activities. The survey revealed that picnicking, walking for pleasure and sight-seeing were rated high-preference items by those over the age of 65.

However, the survey also noted that the results did not necessarily mean that the elderly wasn’t interested in other types of activities. In fact, factors that prohibit more involvement included:

- Lack of specialized facilities.
- Inadequate financial resources for more costly activities.
- No means of transportation.
- Feeling of incompetence to participate in some activities.

Therefore, it is essential that in the years ahead local recreation planners have at their disposal facilities specifically designed for, or that are adaptable to, the needs of older people. Such facilities should be a part of any new housing development for the elderly.

Some equipment and certain new products have much potential for use by the aging. The golf cart is a good example. Its usefulness in such activities as traversing nature trails and scenic walkways needs to be explored. Use of synthetic turfs on rooftops or in basements of senior citizen complexes also has multipurpose possibilities.

Moreover, the elderly want easily accessible near-by parks where they can sit and chat and watch younger people and their activities. Parks have a valuable role to play in alleviating the loneliness which is a blight of city life. Heated glass pavilions could provide meeting places for elderly people throughout the year where they could watch the landscape and life of the park.

When planning for such special needs, it is important not to add to the isolation of the elderly by creating ghettos. The test of a successfully planned park is one where every type of person feels at home without resenting anybody else impinging on him or her.

A few cities have already developed fully equipped buildings and centrally located recreation areas for the exclusive use of the elderly. One New York county has gone so far as to assist older citizens in training to become 'club' leaders. It also provides consultation services, publishes a quarterly newsletter and an annual directory of services, conducts countrywide bowling and golf tournaments and organizes an annual boat ride for its senior citizens.

The increasing ranks joining the aging each year, plus their expanding need for leisure services, mean a significant share of the efforts to fulfill these needs and desires will be placed on cities and counties and their parks and recreation staffs.
square rigged schooners are moored at the port. A variety of well attended activities related to ships and the sea have emerged as a result.

Technology’s role

Shortly after the development of urethane wheels, skateboards swept the country. Fiber glass has made possible strong surfboards, kayaks and less expensive sailboats. Metal skis and plastic ski boots, along with snowmaking equipment, helped popularize downhill skiing. Lightweight cross-country skis and boots, and long lines and lift costs for downhill skiing, have promoted that sport. Ten-speed bicycles have greatly increased participation in biking.

Not all new developments are applauded. Snowmobiles have given new freedom to thousands. But they threaten formerly inaccessible areas with noise and pollution. Trail bikes have similar benefits and drawbacks.

The products of our technology will continue to present new recreation opportunities. They will sometimes create new threats to the environment.

The challenge is to provide facilities for those emerging recreation activities in balance with existing facilities. New activities should be enjoyed by both participants and spectators without disturbing the enjoyment of others. Some examples of how this might be accomplished are:

- Skateboard tracks with requirements for safety equipment by users.
- Beach areas set aside for surfing.
- Trails for snowmobiles and trail bikes with limits to their use in ecologically fragile areas.
- Underwater trails for scuba divers similar to the underwater preserve in St. Johns, Virgin Islands.
- Hills set aside for hang gliders, possibly utilizing ski hills during the summer months.

Existing facilities should be reviewed periodically. No doubt some newly emerging activities and interests could be accommodated within their confines without too much effort and expense.

For increasing numbers, work offers insufficient interest, excitement and challenge. They look to leisure pursuits for those satisfactions.

Much work has become dull, repetitive and devoid of risk or challenge. To compensate for this, we are seeing a rise in such dangerous and challenging sports as mountain biking.

Planning for the handicapped

Few aspects of the public recreation service have attracted greater interest in recent years than that of the physically handicapped and mentally retarded. Underlying the establishment of these programs is the conviction that this segment of our population, although remaining relatively stable, has the same right to participate in enjoyable recreation and to become as involved as others.

Recent federal regulations that make provisions for the handicapped a requirement for receiving funds have also spurred greater activity along these lines. Most important, experience demonstrates that while these people become absorbed in recreation, they forget about their infirmities and acquire confidence and satisfaction previously denied them. Still, much more will be expected in the future.

In planning for these citizens, it is necessary to concentrate on their abilities rather than their disabilities. Begin with the normal program and modify it as little as possible. Every community must have extensive opportunities for the deaf, the blind and those confined to wheelchairs. Making all facilities accessible is the first big step.

An attempt to integrate handicapped children into the normal recreation program through a carefully structured and gradual sequence of activities achieved success in a Massachusetts community. Family nights, buddy days and other integrated events supplemented the day camp and swimming programs for the physically handicapped children.

The program bridged the gap from segregated to total integration. As a result, many disabled children now participate in activities with their nonhandicapped friends.

Several cities have constructed nature trails for the blind. These ‘sensory trails’ help blind persons experience the wonders of nature through tasting, touching, smelling and hearing. Taped comments or legends in braille interpret the various stopping points along the trails.

What has transpired in West Germany might be a cue for the future in the U. S. Government agencies in that country will not subsidize the construction of a swimming pool at a public school unless it has an adjustable floor that can be raised and lowered hydraulically.

Weighing 80 tons, the pool floor is an Olympic size installation lifted by four hydraulic rams. It can be raised or lowered at the touch of a buttom from 1-10 feet. If desired, the floor can be lifted flush with the surrounding area and become a gym floor.

There has been more reluctance to initiate programs for the mentally retarded. But this is changing and the future appears brighter.

The Joseph P. Kennedy, Jr., Foundation, through its educational programs and financial grants, has focused attention upon the needs of the retarded.

One successful project is the Special Olympics program. Here, mentally retarded children participate in a variety of track and field events and team games. Many local departments already cooperate in this program. It gives children the chance to learn skills, follow rules, develop their capabilities and confidence and to take part in many activities previously not available to them.

In the future, we will continue to see these ‘therapeutic’ recreational services move out of the hospital, institution and treatment center and into the community. Cities and counties must prepare their staffs and their facilities now for these programs.
climbing, white water rafting and sky-diving. Areas should be set aside for these activities. Adequate protection for both participants and spectators must be provided in order to avoid possible costly (and extended) legal entanglements.

Alienation of many young people needs attention. We must involve them as much as possible in developing their own activities. Sports, drama, crafts and camping are a few. The alternative is disaffection and destruction. We can see this in the rising costs of vandalism. Strong materials are only the second line of defense. The first line must be the young people's belief that they count and that their needs are being considered as much as others.

Adults also need the opportunity to affect their environment. Not only should they choose how to use their leisure time, they should have a voice in decisions affecting their recreation options. Because resources are limited, all must participate in making the necessary choices among possible alternatives.

Many researchers, led by the findings of Swiss psychologist Jean Piaget, indicate that play is an essential activity in the development of growth. More than merely exercise or letting off steam, play constitutes the child's primary means of interacting with and understanding the world around him.

Play facilities become a vital component of every park, recreation place and school. Playgrounds need to be places where children can use their fantasies, explore the physical world and learn to get along with others.

Creative playgrounds, adventure playgrounds, and playgrounds oriented to nature will come to replace the current asphalt lots with scattered equipment. This kind of playground exists in Riverfront Park in Tampa, Fla.

A series of grass covered earth berms enclose an area of timber and cargo net structures on a bed of deep sand. Long slides wind down the earth mounds to the sand. Since they are built into the berms, there is no possibility of a fall.

None of the structures resemble animals, spaceships or fire engines. Rather, they allow the child the freedom of using his own imagination. A nearby building (also built into a berm) contains storage space for such creative play materials as paints, clay and paper.

Change is certain
The period we are entering will be full of technologi-
(Continued from Page 19)

cal, economic and social changes. All will affect the nature of recreation.

This presents the challenge of providing the required facilities in time of shrinking resources and competing priorities. Some solutions might include:

• Providing more facilities closer to people’s homes.
• Removing barriers to use by the handicapped.
• Emphasizing activities suitable for older users.
• Preserving valuable natural and man-made areas.
• Establishing energy-efficient transportation to parks.
• Providing specialized facilities for newly emerging sports.
• Involving people in decisions affecting their recreation options.
• Recognizing the creative play needs of young children.

The task will be difficult and challenging. Like recreation itself, it should be fun.

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