PROCEEDINGS

TWENTY-THIRD ANNUAL

SOUTHEASTERN TURFGRASS CONFERENCE

GEORGIA COASTAL PLAIN EXPERIMENT STATION

and

ABRAHAM BALDWIN AGRICULTURAL COLLEGE
COOPERATING

TIFTON, GEORGIA

APRIL 14-16, 1969

PROCEEDINGS

23rd Annual

Southeastern Turfgrass Conference

Tifton, Georgia

April 14-16, 1969

Sponsored By

UNIVERSITY OF GEORGIA COASTAL PLAIN EXPERIMENT STATION

In Cooperation With

ABRAHAM BALDWIN AGRICULTURAL COLLEGE,

UNITED STATES GOLF ASSOCIATION GREEN SECTION

and

SOUTHERN GOLF ASSOCIATION

TABLE OF CONTENTS

FOREWORD

Our America is desperately struggling with many problems — war, economic pressures, income tax revisions, schools, highways, airports and many others. We are struggling with the problem of the concentration of people and how to give them a little more living room for relaxation. Most employment is now based on a work week of 40 hours, but we are thinking in terms of a 36-hour week, and then possibly a 30-hour week. We are moving toward a system of holidays on Mondays, so we can have a long "week-end" for relaxation from our job.

Our "rest from work" is best spent under those conditions that relax us most — for one man, it may be along a trout stream, for another, on an emerald lake; or another, in a forest; or for still another, a beautiful golf course or a well manicured home lawn. As those of you associated with golf courses know, golf is becoming an increasingly important game for healthful exercise and relaxation. Those of us associated with turf appreciate your interest and support in our work. It is gratifying to know that we have been able to make some small contribution toward helping relieve some of the everyday tensions of mankind, and to be working with you who are making such major contributions. Hopefully, together through this 23rd Annual Southeastern Turf Conference, we have added a little more to the good life.

---Frank P. King, Resident Director
Georgia Coastal Plain Experiment Station

FACTORS THAT INFLUENCE GRASS GROWTH

R. H. Brown
Associate Professor of Agronomy, University of Georgia, Athens, Georgia

The subject at hand is too broad and inclusive to be dealt with in any detail. The discussion will be general, since special application of physiological principles to growing of turfgrass would be better left to those persons engaged in turf management. The clarity of our understanding of grasses is not sufficient to permit the abandonment of the "art" portion of managing turf, but continued development of our knowledge will mean easier solutions to some of the problems.

The management we subject grasses to depends on what we expect from these plants. If we expect a grass to furnish nutrients for livestock, we want as high a yield as economically practical, a high degree of palatability and digestibility, persistence, and perhaps good curing and storage qualities. If we wish a grass to provide a good carpet on which we get the proper "roll" from a golf ball, the only above quality we need is persistence. In addition, however, the grass should have desirable color, texture, disease resistance, and other characteristics which make it dependable. The basic factors involved in growing both of the above grasses are the same. Our management simply stresses manipulation of those factors in a way to obtain the desirable product.

Species and Varieties

It is obvious that not all plants or, for that matter, all grasses can be managed to give a proper turf. Some are too large and upright, others simply will not form a dense sod or maintain it. The range of species and varieties have, therefore, been narrowed tremendously. Genetic manipulation is a very useful method for improving turf grasses and it is being effectively used. The improvements made through breeding result, no doubt, from changes in morphology or physiology and an understanding of these two aspects of plant growth would allow plant breeders to more closely tailor grasses to specific needs. Although selection of species and varieties is an important consideration in turf management, we will omit this area from our discussion except as it relates to certain other factors.

Photosynthesis and Respiration

Although much research is being conducted into the basic nature of photosynthesis, the overall process can be expressed by the equation below:

$$CO_2 + H_2O \xrightarrow{\text{Sunlight}} \text{Sugars, amino acids, etc.} + O_2$$

In the process, carbon dioxide is absorbed and oxygen (O_2) is released. The sum of carbon, oxygen and hydrogen in photosynthetic products accounts for over 90% of the dry weight of plants. We normally estimate photosynthesis by measuring the amount of CO_2 absorbed by a leaf or plant. The process of photosynthesis is the transformation of energy from sunlight to chemical energy in the form of sugars, protein, and other organic compounds. Some of these components, particularly sugars and starch, serve as reserve energy sources for plants.

While photosynthesis may be described as the conversion of the sun's energy into chemical energy, respiration is the conversion of stored chemical energy into metabolic energy for the purpose of doing work in the plant. This work includes uptake and transport of nutrients, the pushing of reactions which make new cells and other functions. In some ways, respiration is the reverse of photosynthesis. Oxygen is used in the process and CO_2 is released. Energy is released by the breakdown of organic compounds rather than being stored. Instead of looking upon respiration as a wasteful and destructive process, however, we should view it as a process by which the energy stored by photosynthesis is used. We can estimate respiration by measuring the amount of CO_2 given off from a plant or organ.

Let us consider CO_2 absorption as a measure of photosynthesis and CO_2 loss as a measure of respiration and look at some factors which affect these processes.

(a) Light - Since sunlight is the source of energy used in fixing CO_2 in plants, it is logical to expect photosynthesis to increase with increased light intensity. This means that shaded plants and lower leaves in a grass community would fix less CO_2 and yield less than if they were in full sun.

Figure 1 shows the increase in photosynthesis by individual grass leaves as light intensity is increased. Under conditions of darkness, the leaves lose CO_2, that is, they respire, but do not carry on photosynthesis. As the light intensity is increased, photosynthesis increases rapidly at first and then by smaller and smaller amounts at higher light levels. Leaves become "light saturated" when light intensity is raised to a certain value. When light intensity increases above this value, no further increase in photosynthesis occurs. The amount of light required for light saturation

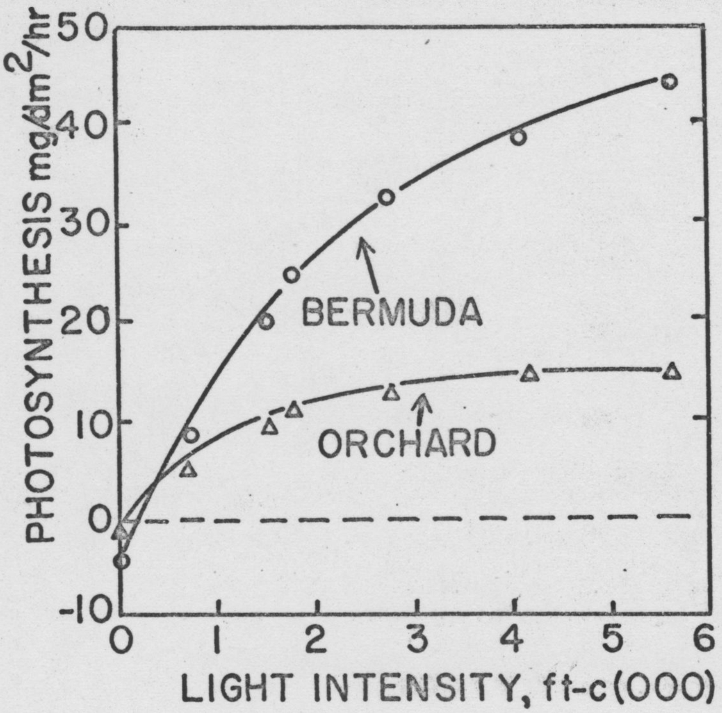

Figure 1. Photosynthesis (CO_2 uptake) of bermudagrass and orchardgrass leaves as influenced by light intensity.

depends on the species and conditions under which it is grown.

In recent years, it has been found that grasses are divided into two broad groups on the basis of their photosynthetic response to light. Tropical or warm-season grasses, such as bermudagrass and bahiagrass, increase in photosynthesis with increased light intensity up to near full sunlight. Cool-season grasses, such as ryegrass or bentgrass, are "light saturated" at 3,000 to 4,000 footcandles or about one-third of full sunlight. In addition, cool-season grasses have a photosynthetic capacity in full sunlight of about 50% of that for warm-season grasses. If photosynthesis is closely related to growth, as would be expected, then warm-season grasses should be more aggressive in full sunlight than temperate species. This is borne out in yields of pasture species from the two groups.

Effects of light on respiration are not as obvious as its effect on photosynthesis. There is a basic respiration process, called "dark respiration" because it is not affected by light, which provides much of the metabolic energy for the plant. In recent years, the process of photo-respiration has been discovered and studied. This is the loss of CO_2 in the light over and above dark respiration. Photo-respiration appears to be a special kind of respiration which contributes no useful energy to the plant. Photo-respiration reduces net photosynthesis, too, since it represents a loss of CO_2 at the same time that the plant is taking up CO_2.

In photo-respiration, as in light response to photosynthesis, there seems to be a difference in warm- and cool-season grasses. No photo-respiration has been demonstrated in warm-season grasses and this may partially account for the higher photosynthetic rate in these than in the cool-season grasses. Some preliminary work with tobacco and other plants indicates that the amount of photo-respiration may be genetically controlled. Therefore, it may be possible to use this characteristic in the selection of better plants once the significance of photo-respiration is understood.

(b) Temperature - Grass species have an optimum temperature range, above and below which photosynthesis decreases. The precise optimum temperature may shift, depending on light intensity and conditioning of the plants. Optimum temperatures are reduced at low light intensities.

Warm- and cool-season grass species differ in their optimum temperature for photosynthesis. Under full sunlight, the optimum temperature for cool-season species is 60 to 80° F., whereas the optimum for warm-season grasses is in the range of 80 to 100° F. Since photosynthesis supplies energy and materials for growth, it follows that optimum temperatures for growth are in the same range as those for photosynthesis. However, during short periods when a plant is using up stored reserves, it may grow faster at temperatures above the optimum for photosynthesis. This is because cell division and expansion and the process which drives them (respiration) increase up to temperatures much higher than those which are optimum for photosynthesis. Respiration and its relationship to reserve carbohydrate will be referred to later.

Plant breeding techniques may be used to alter the response of a species to temperature. Kentucky bluegrass varieties have been found to differ in temperature response by researchers at Virginia Polytechnic Institute.

Growth of the Nugget variety was much lower than that of PSU-124 at high temperatures (95-70^{O} F. day-night), but was greater at low temperatures (65-50^{O} F. day-night).

Temperature exerts an indirect effect on photosynthesis in addition to its direct effect. If moisture supply is limited, higher temperatures cause moisture loss from leaves to be excessive, producing dehydration and closure of stomata.

In addition to the direct effects of temperature on photosynthesis, it also affects respiration. Respiration does not respond in the same manner as photosynthesis, but increases with temperature until thermal damage of the tissue occurs. The temperature required for maximum respiration is, therefore, different from that required for maximum photosynthesis. Low temperature restricts respiration and growth is slowed down. In most cases, photosynthesis proceeds faster at low temperatures than does respiration and growth, giving the plant a surplus of energy which is stored for future use.

(c) Water - Biochemical reactions often involve water as one of the reactants. The main use of water in plants, however, is as a solvent in which enzymes can function as catalysts in putting together or breaking down organic compounds. Water is equally as important in its physical function of maintaining cell shape and arrangement. Photosynthesis is reduced when leaf-moisture content is low enough to close stomata, the entry ports for CO_2. We normally think of this as the way in which moisture shortage reduces plant growth. Some evidence suggests, however, that other processes are involved. In germinating seeds where respiration is the dominant process and photosynthesis is absent, low water content reduces both the germination and respiration rates. Respiration rates of leaves also drop when water content is low.

(d) Nutrients - The influence of various mineral nutrients on the processes we have been discussing is so vague and apparently complicated that I would like to touch on just a few points of interest. Some of the functions of mineral nutrients are apparent. Magnesium is a part of the chlorophyll molecule and, therefore, its importance in photosynthesis is in the manufacture of chlorophyll. Phosphorus is contained in the high energy intermediate compounds which are used to transfer energy trapped by photosynthesis and released through respiration to do the work of the cells. Many nutrients, such as magnesium, cobalt, molybdenum, copper and potassium, are required as cofactors in reactions mediated by enzymes. In other words, they help the enzyme in a specific manner to synthesize or break down metabolic components.

Nitrogen is an especially important nutrient to the turf manager because it enables him to maintain color and quality in grasses. It is the most abundant mineral element in most plants. Most of the compounds which direct the metabolism of plants, such as enzymes, chlorophyll and nucleic acids contain nitrogen. It would simplify matters if we could say the effects of increased nitrogen rates were the increase of synthesis of these compounds, but apparently its action is much more complicated. We do not know to what extent, if any, nitrogen fertilization at different levels influences photosynthesis of individual grass leaves. We are sure that respiration is stimulated at high nitrogen rates and there is evidence that it is stimulated to a greater extent than photosynthesis. The balance between photosynthesis, respiration and reserve substances may be the most important factor in the success or failure of a nitrogen-fertilization program.

(e) Aeration - When we think of aeration, we normally think of the effects of soil moisture and texture on root growth. Aeration of plant tops is just as important, but we do not dwell on this subject simply because it is not easy to do anything about it in the open air. Nurserymen can increase CO_2 content in a sealed greenhouse and increase photosynthesis.

We do need to aerate, that is, get oxygen to the roots so that they can oxidize their reserve materials to get energy for nutrient uptake, production of new roots, and other functions. Turf managers have various means for doing this and the experts in turf management are better qualified than I to discuss these methods.

Organic Reserves

Grasses store energy in the forms of organic compounds, mostly protein and carbohydrate. Reserve carbohydrate has been studied more thoroughly and we will limit our discussion to this fraction, although protein is undoubtedly used as reserve in some instances. Surplus carbohydrate accumulates when the energy supply through photosynthesis exceeds the needs of the plant for new tissue formation and other metabolic work. The level of reserve carbohydrates may then be an indication of the balance between photosynthesis and respiration plus growth. A plant growing at the limit of its photosynthetic supply would not be expected to store much carbohydrate. If growth rate is slowed down, the demand for energy and materials would drop and unless photosynthesis is reduced by a like amount, surplus carbohydrate would accumulate in stolons, roots and leaves. If storage reservoirs were filled to capacity, then photosynthesis would be reduced for lack of a place to store the products. In such a case, growth would control photosynthesis rather than the other way around. This may happen in perennial grasses more often than is realized.

Factors which affect carbohydrate storage include the following:

(a) Nitrogen - Numerous experiments show that high nitrogen rates reduce stored carbohydrate. The results in Figure 2 show a reduction in reserve carbohydrate when Kentucky 31 fescue was fertilized with 125 lbs. of nitrogen per acre. Growth increase and reduction of carbohydrate were both small when only 25 lbs. of nitrogen were applied. If the main effect of high nitrogen were stimulation of photosynthesis, reserve carbohydrate should increase. The fact that it drops indicates that nitrogen increases the demand for energy and materials (synthesis of new cells, respiration, etc.) more than the supply (photosynthesis). The stimulation of energy demands by high nitrogen rates at a time when demand is already high may create problems in maintenance of grass stands. In spring, when grass growth is rapid, carbohydrates are usually low. If high rates of nitrogen are applied at this time, added stress may be placed on the plant, resulting in a weakening of the turf. Presumably, grass plants may die when the need for energy and materials is much greater than the supply. One factor

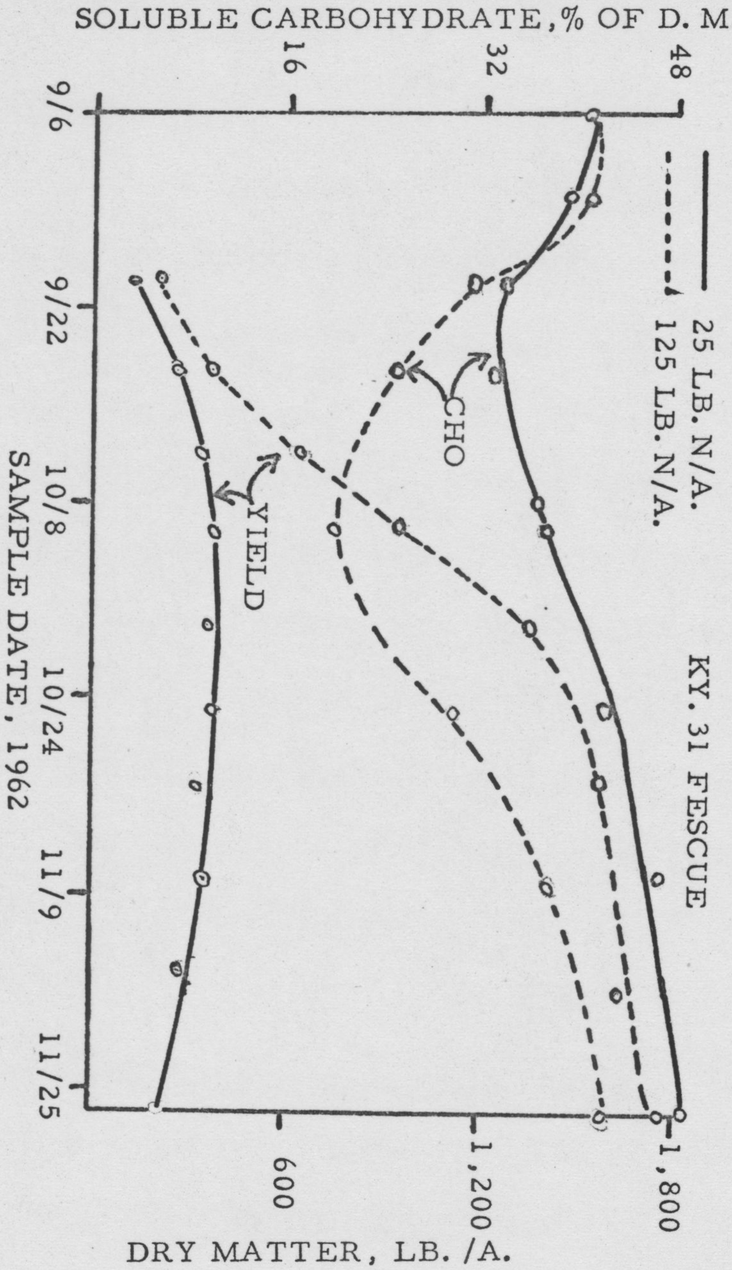

Figure 2. Growth and reserve carbohydrate changes in Kentucky 31 fescue fertilized with 2 rates of nitrogen.

which may weaken turf fertilized with high rates of nitrogen is reduced root growth. Experiments conducted in Virginia by Drs. R.E. Schmidt and R.E. Blaser[1] show reduced root growth at high nitrogen rates. Monthly applications of nitrogen at 2 lbs. per 1,000 sq. ft. during winter improved color, but reduced root growth as compared to 1 lb. per 1,000 sq. ft.

(b) Temperature - In general, reserve carbohydrate will be at a higher level when temperatures are low. Respiration and probably cell division and expansion increase with temperature up to high levels, so that the demands for energy increase. Photosynthesis reaches maximum at some optimum temperature and then decreases. At temperatures above the optimum for photosynthesis, reserve carbohydrates will be low because demands for energy are high. As mentioned earlier, this situation may be aggravated by high nitrogen fertilization. At temperatures below the optimem for photosynthesis, respiration and growth will usually be reduced more than photosynthesis, so surplus carbohydrates accumulate. In cool-season grasses, such as ryegrass, growth is slow below 50° F., but photosynthesis is near maximum. At this temperature, reserve carbohydrate accumulates to high levels.

(c) Water - One generally thinks of the primary effect of moisture stress as being closure of stomata, thereby cutting off photosynthesis. If this were so, reserve carbohydrate should drop. This is not the case, however, in most experiments. Instead reserve carbohydrate increases during drought. This indicates that water shortage may reduce cell division and

[1] Personal communication.

expansion to a greater degree than it does photosynthesis. It appears that the deleterious effects of drought are not due to carbohydrate depletion.

Distribution of Photosynthetic Products Among Plant Parts

In field crops, where we are interested in yield and often, from only a certain portion of the plant, the distribution of photosynthetic products is as important as the amount. If we harvest grain, a high yield of leaves and stems is of little interest. Distribution of dry weight among plant parts may be important in turf from the standpoint of maintaining a vigorous sod. In most cases, a high yield of leaves is not necessary if the color is good and, I suppose, is actually undesirable, since this leafage must be removed frequently. The diversion of photosynthetic products to stolons, rhizomes, or roots may be desirable. Such a diversion may be accomplished to some extent by cultural practices, but probably much better by selection of desirable plant types, such as dwarfs.

One unique aspect of this distribution problem may be involved in shade tolerance. Some recent Japanese work[2] with plants other than grasses indicates that those plants which shift distribution of photosynthetic products to organs other than leaves when placed in heavy shade are not tolerant (Table 1). On the other hand, shade-tolerant plants maintain or increase the percentage of dry weight going to leaves when placed in the shade. It is possible that turf grasses which differ in shade tolerance also differ in the distribution of dry weight among plant parts.

---

[2] Hiroi, T., and M. Monsi. 1964. Botanical Magazine of Tokyo 77: 1-9.

Table 1. The effect of shading on the growth of leaves as a percentage of total plant growth.

Plant Species	Sunlight %			
	100	50	22	10
Helianthus annuus (Not tolerant	31	38	16	-
Phaseolus aureus (Intermediate)	59	47	46	35
Impations parviflora (Tolerant)	47	45	47	55

CONCLUSION

The complications of physiology in plants often make one wonder how a comprehension of the whole picture will ever be obtained and of what use it will be in turf management. We have only to look at the powerful weed-control chemicals and the superior grass varieties we now use, which were developed with a scant knowledge of physiology, to get an idea of what can be accomplished when our knowledge is more complete. The most exciting prospect of all is that this knowledge will be put to practical use almost as fast as it is obtained.

GRASSES FOR THE GOLF COURSE

Glenn W. Burton
Research Geneticist, USDA and Georgia Coastal Plain Experiment Station, Tifton, Georgia

Grasses for the golf course may be classified into five types based on their use. These types, in order of their importance, are greens, tees, fairways, lawns, and roughs. Each has its specific demands dictated by the game. And we will do well to first consider these demands as we choose new varieties for the Southern golf course.

For top-quality golf greens, a variety must be able to withstand daily defoliation to a height of 3/16 inch and maintain a smooth, uniform surface that will keep the ball on a true course. Its leaves must be fine, soft and closely spaced to meet this requirement. Only two species, bentgrass and bermudagrass, can supply varieties that will meet these rigid demands and bentgrass is not dependable in most of the South.

For tees, a variety must be tough to stand the punishment doled out by the golfer and his clubs. It must have dense, stiff leaves to hold the ball well above the soil and it must heal rapidly to fill in holes left by the game. Bermudagrass, with its dense, rhizomatous habit, is unquestionably the South's best species for tees.

For fairways, a variety must make an attractive, uniform carpet dense enough to give a good lie to the ball. It must be able to heal divots rapidly and must tolerate considerable traffic. It must do all of this over a great variety of micro-environments with less water and care than greens and tees can afford. Many pros rank bermudagrass above all other species for fairways.

For lawns, a variety must make an attractive, green, weed-free surface in a number of sites, many of which are shaded and otherwise unfavorable for grass growth. A number of species, including bermudagrass, centipedegrass, St. Augustinegrass, carpetgrass, and zoysiagrass, may be used for this purpose. Although lawn areas do not affect the game directly, they add or detract from the beauty of the golf course and should be well maintained. Varieties that will achieve a satisfactory turf with minimum maintenance costs should be sought.

For roughs, a variety should make a green, reasonably weed-free cover of acceptable height with very little maintenance. It should not be a source of weed seeds for the remainder of the golf course and should not take over the fairway by gradual encroachment. Usually, the fairway grass, cut higher and less frequently, serves this purpose but the benefits to be derived from using another species should not be overlooked.

In addition to these specific demands, there are a number of general characteristics that should be present in golf-course varieties for the South. First and most important, I think, is dependability. These varieties (except for overseeded winter grasses) should be perennial regardless of the weather. They should maintain a green color throughout their growing period (hopefully to be extended by increasing frost resistance). Low maintenance costs and, of lesser importance, low establishment costs should receive major attention in the choice of each grass. Wear resistance, shade tolerance and low weed potential are other important traits to look for.

We can lower maintenance costs materially when we use grasses resistant to drought, disease, insects, nematodes, and weeds. Choosing the dark green, dense Tifway bermudagrass can reduce fertilizer needs, but may increase thatch problems, particularly if fertilizer applications are not reduced to match the needs of this grass. The dense growth required to give a good lie to the ball also adds wear resistance and materially reduces weed problems. Too much fertilizer, as it makes too much grass, will increase mowing costs, disease and insect-control problems, and will add to the difficult job of removing thatch. Finally, small or dwarf varieties that rarely produce seedheads can reduce mowing frequency and lower maintenance costs. Such savings may be offset, in part, by expenditures for herbicides to control the weeds that are usually more prevalent in areas planted to these less-vigorous grasses.

Except where greens cannot be overseeded, Tifdwarf is believed to be the best variety for golf greens. Properly managed (with regular mowing, verticutting, and top-dressing), Tifdwarf will make a better, faster putting surface than Tifgreen. Tifgreen is certainly the No. 2 variety for golf greens in most of the South and is first choice where overseeding is not practiced. It does not develop the purple color of Tifdwarf when temperatures are low.

For much of the Deep South, Tifway appears to be the best bermudagrass currently available for fairways and tees. Although Tifgreen has been used in this way on some courses, its greater susceptibility to insects and weed encroachment will probably require the use of more chemicals to maintain a turf comparable to that obtained from Tifway.

The maintenance costs on roughs can be materially reduced by planting them in centipedegrass. The low-growing centipedegrass, with very little fertilizer, mowing or insect control, can make a weedfree rough from which a ball can be quite easily played.

Choosing the best grass available for each job on the golf course can improve the course and usually reduce maintenance costs.

EFFECTIVE MOWING TECHNIQUES

J. R. Watson
Director of Marketing, Toro Manufacturing Corporation, Minneapolis, Minnesota

To be suitable for the production of turf, a grass plant must be able to grow and persist under the environment to which it is subjected. Good turfgrass is judged by standards of play-ability and usability as the case may be, and unless a grass is able to survive under the type of maintenance demanded by players or users, it must be replaced or maintenance practices be modified. Otherwise, use must be restricted. For those concerned with the production of turfgrass, restriction of use always should be considered a last resort. The primary objective of the golf course superintendent or turfgrass manager is to produce high-quality turfgrass suitable for play irrespective of environmental adversity.

More often than not, practices which are desirable for good grass growth have to be modified extensively to meet requirements for play. Such is the case with mowing practices. Height of cut on a putting green may serve to illustrate this point. The reduction in root growth that clipping to a height of 3/16 to 1/4 inch produces is well known — but try and convince a golfer that the green should be cut at a height of 1 or 1-1/2 inches, even 1/2 inch for that matter! To compensate for the reduction in root growth, all other maintenance practices — fertilizing, watering, cultivating and programs of disease, insect and weed control — must be balanced one against the other and applied more intensively and with greater care.

Management practices, including mowing, must be keyed to the use for which the turfgrass area is being produced — for example, a golf green, athletic field or industrial lawn. Such severely limits the number of grasses that may be used to produce satisfactory turfgrass, only a few (25-30) out of the more than 1,100 species known to grow in the United States. In view of the limitation that mowing places on selection of grass and intensity of management, it may be well to ask, "Why mow?"

Why Mow?

Appearance and playability are the principle reasons for mowing turfgrass. Unless it is mowed, a turfgrass area would soon become like an overgrown pasture — an area covered with loose-growing, spindly grasses and tall, rank weeds, which cannot persist under normal mowing practices. The manner in which turfgrass is mowed will greatly influence its health, vigor, density, degree of weed invasion and longevity. In fact, good mowing practices are perhaps the most important factor contributing to a well-groomed appearance and the longevity of any turfgrass area. The development of good mowing practices from an agronomic standpoint must be based on an understanding of growth habits and characteristics of grasses.

Growth Habits and Characteristics

On the basis of growth type, grasses like ryegrass, produce new shoots that grow inside the sheaths of the previous stem growth. Stoloniferous grasses, like bentgrass, spread by runners or stolons, which develop from shoots that push through the sheath and run along the surface of the ground. They root at the nodes (joints). Kentucky bluegrass, a rhizomatous type of grass, develops shoots at the underground nodes. Some grasses, such as bermudagrass and Zoysia, spread by both rhizomes and stolons. This is one reason why bermudagrass is such a vigorous grower and is so difficult to control and keep out of flower beds, gravel walks and similar areas. There are also intermediate types, with decumbent stems which root at the nodes, such as crabgrass and nimblewill.

The grass leaf is remarkably adapted for intercepting a maximum of sun rays essential for photosynthesis. The long, flattened grass blades provide a maximum of exposure with a minimum amount of protoplasm, thus, making efficient use of the living tissue. A reduction in the plant leaf area exposed to sunlight reduces the plant's capacity to carry on photosynthetic activity. This is a vital and basic consideration in determining the frequency and height of cut of turfgrasses.

The ability of grasses to withstand frequent and relatively close cutting is related to certain peculiarities of the grass family. Grasses exhibit basal growth, as opposed to terminal growth found in most other plants. Basal growth means growth initiates at the base rather than at the tip of the blade or stem. From a practical standpoint, this means that normal and frequent mowing does not cut off the growing areas of the grass leaf. Removal of too much leaf surface at any one cutting may, however, destroy some of the growing points.

<u>Height of Cut</u>

The height at which a given perennial grass can be cut and still survive for extended periods is directly related to its ability to produce sufficient leaf surface for the photosynthetic activity required for its growth. Basically, this ability is related to the inherent type and habit of growth found in the grass. The length of internodes, the number of stolons or rhizomes and the number of basal buds all influence the amount of leaf mass produced by a given grass, hence, affects its ability to withstand low heights of cut. Recent bluegrass selections — Prato, Windsor, Fylking, like Merion — are more tolerant of low heights of cut than common because of inherent characteristics.

Creeping-type plants, such as bentgrass and bermudagrass, when properly fertilized and watered, are able to produce adequate leaf surface at very low heights of cut (3/16 inch). Buffalograss, although a creeper, cannot produce sufficient leaf mass at low heights because too few basal buds exist and, therefore, cannot withstand low clipping. For this same reason, Kentucky bluegrass and fescue must be cut relatively high (1 to 1-1/2 inches). If bunch-type grasses are cut close, too much leaf surface is removed and the plant can no longer carry on sufficient photosynthetic activity to sustain satisfactory growth.

Frequency of Cut

Frequency of mowing is a most important consideration in the maintenance program. Infrequent clipping allows the grass to elongate to such a degree that any subsequent clipping removes an excessive amount of leaf surface. At no time should clipping amounts in excess of one-third of the total leaf surface be removed at any given mowing. Removal of large amounts of leaf surface will produce stubbly, unsightly turf, cause excessive graying or browning of the leaf tips, and curtail photosynthesis (production of food) with a resultant depletion of root reserves.

In addition, the accumulation of excessive clippings may smother the grass and provide an excellent environment for disease organisms and insects. The frequency of clipping must be governed by the amount of growth, which, in turn, is related to weather conditions, season of the year, soil fertility, moisture conditions, and the natural growth rate of the grasses and most important, the use for which the area is being grown. The use factor plays a major role in this respect because of its relation to height of cut. For example, greens are mowed daily because only a few hours are required for the plants to grow 1/16 of an inch; fairways, lawns and roughs less frequently because of their higher height of cut.

Other Considerations

In addition to the mowing practices related directly to habit of growth, there are other considerations that must be taken into account when developing sound mowing practices.

State of Growth

The stage of growth of turfgrass plays a major role in mowing practices. Young, tender growth in the spring is generally soft and succulent. The moisture content of young, immature turfgrass is much higher than that of mature grass. Such a condition influences mowing practices. Tender, young grass must be cut with a sharp, well adjusted mower to avoid mechanical damage, and the early growth must be cut frequently to avoid the problems associated with high moisture.

Moisture content and degree of softness or succulence at any given time will likewise affect mowing. Succulent grass will stick to mowers and "ball up."

Mowing practices during the early stages of growth exert a material influence on density of turfgrass. Cutting at heights somewhat lower than normal during early spring will encourage lateral growth, which, in turn, promotes density and helps prevent weed invasion.

Washboard Effect

Turfgrass areas regularly cut with power mowers or gang mowers sometimes develop a series of wave-like ridges running at right angles to the direction of mowing. If such is not caused by too wide a frequency of clip, it may be prevented or partially remedied by regularly changing the direction of mowing (diagonal or right angles). Alternate directions of cut will partially control runners of creeping grasses and aid in the prevention of grain and thatch. If clip is responsible, the height of cut must be raised or the mower replaced with a unit having more blades or a faster reel speed.

A very similar washboard appearance is often observed on turf areas, but is no fault of the mowing equipment or the operator. Many times, land is plowed for seedbed preparation and not properly leveled prior to seeding. Settling then takes place in the plow furrows and unevenness develops. Such a situation may be reduced in severity over a period of years by heavy aeration followed by dragging. The dragging operation helps to remove the soil cores from the high areas and deposit them in the low areas.

Wet Conditions

Mowing wet grass should be avoided as much as possible, although available labor and time often make it impractical to do so. Dry grass cuts more easily, does not ball up and clog the mower, and gives a much finer appearing lawn. Timing tests show that mowing dry grass requires less time than mowing wet grass.

Uneven Terrain

Mowers are not built for grading purposes. Turf areas containing high areas which are continually scalped should be regraded in order that they may be cut properly and to reduce the wear and possible damage to mowing equipment.

Inadequate insect control can become a serious mowing problem. Areas heavily infested with earthworms or ants may have many soil mounds caused by their activity. Such may cause soil to build up on rollers or in severe cases, simply cause the units to bounce, both cases resulting in an uneven cut. Mounds of earth, thrown up by gophers and other soil-burrowing animals will have the same result.

Improper Operation

Irregular or uneven cutting often occurs due to bouncing of the mowing units when they are pulled at excessive speeds. On specialized areas, such as putting greens, bowling greens, lawn tennis courts and sometimes tees, fairways and lawns, improper handling of the mower on turns will result in turf damage through bruising and wearing of the grass. Such damage frequently occurs when the grass is under stress for moisture.

Terraces and Banks

Terraces and banks offer a difficult mowing problem. Scalping generally will occur if the bank or terrace is mowed across the slope. Up and down mowing generally is the most satisfactory method of cutting these areas.

SUMMARY

Mowing is not a simple operation to be regarded merely as a means of removing excess growth. Mowing practices are related to the species and strain of turfgrass being grown. The inherent physiological, anatomical and morphological characteristics of a given grass will determine the height and frequency of mowing that will give the most satisfactory performance. Mowing is the most time-consuming of all management practices. It also has the most far-reaching effects on the appearance and longevity of any turfgrass area.

THE WHY AND HOW OF MOWING—REELS, ROTARIES AND VERTICAL MOWERS

J. R. Watson, Jr.
Director of Marketing, Turf Products, Toro Manufacturing Corporation,
Minneapolis, Minnesota

Machinery and equipment required for grass maintenance should be selected on the basis of the level of maintenance, the size, landscaping, kind of grass and use to which the turfgrass will be subjected. These considerations are basic when determining the size, number and types of equipment needed for efficient and economical operation.

To properly maintain grass areas, certain basic units are required. These include mowers, fertilizer spreaders, seeders or drills, aerators, sprayers, irrigation equipment and certain specialized items, such as edger trimmers, sweepers and rollers. For large scale areas, additional items like tractors, trucks, mist blowers, dusters, hydro-seeders and wood chippers may be required for the most efficient operation.

Mowers

Grass cutting is likely the major time-consuming phase of the grass maintenance program. Likewise, good mowing practices are perhaps the most important single factor contributing to the well-groomed appearance of turfgrass. In addition, proper mowing encourages more rapid coverage of turfgrass, promotes density and vigor and serves to check the growth of weeds. For these reasons, the selection and care of the mower are particularly significant.

The proper type and size of mower are important in maintaining any turf area. Mowers are available in varying widths and with numerous features. Requirements of a good mower are maneuverability, easy adjustment, durability, sturdiness, and adequate horsepower for the size of the mower and the usage expected.

Most manufacturers build two lines of equipment — "consumer" and "industrial" or "institutional." Consumer equipment is designed and constructed for cutting home lawns. It operates satisfactorily when used for a few hours a day or a few days a week. Industrial equipment, on the other hand, is built to stand up under 8 hours a day, 5 days a week usage for extended periods. It is of a rugged construction, functional design and is capable of performing under continuous use if cared for properly. Obviously, there is a considerable cost differential between the two lines, but as with most items, cost is a function of value received.

Four basic types of mowers are available — reel, rotary, sickle and vertical, including "hammerknife." Choice of a given type will be governed by the particular duties expected from the mower. Each type has certain advantages and certain limitations which need to be carefully considered when the selection is made.

<u>Reel</u>-type mowers are always recommended for the cutting of formal and semi-formal turf areas. High-speed, reel-type gang mowers are also the most efficient and economical types for mowing large open areas, such as fairways, parks, schools and airports. The cutting action of the reel is like that of a pair of scissors. Reels, when sharp, properly adjusted and in good operating condition, give a clean, even cut and leave turf areas with a smooth, well groomed appearance. The quality of cut

obtained with a reel cannot be equalled by any other mower; also less power is required to operate reels than rotaries.

Certain kinds of grass areas should always be cut with reel-type mowers. Special areas, such as putting greens, are a primary example. Bentgrass and fine-leafed bermudagrass lawns are another. To be properly groomed and cut, both require a high frequency of clip (the number of times the blades pass the bedknife as the mower traverses a given distance); otherwise, a riffled or corrugated appearance will result. Frequency of clip is a function of reel speed and the number of blades on the reel. With any given number of blades and a constant ground speed, the frequency of clip may be increased by increasing the speed of the reel.

Practically all reel-type power lawn mowers are self-propelled. Those towed in gangs require a prime mower; hence, self-propelling is unnecessary. Desirable features to look for in reel mowers are: (1) Handles easily adjusted for height to suit the individual operator; (2) Large sectional rollers or easy rolling casters, both of which improve handling qualities and prevent damage to good turf; (3) Safety guards over chains and mowing parts; (4) Controls mounted on handles or otherwise easily accessible; (5) Positive action clutches, which operate independent of engine speed; (6) A satisfactory range in cutting-height adjustments to adequately cover any use for which the particular mower is purchased; (7) Independent controls for tractions and reels to improve maneuverability and handling; and (8) Differential action to improve maneuverability and to prevent damage to turf.

Some of the limitations of reels include: (1) Reasonably smooth ground is required for good cutting; (2) They do not cut tall, rank weeds; (3) Height of grass that can be satisfactorily cut is limited by the diameter of the reel. As a general rule of thumb, the height to which grass may be cut is equal to one-half the diameter of the reel; (4) Reels are more subject to damage than rotaries; and (5) The cost of maintenance is generally higher than rotaries.

Rotary mowers are more adaptable to rough conditions and to areas where control of grass, rather than appearance is the predominant consideration. In addition to controlling the grass, they may also be used to: (1) Pulverize or grind leaves, thus, returning valuable organic matter to the soil; (2) Cut tall-growing, stemmy weeds, tall grass and other unruly vegetation; and (3) Trim, for which a small rotary may be used.

The rotary cuts by "impact," similar to the cutting action of a scythe. For this reason, a sharp, properly balanced blade is necessary to avoid a ragged tearing of the grass blade. Cutting with a dull blade generally results in a graying and subsequent browning of the leaf tip. An occasional touching-up of the cutting portion of the blade with a hand file will help reduce this condition. Keep a second sharp blade available.

Self-propelling of small, light-weight rotaries is generally not necessary. These units may be pushed with little effort. Self-propelling of large rotaries is a necessary feature. Other features to be considered when selecting a rotary mower are: (1) Safety — the blade should be completely covered, so feet and fingers cannot contact the blade when the engine is running. If ejection chutes are present, they should be designed to deflect downward. This prevents stones and other objects which may be picked up by the blade and ejected from causing damage to persons or property. (2) Blade should be firmly mounted to insure that it will never loosen up during operation. (3) Handle should be adjustable to suit operator. (4) Cutting height should be easy to adjust. (5) General purpose blades should be of the "suction lift" design to create air flow. This, in general, gives a better cut and is necessary if the mower is to be used to mulch leaves. A flat blade requires less power and could be used to advantage when high, rank growth is to be cut. (6) Wheels should be large enough to permit easy operation.

The cost of maintenance is low on rotary mowers; however, engine maintenance may be higher than on reel mowers. This is particularly true when rotaries are being used on thin turf and under dusty conditions, such as often exist when leaves are being mulched. Periodic cleaning of the air cleaner, as well as the use of a cloth bag over the cleaner, will greatly reduce this problem.

Power requirements — the highest of any type of mower, and scalping on uneven or rough terrain, along with poor quality of cut when blades are dull, are the major limitations of rotary mowers. The cost of maintenance is low on the rotary unit, although the cost of engine maintenance may be much higher than on reel units, particularly if the unit is underpowered.

Sickle mowers, because of their nature, are universally self-propelled. Sickles may be used to cut swaths along the base of steep slopes and along highway berms, where foreign objects, such as cans, bottles, etc., often interfere with proper reel or rotary operation. They may be used to advantage in rank, weedy growth, where only an occasional mowing is required and where the cut vegetation can be left without creating any particular hazard. The cutting action of a sickle is similar to that of a reel and if the knives are kept sharp, a satisfactory cutting job results. They have a wide range of height of cut and may be raised or lowered at will. This is particularly advantageous where mowing obstacles occur frequently. Sickles will cut a wider swath than any other single cutter available and the power requirements are probably the lowest for any type of mower. Hydraulic drive types are superior to the conventional mechanical drive types.

The very high cost of maintenance and relatively slow ground speed, 3 to 4 miles per hour, are the major drawbacks to sickle operation. On large expansive areas, their use is further limited because the single swath which they cut is considerably smaller than can be obtained by towing gang mowers.

<u>Vertical</u> - Vertical mowers are made with fixed blades or with free-swinging blades (hammerknife). They cut by impact similar to the rotary mower except that the blades travel in a vertical plane rather than in a horizontal plane. Hammerknife mowers can be used on a rough terrain more satisfactorily than rotary mowers because their short wheel base

lessens the possibility of scalping. They have a relatively high cost of maintenance.

Vertical mowers having fixed blades are used primarily for controlling thatch and grain on golf greens and other highly specialized turf areas.

CARING FOR THE MOWER

Lasting and satisfactory operation of all mowers may be obtained by following a routine program of care. The first step is to carefully read the service manuals (engine and mower) supplied with the machine. Train operators to clean, oil and grease equipment and to check each piece of equipment for loose bolts, nuts, chains, belts, etc. daily. On reel-type mowers, the life of the mower and quality of cut is dependent entirely on proper care and adjustment of the reel and bedknife. Any malfunctions which the operator cannot correct should be reported immediately to the service shop. Included in the owner's manual, which is supplied with every machine, is a suggested procedure for making adjustments. In almost every instance, the engineers who designed a piece of machinery also draw up procedures for adjustments. It should be standard practice to read and consult these manuals frequently. Such may save time in labor and money in parts. Mowers, in the final analysis, are wheeled vehicles; they have the same maintenance requirements and should receive the same type of care given trucks, cars and tractors.

SUMMARY

Adequate grass-maintenance equipment for one golf course, cemetery, park, highway or school system may be inadequate for another and excessive for a third. Therefore, equipment must be selected on the basis of the individual requirements for a particular organization. Terrain, landscape and available labor are some of the factors that will dictate the various kinds, sizes and types of equipment required for efficient operation. In addition, treating equipment purchases as capital expenditures and consulting the manufacturer or his local representative are other factors to consider when selecting equipment. The importance of selecting proper mowing equipment is evident when it is recognized that grass cutting is the most time-consuming of all turfgrass maintenance practices, and that mowing techniques contribute to the well groomed appearance desirable in all lawns.

DISEASE AND PEST CONTROL

Panel Discussion

Moderator: Dr. Homer D. Wells, Pathologist, USDA, Georgia Coastal Plain Experiment Station, Tifton, Georgia

Talk by Dr. Homer D. Wells

In bringing to your attention prospective new fungicides for the turf industry, it must be understood that these materials will have to meet a number of requirements before they become available to you. Only one of the criteria involves whether or not the fungicides are effective in reducing the amount of damage caused by certain turf pathogens. The materials that I mention have shown activity against certain turf pathogens, which I will discuss. Additional qualifications include health safety from the standpoint of the applicator, maintenance, personnel, and players using the turf. In addition to these factors, the manufacturers and suppliers must study the cost of production and the market potential to determine if sufficient profit can be made to warrant marketing the fungicide. Even though I may comment very favorably on the effectiveness of a new fungicide, it may never appear on the market with a turf label.

Non-Systemics

Terrazole has been evaluated by State experiment stations and on golf courses in several states. It is highly specific in reducing cottony blight damage caused by Pythium on ryegrass and bentgrasses. Present indications are that it will be necessary to apply the material at the rate of 1.4 oz. active per 1,000 sq. ft. at 6-day intervals during warm, humid weather to control Pythium. This fungicide is NOT EFFECTIVE against turf pathogens other than Pythium and, thus, will have to be used in a program in which other fungicides are relied upon to control such pathogens as those which cause leaf spots, brown patch, dollar spot, etc.

Systemic Fungicides

There are two Oxathiin compounds that have shown systematic activity against Pythium sp. and Rhizoctonia solani (the organism that causes brown spot on turf) on some non-grass crops and for the control of smut on grass. In some of our tests, Chloroneb has been effective in reducing cottony blight of ryegrass. However, we have not demonstrated this effectiveness in controlling cottony blight on ryegrass to be systemic.

The new and closely related systemic fungicides, Benomyl and Thiabendazole, appear to be highly effective in controlling both brown patch and dollar spot on turf. They also appear specific for one or two other turf diseases. In addition to having a curative effect, as much as 30-day protection has been obtained against both brown patch and dollar spot with the rate of 2 oz. active per 1,000 sq. ft. A number of turf pathogens are not affected by these fungicides.

The exciting feature of all these systemic fungicides is that once it is absorbed into the plant, irrigation and precipitation will not wash them off the plants.

Currently Used Fungicides

I am not going into a description of the currently available fungicides or discuss their merits. Most of this information has been available to you for a considerable period of time. You will need to continue using most of these fungicides in your disease-control programs. However, we must readily admit that Pythium sp., Rhizoctonia solani, and Sclerotinia homeocarpa are responsible for extensive damage under our present fungicidal programs. Therefore, new fungicides that may be more effective in controlling these three pathogens will certainly aid in solving our current disease problems. One must caution, however, that a shift to the newer compounds and a discontinuance of the present fungicides could result in a disaster from an organism that is currently being effectively controlled and, thus, not noticed. Therefore, I recommend that new fungicides, when they become available, be used as additions to the current disease-control program and not as a substitute.

Talk by Dr. A.W. Johnson, Nematologist, USDA, Georgia Coastal Plain Experiment Station, Tifton, Georgia

Many types of plant-parasitic nematodes are found abundantly in turf, apparently in all areas of the world. Much of the early work in nematology was taxonomic in nature and only recently has attention been focused on nematodes as turf pathogens.

Research into the pathogenic capabilities of ectoparasitic nematodes by workers in Florida made possible an understanding of nematode damage to turf grasses. Subsequently, the introduction of relatively non-phytotoxic nematicides containing 1,2-dibromo-3-chloropropane and other nematicides provided nematologists with chemical tools for demonstrating the effects of nematodes through control. Numerous trial applications of nematicides have been made during the past 15 years and, in most cases, significant growth response was noted. Gradually, the use of nematicides on golf greens and home lawns has become a standard practice in areas where nematodes are an acute problem and high quality turf is desired.

Plant-parasitic nematodes are microscopic animals (1/75 to 1/10 of an inch long) that inhabit the soil as eggs, larvae, and adults. They are round in cross section and usually are worm-shaped, but later stages of some, such as root-knot nematodes, become swollen to a pear shape. Most nematode species have males and females, but some reproduce by parthenogenesis.

Plant-parasitic nematodes are equipped with a stylet (a hollow, needlelike structure), which is used to puncture and enter individual plant cells while feeding. Some mechanical injury results when nematodes penetrate roots and individual cells, but most plant responses are caused by secretions from the esophageal glands of nematodes. These secretions act in a variety of ways and affect the morphology and physiology of plant hosts. Grasses respond to the feeding of root-knot nematodes by producing a group of enlarged cells and by producing a large number of cells near the giant cells, which result in a galled or enlarged root. In contrast, the ectoparasitic nematodes, such as sting and stubby-root, usually feed at or near the root tips by inserting their stylets into the developing cells. The esophageal secretions suppress cell division by the host and cause cessation of root growth that results in a stubby, shallow root system. Other nematodes feed along the sides of older roots, while wholly or partially embedded within the roots.

Plant-parasitic nematodes have been associated frequently with turf decline and are considered responsible for injury to grass in home and industrial lawns, turf nurseries, and golf course greens. For the most part, experimental tests to determine the type and extent of nematode damage to most grasses have not been conducted. However, the pathogenicity of a few parasites has been established on several major turf grasses, including Tifgreen and Tifdwarf bermudagrass.

The sting nematode (Belonolaimus spp.) is one of the largest nematodes that feed on turf. Generally, the nematode is found in sandy soils and is one of the most commonly found genera on turf in Florida, Georgia, and South Carolina. However, it can become established on golf greens in other areas if it is introduced. Sting nematode causes a severe chlorosis, stunting of top growth, and a stubby-root system.

The stubby-root nematode (Trichodorus spp.) is a relatively small animal. Its stylet is curved, and it feeds exclusively at root tips. The major effect on grass caused by the stubby-root nematode is reduction in root size with fewer and shorter rootlets and stubby tips, very similar to sting nematode damage.

The lance nematode (Hoplolaimus spp.) is one of the most commonly found genera in turf surveys. This nematode may feed while partially or completely embedded in root tissue, and causes severe stunting and "dying out" in some of the bermudagrasses.

Stunt nematodes (Tylenchorhynchus spp.) are often referred to as pests of turf. Several researchers have reported the presence of stunt nematodes in turf grasses, although little is known about the effects of these nematodes on turf. Severe turf decline has been associated with these nematodes, especially on sandy soils of the Lower Coastal Plains.

Ring nematodes (Criconemoides spp.) are so named because of the heavy annulation of the cuticle. These nematodes are very short and are equipped with a long stylet. The exact role of these parasites is questionable, but in some areas, injury to turf has been attributed to certain species. These nematodes feed in the root hair zone on large and small roots.

Pseudo-root-knot nematode (Meloidogyne graminis) larvae enter roots and migrate through root tissue until they find a desirable feeding site. They begin to feed, and maturing females swell and assume a pear shape. At this stage of development, they are no longer mobile and remain in the stationary position for the remainder of their life cycle. Adult females are usually embedded completely in the root tissues, although some variations have been noted. The pseudo-root-knot nematode, described in 1964, has attracted much attention as a parasite of turf grasses. It is thought to be widespread in the United States. Although the nematode appears very similar to the root-knot nematode, it causes only slight swellings at infection sites on grass roots. The pseudo-root-knot nematode causes grass to be stunted and chlorotic, and prevents normal root development.

There are several other genera which probably cause injury to turf, but because research on pathogenicity is lacking, they have not been implicated as serious parasites of turf.

The general symptoms of nematode injury to turf grasses may appear on the foliage as slight to severe chlorosis and declining growth, usually in circular to irregular patches. These symptoms are generally more evident in periods of hot weather, moisture stress, and under poor fertility management. However, under the most ideal conditions, such as turf on golf greens, nematode injury will become evident once populations have increased to damaging levels. Most golf greens are constructed to provide optimum aeration and available soil moisture. These conditions are ideal for development of most nematodes. Damage to roots may appear as sparseness of roots, discoloration, a stubby-root condition, galled or slightly swollen rootlets, or a combination of these symptoms depending on the species of nematodes attacking the grass.

Control of nematodes in turf is difficult because they are in the soil, feeding on or within roots. Chemicals used for control must kill nematodes in or around the roots without causing significant damage to turf. To date, eradication has not been obtained in turf because nematodes are found at all depths in the soil where roots grow. Two types of nematode control are possible — chemical and non-chemical. Much more emphasis has been placed on chemical control because other means have not proved effective.

Chemicals which act as fumigants are not satisfactory on established turf because of their phytotoxic effects. To qualify for turf use, a fumigant should convert to a gas when placed in the soil, penetrate the soil, and kill nematodes without causing significant injury to grass roots.

Fumigants are especially useful if they are applied prior to planting turf.

Recently, a number of nonvolatile insecticide-nematicides have been investigated. These materials are applied to the turf surface and washed in with irrigation water. There is no fumigant action from the materials, thus, the nematode must come in contact with the chemical. Among the nonvolatile nematicides are a group known as organophosphates. When applied to turf, some of these materials are absorbed by roots and become systemic in plants. Excellent control and turf response have been obtained for many of the nonvolatile nematicides, and several states have approved them for use on turf. These nematicides, listed in Table 1, have proved effective at rates given in the Southeastern United States. Others may prove effective in different areas. These materials are applied to the surface and then drenched into the soil with water. Emulsifiable liquids should be applied with a low-pressure sprayer or a sprinkler can and then additional water should be applied by sprinkler irrigation. Granular formulations may be applied dry and the treated areas then irrigated. Apply a minimum of 100 gallons of water per 1,000 sq. ft. of turf area. Best results are obtained with irrigation of up to 1 inch of water. Irrigation must immediately follow application in order to minimize the chances of foliage burn by chemicals.

Organophosphate nematicides affect nematode population densities differently than do fumigants such as Nemagon. Populations are reduced much more gradually by the organophosphates, but the visible turf response is quicker. Application should be made in early spring, when the grass begins to grow. Any response by the grass should be visible within 4 weeks. The degree of response is determined by the type and quantity of nematodes present.

Although a few turf grasses show resistance to certain nematode species, there is no single grass that is resistant to all species of nematodes. Little attention has been given to the possibility of breeding nematode-resistant turf grass varieties.

To date, nematode control in turf is not adequate, and research must continue in this field to produce a means or a chemical that will provide long-term control of most nematodes that attack turf.

Table 1. Chemicals suggested for nematode control on established turf.

Nematicide[a]		Rate of active ingredient/A.
Nemagon	1,2-dibromo-3-chloropropane	3 gallons
Sarolex	O,O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate	30-40 lbs.
Dasanit	O,O-diethyl O-[(p-methyl-sulfinyl) phenyl] phosphorothioate	10-20 lbs.
Mocap	O-ethyl S,S-dipropyl phosphorodithioate	15-20 lbs.

a/ These chemicals are not registered for turf use in all states. Care must be taken to check with state authorities before using.

Mention of tradename or a proprietary product does not constitute a guarantee or warranty of the product by the USDA, and does not imply its approval to the exclusion of other products that may be suitable.

MANPOWER ON THE MOVE

Panel Discussion

Moderator: Mr. James B. Moncrief, Southern Director, USGA Green Section, University of Georgia, Athens, Georgia

<u>Talk by Palmer Maples, Jr.</u>, Charlotte Country Club, Charlotte, North Carolina

If we are to have men to do the required work on golf courses, and are to have an efficient operation, we first first consider the man himself. This outline is of things that may be considered in relation to hiring men, benefits, and some other helpful items of consideration in keeping manpower on the move.

<u>Men</u>

Wage and hour laws

Competition with surrounding industry

Medical and life insurance

Retirement plans

Uniforms

Policy: Work hours, time off, sick pay

<u>Training for Work</u>

Show how

Communicate

Make sure all training is understood

Explain what, when, where, how, and why

Telephone

Means to communicate

Order supplies

Check with other superintendent

Camera

Pictures are a good source of information and record.

Records

Weather

Fertilizer

Top-dressing, etc.

Salesmen

Time

Reason for call

Information

Member of local association

Equipment

Trays for tractors

Transport greens mowers

Riding mowers

Top-dressing machines

Cleaning time allowed

Radios

Bulletin boards for instructions

Automatic irrigation equipment

<u>Talk by Stan Clarke,</u> LaGorce Country Club, Miami Beach, Florida

I would like to name my part of this program "Efficiency in Operations Through Newer and More Effective Use of Machinery."

Many man hours can be saved by the use of machinery. The man hours saved can be used for other operations on the golf course.

The following slides show some of the changes in the last seven years that I now use. The first slide shows the old way and the second slide shows a more efficient method of doing a particular operation. I am sure, as golf course superintendents, you are currently using methods I know nothing about at this time that could help me.

I am not endorsing the use of any type product, but use these slides to show the idea of manpower on the move through efficient use of machinery.

Slide #1 - Mowing greens

Slide #2 - Aerifying greens

Slide #3 - Vacuuming greens

Slide #4 - Moving men and equipment

Slide #5 - Automatic irrigation

Slide #6 - Mowing tops of tees

Slide #7 - Fairway mowing

Slide #8 - Top-dressing greens

Slide #9 - Verti-cutting greens

Slide #10 - Edging sand traps

Slide #11 - Raking sand traps

Talk by William R. Graham, Manager, Grounds Maintenance Department, Physical Plant Division, University of Georgia, Athens, Georgia

Thank you, gentlemen, for giving the University of Georgia an opportunity to get up here and present to you a little information on our grounds maintenance program. You have heard from three representatives of the golf course industry, telling you about their particular maintenance programs and their manpower situations.

In ancient Greece, philosophers thought out their grandest ideas walk-up and down their groves. Nature sobers man. But if nature sobers, she also consoles.

Edmond Burke said, "To make men love their country, one must make their country lovely." This is very true because actually, all of us are involved in this business of making our particular areas lovely, in the broadest sense of the word. At the University of Georgia, we feel that this is our direct responsibility — to make our campus into such a place that the environment will encourage students to learn. A shabby, unattractive, unimaginative campus is a very discouraging place and, certainly, is not conducive to learning.

How is all of this accomplished? Through planning, designing, developing and then, maintaining. Manpower — the proper manpower — is the indisputable, most important single factor in accomplishing this purpose.

The University of Georgia campus consists of 575 total acres. Broken down into how this land is used, we have: 414 acres of grounds, 93 acres of pavement, 53 acres of buildings, and the rest is county and city streets and railroads. The Grounds Maintenance Department is responsible for maintaining 507 of these acres. This includes the grounds and the University-owned pavement.

I know that we are extremely fortunate at the University of Georgia in having good manpower. We do not have an adequate supply of manpower and at present, are under our budgetary strength by 10 people. The vast majority of the people on the payroll are good, reliable, hard-working men and perform their jobs in a satisfactory manner. I think that an important reason for our having this good labor force is because the hiring is done only by our foremen. The foremen are in contact throughout the day with these workers and know enough about people and our work requirements to properly evaluate each applicant. Naturally, we make some mistakes but by placing the hiring and firing responsibility on the foremen, we have fewer mistakes.

I have a series of slides here that I think will illustrate to you in a more vivid manner what type manpower I am talking about and how this manpower has been used to produce some very, I think, beautiful results.

Thirty-six slides were shown to illustrate the abovementioned point.

Thank you, gentlemen, for giving me this opportunity and in closing, I would like to again point out that the importance of having the proper environment on our campuses. This is being realized by the University System Administration and, consequently, we are being given a fairer share of the funds that are needed to accomplish this. I also strongly feel that because of the growing importance of the ground work at these institutions, the equipment manufacturers will soon turn more of their time and attention to solving the problems that we have on our campuses.

ATTENDANCE ROSTER

ALABAMA

Name	Affiliation	City
Borland, Bob	Arrowhead Golf Club	Montgomery
Brown, W. M. L.	Tieco, Inc.	Birmingham
Casey, A. F.	Casey Enterprises, Inc.	Birmingham
Edmondson, Carl J.	Bonnie Crest Country Club	Montgomery
Goodwin, Gary D.	Hillcrest Country Club	Birmingham
Green, John J.	Cumberland Lake Country Club	Birmingham
Moses, Cecil (Pee Wee)	Montgomery Country Club	Montgomery
Nelson, Norman E.	Cumberland Lake Country Club	Pinson

DELAWARE

Miller, Bob	DuPont Company	Wilmington

FLORIDA

Arnold, Charles L.	Florida Tractor Company	Jacksonville
Baker, Chan W.	860 N. E. 75th Street	Miami
Burt, E. O.	Plantation Field Laboratory	Ft. Lauderdale
Caswell, Barry	Melbourne Golf & Country Club	Melbourne
Clarke, Stan	LaGorce Country Club	Miami Beach
Davis, Vander B.	Eglin AFB Golf Course	Crestview
Deatherage, A.M.	Daytona Beach Golf & Country Club	Daytona Beach
Derzypolski, M.S.	Capital City Country Club	Tallahassee
Ervin, Eddie L., Jr.	Turfgrass Times	Jacksonville Beach
Heine, Bobby Ray	Woodlands Country Club	Ft. Lauderdale
Hensel, Art	O.M. Scott & Sons	Apopka
Hines, Reuben P., Jr.	Sunset Golf Course	St. Petersburg
Hitchings, Dave	Rohm and Haas	Homestead
House, Lee M.	Gadsden Country Club	Quincy
Jacob, Karl	Westview Country Club	Miami
Johnson, Lawrence	Buckner Sprinkler Company	Jacksonville
Lambert, Skip	Vero Beach Country Club	Vero Beach
Mascaro, Charles G.	Milwaukee Sewerage Commission	Miami
McCartha, Harry	Florida Milorganite	Miami
Morrison, Oscar P.	Biltmore Golf Club	Miami
Nelson, W. F.	2011 - 3rd Ave., No.	St. Petersburg
Nutter, Gene	Turfgrass Times	Jacksonville Beach
Ousley, J.E., Sr.	Ousley Sod Company	Pompano Beach
Proud, Roland	E-Z-Go Car Div., Textron, Inc.	Ft. Lauderdale
Reemelin, Ben	Zaun Equipment	Jacksonville
Schmeisser, Hans	Forest Hill Golf Course	Hollywood
Schmeisser, Otto	Indian Creek Country Club	Miami Beach

Name	Affiliation	City
FLORIDA (cont.)		
Sheff, Richard P.	Sheff Chemical	Bradenton
Shepard, Willie	Riviera Country Club	Daytona Beach
Smith, Carl	Palm Beach Country Club	Palm Beach
Thomas, M. O.	Woodbury Chemical Company	Princeton
Turcotte, Paul	LeJeune Golf Course	Miami
White, Colman	A.C.R. Golf Course	Pensacola
White, Ralph	Southern Turf Nurseries	Lighthouse Point
Williams, James R.	924 S. Campbell Street	Daytona Beach
GEORGIA		
Armstrong, Gene	Cowan Supply Company	Atlanta
Balfour, Robert L.	Club Car, Inc.	Augusta
Baston, Allen	Augusta National Golf Club	Augusta
Baston, Gene	Savannah Inn & Country Club	Savannah
Bateman, Edwin N.	Bateman Company	Albany
Baumgardner, T.M.	Sea Island Company	Sea Island
Bolton, J. E.	Ga. Tech Athletic Assn.	Atlanta
Bouwmans, Jan H.	City of Atlanta, Parks Dept.	Atlanta
Boyette, Henry	Coastal Plain Exp. Station	Tifton
Briguglio, Joseph P.	Navy Glynco Golf Course	Glynco
Brown, Maynard, Jr.	Idle Hour Country Club	Macon
Brown, R. H.	University of Georgia	Athens
Browne, George R., Jr.	Route 2	Cleveland
Bruner, J.C., Sr.	Calhoun County Country Club	Edison
Burns, Robert E.	Georgia Experiment Station	Experiment
Burton, Glenn W.	Coastal Plain Exp. Station	Tifton
Cagle, H. M.	Druid Hills Golf Club	Atlanta
Carter, Robert L.	Coastal Plain Exp. Station	Tifton
Cason, Tom	Grounds Maintenance	Tifton
Chason, W. B.	Patten Seed Company	Lakeland
Clements, Lee	Coastal Plain Exp. Station	Tifton
Cocke, William W.	Dublin Country Club	Dublin
Conner, Jerry	Regents of University of Ga.	Atlanta
Cook, Earl	Coastal Plain Exp. Station	Tifton
Cooper, Jarrell	Coastal Plain Exp. Station	Tifton
Cordell, T. M.	Abraham Baldwin Agr. College	Tifton
Cottle, Donald H.	Dixie Turf Farms	Ty Ty
Crumpton, John R.	Grounds Maintenance	Tifton
Danner, Charlie	Capital City Country Club	Atlanta
Dasher, Lee	Cowan Supply Company	Atlanta
Dekle, C. I.	Forest Heights Country Club	Statesboro
Derrickson, M. E.	Cherokee Golf & Country Club	Cedartown
Douthit, Gene	Pineknoll Country Club	Sylvester

Name	Affiliation	City
GEORGIA (cont.)		
Doyle, Neal	Fort Gordon Golf Course	Augusta
Driggers, J. Clyde	Abraham Baldwin Agr. College	Tifton
Dunning, Alvin W.	Augusta Country Club	Augusta
Ellis, Bobby G.	Robins Air Force Base	Robins AFB
Elsner, Earl	University of Georgia	Athens
England, Henry G.	Bobby Jones Golf Course	Atlanta
Evans, Rufus	Dixie Turf Farms	Ty Ty
Evans, Thurlow	Stovall and Company	Atlanta
Faria, James M.	Monsanto Company	Atlanta
Fincher, B. A.	Stovall and Company	Atlanta
Flanders, C. Dyson	Sea Island Company	St. Simons Island
Fussell, George T.	Dalton Country Club	Dalton
Goodwin, Howard	Club Car, Inc.	Augusta
Goodwin, J. Wayne	Lawn and Turf, Inc.	Conyers
Graham, William R.	University of Georgia	Athens
Greenway, James L.	Kaiser Agricultural Chemicals	Savannah
Hardcastle, W. S.	Georgia Experiment Station	Experiment
Harris, Verdon	Jekyll Island Golf Club	Jekyll Island
Harrod, J. E.	DuPont Company	Atlanta
Hassell, Grady T.	Lawn and Turf, Inc.	Conyers
Hayden, Harold H.	Cowan Supply Company	Decatur
Hendrix, Sammy	Evans Height Golf Club	Claxton
Herb, Richard	Overlook Golf Course	Loganville
Holman, Bob	Cowan Supply Company	Atlanta
Howell, D. B.	Athens Country Club	Athens
Jensen, Ray	Southern Turf Nurseries	Tifton
Johnson, A. W.	Coastal Plain Exp. Station	Tifton
Johnson, Dewey W.	Lawn and Turf, Inc.	Conyers
Johnson, Marion E.	Savannah Golf Club	Savannah
Jordan, Alvin E.	Mystery Valley Golf Course	Lithonia
Kincaid, Ed	Lawn and Turf, Inc.	Tifton
King, Eugene	Special Service Golf Course	Ft. Benning
King, Frank P.	Coastal Plain Exp. Station	Tifton
King, M. E.	Newton Crouch Company	Griffin
Kirby, Carlton	International Minerals & Chem.	Tifton
Kozelnicky, George	University of Georgia	Athens
Kraft, Art	Newnan Country Club	Newnan
Lake, John E.	Elanco Products Company	Lawrenceville
Lambert, Jimmy	Evans Implement Company	Atlanta
Lambert, Paul	Stovall and Company	Atlanta
Lance, Willard	Route 2	Washington
Langer, Bill	Callaway Gardens	Pine Mountain
LaPlante, Merritt G.	University of Georgia	Athens
Lawrence, Lester	Main Officers Open Mess G.C.	Ft. Benning
Miller, James	University of Georgia	Athens

Name	Affiliation	City
GEORGIA (cont.)		
Lawson, Kenneth	909 Thurman Street	La Fayette
Lawson, Lee	909 Thurman Street	La Fayette
LeBlanc, Lloyd	Coastal Plain Exp. Station	Tifton
Lee, Harold E.	City of Atlanta, Parks Dept.	East Point
Lott, S. S.	4-Seasons Country Club	Wrens
Lovett, Rufus	Sea Island Company	Sea Island
Lyons, Calvin E.	Jekyll Island Golf Course	Jekyll Island
Madden, Loyd	Marietta Country Club	Marietta
Mallard, John	Vidalia Country Club	Vidalia
McGee, Bobby D.	Atlanta Athletic Club	Duluth
McGinnis, J. L.	City of Atlanta, Parks Dept.	Atlanta
McKendree, Marion	Sea Island Golf Club	St. Simons Island
McWhirter, Ben	Robins AFB Golf Course	Warner Robins
Miller, Edward	Sea Island Golf Course	St. Simons Island
Moncrief, James B.	U.S.G.A. Green Section	Athens
Monson, Warren G.	Coastal Plain Exp. Station	Tifton
Morgan, Loy	Coastal Plain Exp. Station	Tifton
Neese, Jack	Country Club of Columbus	Columbus
Newton, J. P.	Georgia Experiment Station	Experiment
Othlton, Ralph	Green Meadows Country Club	Martinez
Patten, Robert L.	Patten Seed & Turfgrass Co.	Lakeland
Pendley, Jerry B.	City of Atlanta, Parks Dept.	Atlanta
Petrie, Paul	University of Georgia	Athens
Poss, Bob	Russell Daniel Irrigation Co.	Tifton
Powell, Jerrel B.	Coastal Plain Exp. Station	Tifton
Rampley, K. C.	City of Atlanta	Atlanta
Rhymes, W.W. (Bill)	Mallinckrodt Chemical Works	East Point
Roberts, Bill	Sea Island Company	Sea Island
Rogers, Elmer J.	Fort Gordon Golf Course	Augusta
Seawright, Clyde	Cowan Supply Company	Hartwell
Shields, E. A.	The Standard Club	Atlanta
Shirley, Jim	Cross Creek Golf Club	Atlanta
Skinner, Albert	Coastal Plain Exp. Station	Tifton
Sloan, Wayne	University of Georgia	Athens
Smith, Gerald E.	University of Georgia	Athens
Smith, Randolph W.	Jacobsen Manufacturing Co.	Atlanta
Southwell, Oren F.	Ga. Crop Improvement Assn.	Leesburg
Steine, Ben H.	Warren County Golf Club	Warrenton
Stevenson, Jimmy	Pinecrest Country Club	Pelham
Strickland, Emory	Sea Island Company	Sea Island
Sumrell, Billy	Callaway Gardens	Pine Mountain
Thomas, Charles L.	Atlanta Athletic Club	Atlanta
Underwood, Charlie	Northwood Club, Inc.	Lawrenceville
Walcher, Kern	Velsicol Chemical Corporation	Atlanta

Name	Affiliation	City
GEORGIA (cont.)		
Watson, Ted	City of Atlanta, Parks Dept.	Atlanta
Wells, Homer D.	Coastal Plain Exp. Station	Tifton
Wheeler, Buck	Southern Turf Nurseries	Tifton
Wheeler, Clara	Coastal Plain Exp. Station	Tifton
White, Don D.	Southern Turf Nurseries	Tifton
White, H. G.	City of Atlanta, Parks Dept.	Atlanta
Whitehead, Don	Whitehead and Company	Atlanta
Wilcox, David B.	Route 1 - Box 12	Alpharetta
Wilder, Mac	Southern Turf Nurseries	Tifton
Williams, L. G.	Jekyll Island Golf Club	Jekyll Island
Williams, Lloyd	Certified Laboratories	Valdosta
Willis, Jerry	Piedmont Golf Course	Atlanta
Wilson, William H.	Coastal Plain Exp. Station	Tifton
Winn, Joe L.	Merritt Equipment	Tifton
Yeatts, J. T.	U. S. Steel	Decatur
Zink, Harold L.	Fieldstone Golf & Country Club	Conyers
ILLINOIS		
Walling, Robert	Roseman Mower Corporation	Glenview
INDIANA		
Boyd, Ed	Evansville Country Club	Evansville
KANSAS		
Rogers, Buck	Jacobsen Manufacturing Corporation	Olathe
KENTUCKY		
Grandison, Pete	Bowling Green Country Club	Bowling Green
MINNESOTA		
Dieson, Georgianne	3950 Xerxes Ave. South	Minneapolis
Watson, J. R., Jr.	Toro Manufacturing Corporation	Minneapolis
MISSOURI		
Small, Bill	Mallinckrodt Chemical Works	St. Louis

Name	Affiliation	City
NEW YORK		
Keech, Roger	Kearney National	New York
NORTH CAROLINA		
Campbell, Don	Cherry Point Golf Club	Cherry Point
Carpenter, Walter E.	City of Gastonia	Gastonia
Harris, Claude F.	Happy Valley Golf Course	Wilson
Lineberger, Abel	Gaston Country Club	Gastonia
Maples, Palmer, Jr.	Charlotte Country Club	Charlotte
O'Donnell, Ed	Brook Valley Country Club	Greenville
OHIO		
Nolt, W. H.	Turf Vac Corporation	Worthington
PENNSYLVANIA		
Mascaro, Tom	West Point Products Corporation	West Point
SOUTH CAROLINA		
Bridges, James T., Jr.	Port Royal Inn & Golf Club	Hilton Head Island
Duffee, William H.	Roundwood Corporation of America	Florence
Hamilton, Jack	Pine Ridge Country Club	Edgefield
Hensley, Robert	Myrtlewood Golf Course	Myrtle Beach
Hill, Jack R.	Dunes Golf and Beach Club	Myrtle Beach
Montgomery, Robert	Myrtlewood Golf Course	Myrtle Beach
Rabon, Paul	Quail Creek Country Club	Myrtle Beach
Sigmon, William J.	Myrtlewood Golf Course	Myrtle Beach
TEXAS		
Bullock, Robert J.	Duval Corporation	Houston
VIRGINIA		
Johnson, Lionel	Lake of the Woods Golf & C.C.	Locust Grove
Savage, Hurley	309 Mattox Drive	Newport News
WISCONSIN		
Wilson, Charles B.	Milwaukee Sewerage Commission	Milwaukee

23RD ANNUAL
SOUTHEASTERN TURFGRASS CONFERENCE
Tifton, Georgia

April 14-16, 1969

TOTAL REPRESENTATION FROM EACH STATE:

Alabama	8
Delaware	1
Florida	35
Georgia	138
Illinois	1
Indiana	1
Kansas	1
Kentucky	1
Minnesota	2
Missouri	1
New York	1
North Carolina	6
Ohio	1
Pennsylvania	1
South Carolina	8
Texas	1
Virginia	2
Wisconsin	1
TOTAL	210