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SUCCESSFUL TURFGRASS SODDING PRACTICES-Part I*

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Sodding involves the planting of an entire area with pieces of sod. This practice dates back many centuries, with writings on the subject found in the sixteenth century literature. The source of most sod up to 1950 had been from pastures. Since that time, the commercial culture of sod for the specific purpose of sodding on consumer sites has expanded until today it represents by far the major source of sod utilized in the commercial markets. Techniques and turfgrasses have been developed which enable the commercial grower to produce a high quality product. However, another aspect of the sod industry is the rooting of the sod into the underlying soil as the final step in sod establishment on the consumer site. Only if successful sod establishment has been achieved is consumer satisfaction assured. The following discussions will involve such aspects as (a) time of sodding, (b) sod selection, (c) site and soil preparation, (d) sod transplanting, and (e) post-transplanting care. All are dimensions which must receive attention in order to assure successful sod transplanting and establishment.

I. *Time of Sodding*

Sod transplanting can be accomplished at any time when there is three to four weeks of favorable growing conditions (temperature and water) for rooting following transplanting. This means that sodding can be accomplished for a much longer period during the growing season than seeding.

II. *Sod Selection*

As with any planting, the primary concern is to select appropriately adapted species and cultivars for the specific soil, enviromental, and cultural conditions on the site. Other concerns specifically related to sod involve quality aspects. Characteristics desired in a high quality sod include (a) uniformity; (b) a high shoot density; (c) adequate sod strength for harvesting and handling; (d) free dom from serious weeds, weed seeds and insect, disease, or nematode damage; (e) an acceptable color; (f) sufficient maturity in terms of adequate carbohydrate reserves to permit effective, rapid transplant rooting; and (g) a minimum thatch layer.

In some situations, the individual purchasing sod may wish to specify the desired harvesting depth, then length and width of the sid pieces, and the soil type, specifically soil texture. The thickness at which sod is harvested will vary somewhat with the turfgrass species as shown in Table 1. As a general rule, sod cut relatively thin at 0.5 to 1 inch in thickness will root much faster than thicker cut sod. It is also lighter in weight which reduces shipping costs and is more easily handled while transplanting. In contrast, thick cut sod, while being slower to root, is much more tolerant of droughty conditions if the capability to irrigate does not exist on the specific transplanting site.

The soil texture selected is important primarily on sports fields, golf greens, and golf tees, where divots are a frequent occurrence. If there is a drastic difference in soil texture between the underlying soil and transplanted sod, a distinct cleavage plane exists at the interface which is more prone to divoting. Thus, on sport fields it is important to specify that the soil possessed a soil texture comparable to that on the transplanting site.

TABLE 1. The comparative cutting depths for sod harvesting of turfgrass species. (From Turfgrass: Science and Culture by J. B. Beard, Prentice-Hall-1973).

Relative Cutting Depth	Cutting depth		Turfgrass Species
	inches	cm	
Shallow	0.3-0.6	0.8-1.5	bentgrass
Medium	0.5-0.8	1.2-2.0	Kentucky bluegrass bermudagrass zoysiagrass
Thick	0.7-1.2	1.8-3.0	tall fescue St. Augustinegrass perennial ryegrass

III. *Site and Soil Preparation*

The soil preparation procedures for sodding are exactly the same as for seeding, sprigging, and stolonizing. It is important to take sufficient time and effort for each step in order to build a sound base which will assure minimum problems in a long term maintenance of the sodded area. The steps involved in presodding site preparation include the following:

1. ***Control persistent problem weeds*** before tilling the soil. Weedy grasses which can only be controlled by nonselective mean3 usually require the use of (a) a grass killer such as Amtrole or Dalapon or (b) a soil fumigant such as methyl bromide, metham, or dazomet. Most of these chemicals, except for methyl bromide, have a post-treatment residual period of 3 to 6 weeks before the area can be sodded. Thus, scheduling of such weed control programs need to be accomplished well before the anticipated period of sodding.

*From: Proceedings of the 1976 Turf and Landscape Institute, pp. 16-20.

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2. Remove topsoil and stockpile for future use if major grade changes or building'construction is planned on the site.

3. Remove rocks, wood, and other debris, do not bury in holes on the site. It is particularly important to ut ilize a stone picker or remove stones from the surface 4 to 5 inches of sites where cultivation by coring or slicing will be utilized in the future. The most common situation where this would be practiced would be on sport fields and recreational areas.

4. Till deeply and establish the final subgrade. It is important during this step to ensure that adequate surface drainage is provided.

5. Install subsurface drain tile, if needed, followed by installation of the irrigation system, if this is provided for in the budget.

6. Redistribute the topsoil from the stockpile or if needed, proceed with soil modification. The latter usually is practiced on fine textured clay soils where intense traffic is anticipated. Usually a high percentage of a coarse textured material such as sand is incorporated into the site in order to ensure rapid soil water movement and aeration plus minimum proneness to soil compaction.

7. Apply a liming or acidifying material such as sulfur, if needed as indicated by a soil test. Most soil root zones should be adjusted into the pH range of 6.5. Be sure to thoroughly incorporate into the upper six inches of the soil. It is important to remember that major pH changes are best made by soil incorporation prior to establishment.

8. Apply the appropriate fertilizer rate and ratio based on soil test results for phosphorus and potassium levels. The fertilizer should be incorporated in the upper 3 to 4 inches of the soil. This should be a separate step scheduled as long as possible after incorporation of the liming or acidifying material and just prior to sodding.
9. Complete the final grade.

10. Lightly till, firm by rolling, and level the soil so that it is in a moist, granular, firm, clod-free condition at the time of sodding. This last step is best performed just prior to the initiation of sodding.

IV. *Sod Transplanting*

It is desirable to arrange for the sod to be harvested and transported to the site in as short a time as is physically and economically feasible in order to minimize the potential for sod heating. Factors which enhance the potential for sod heating include harvesting (a) at mid-afternoon when peak temperature occur, (b) when a high amount of leaf area is present, (c) at high nitrogen nutritional level, (d) when disease activity is present, particularly *Helminthosporium* species, and (e) during periods of active seedhead formation. It should also be remembered that the rate of sod rooting is enhanced by transplanting onto a moist soil. Specific steps in sod transplanting can be summarized as follows:

1. Carry or mechanically move the sod pieces to the transporting site. Place the individual sod pieces into the desired position which usually involves a staggered or checkerboard pattern. It is helpful to place the first length of sod pieces along a straight edge such as a walk, driveway, or building foundation.

2. Place the edges of adjacent sod pieces in intimate contact with one another without overlapping. Be sure to avoid stretching the sod during these handling operations in order to minimize shrinkage and the resulting formation of cracks which increase the proneness to turfgrass desiccation.

3. Roll or tamp the sod to ensure continuous contact with the underly soil and to avoid drying.

4. Irrigate as soon as possible after transplanting in order to minimize water stress. On larger sodding operations this may mean initiating irrigation on one portion of the area while another is still being transplanted. The initial irrigation should be at a sufficient rate and during that the underlying soil is wetted to a depth of 6 inches.

V. *Post-Transplanting Sod Care*

The previously listed procedures are frequently followed and given considerable attention by the consumer or firm contracted to execute the transplanting operation. However, post-transplanting care is commonly left to the consumer who frequently fails to recognize the importance of proper timing of the following steps, particularly irrigation. Loss of sod quality or even death of some sod may result. The specific steps to consider in post-transplant sod care include the following:

1. Continue irrigating daily at midday until the sod is well rooted. This usually means a period of 2 to 4 weeks. The amount of water applied is rather minimal if the area is soaked well at the time of transplanting. Thin cut sod needs more frequent irrigation than thick cut sod.

2. Following a cutting height and mowing frequency comparable to that which would normally be used for the particular turfgrass species on that site. The initial mowing should be delayed for a relatively short period of time in order to allow as much rooting to take place as possible. However, do not delay it so long that a large length of grass leaves is removed which will cause a shock to the sod or even scalping.

3. Fertilization of commercially grown sod is usually not required for at least 6 to 8 weeks after transplanting, assuming the proper plant bed fertilizer incorporation has been accomplished as outlined in Section III. The need for fertilization will appear as a yellowing of the leaves indicating a nitrogen deficiency.

4. Weed control is usually not needed assuming that good quality sod was purchased and properly transplanted onto the site.

5. Withhold traffic from the transplanting site until the sod is well rooted. This usually means a period of 3 to 4 weeks. The most common method involves roping the area off and placing the appropriate signs around the edges.

PEST ACTIVITY DUE TO MISMANAGEMENT*

*A. J. Turgeon***

Turfgrass deterioration is frequently associated with the activity of pestiferous agents, including insects, weeds, and disease-causing organisms. However, man is also a significant pest contributing to the decline of turfs. The obvious effects of athletic and recreational activities conducted on turf require little explanation; turfgrass wear and soil compaction from intense traffic are clearly related to poor turfgrass quality on sites where these activities take place. But, the turfgrass manager may also be a primary contributor to declines in turfgrass quality through his implementation of improper cultural practices. This may be termed mismanagement, even though the symptoms of deterioration may suggest some other casual agent. For example, heavy applications of nitrogen fertilized in spring were found to be associated with the severe incidence of fusarium blight disease in summer (1) . Under normal field conditions in which only one fertilizer application rate was used, this relationship would not have been obvious; the turfgrass manager pursuing an intensive spring fertilization program would probably have attributed the severe incidence of this disease to factors unrelated to his cultural practices. Thus, the purpose of this paper is to explore some of the important relationships that exist between turfgrass cultural practices and the activity of pest organisms.

Turfgrass management may be divided into five general categories of cultural activity, including:

1. Selection of turfgrass species and varieties for planting.
2. Site preparation and establishment procedures.
3. Primary cultural practices (mowing, fertilization and irrigation).
4. Techniques of cultivation for controlling thatch and soil compaction.
5. Selection and application of pesticides.

In each of the above categories, errors in selection or implementation may result in increased pest activity. For example, in category 1, tests conducted at University experiment stations have shown that Kentucky bluegrass varieties vary substantially in their susceptibility to several important turfgrass diseases, including leaf spot (*Helminthosporium vagane)* , dollar spot *(Sclerotinia homeocarpa)* and fusarium blight *(Fusarium roseum).* Obviously, selection of turfgrass varieties for planting that are highly susceptible to specific diseases will most likely result in disease problems once the turf has been established. Tests at the University of Illinois have shown that Kentucky bluegrass varieties vary widely in their competitive ability with annual bluegrass in closely clipped turf. (2). Thus, the potential invasion of a turf by annual bluegrass can be reduced, in part, by selecting turfgrass varieties that are best adapted to conditions in which annual bluegrass is likely to occur.

Many pest problems occur in turfs that were not established properly. Inadequate soil preparation prior to planting could directly or indirectly result in turf that rapidlv deteriorates under environmental stresses. These turfs may appear severely diseased or heavily infested with weeds, but the identifiable pest'problems may simply be manifestations of soil conditions which are inadequate to sustain healthy turf. The author was witness to one situation in which poor turfgrass quality during the summer could be directly tied to improper mixing of the growing media; a combination of equal parts of sand, soil and peat were used, but the contractor neglected to mix them together. Consequently, the soil profile was composed of three distinct layers that could not adequately support the turf.

The primary cultural practices of mowing, fertilization and irrigation dramatically influence the environment of the turfgrass community. Frequently, the combination of close mowing, high levels of fertilization and intensive irrigation results in such intense weed and disease pressure that the turfgrass manager has to rely on the extensive use of herbicides and fungicides to sustain the turf. Where feasible, some moderation of these cultural practices (less frequent irrigation, higher mowing and lower rates of fertilization) may actually provide a more vigorous turf in which pest problems are less severe.

Excessive thatch development is usually associated with frequently and intense pressure from certain insects and disease-causing organisms. Sod webworm, leaf spot, and fusarium blight are several examples. Reduction of thatch by mechanical cultivation may substantially reduce the occurrence of these problems, but it may also create others. Youngner (5) observed that vertical mowing of bermudagrass in the fall allowed the invasion of annual bluegrass into the treated turf. The author has observed substantial development of crabgrass and other annual weeds in Kentucky bluegrass turfs that were vertically mowed in late spring. Thus, the timing of cultivations to extract thatch can greatly affect the susceptibility of a turf to weed invasion. These practices should be confined to periods in the growing seasoa which will be immediately followed by environmental conditions that are favorable for rapid turfgrass recovery. Likewise, coring and other destructive procedures for alleviating soil compaction should be timed to avoid periods when weed invasion is likely. Properly timed, these practices can dramatically improve conditions for turfgrass growth and, in many instances, they may be essential for sustaining turf on some sites.

*From: Proceedings of the 1976 Turf and Landscape Institute, pp. 13-15.

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Finally, pesticides play an important role in controlling pests of turf. However, where applied improperly, they can cause extensive damage and other pest problems. For example, applications of MSMA, an organic arsenical herbicide, for controlling crabgrass may severely injure cool-season turf-grasses if the application rates are too high or if applied during hot weather. A result may be even more crabgrass than was originally present on the site. A more subtle effect of pesticides was observed where applications of calcium arsenate and bandane induced thatch development in Kentucky bluegrass through their inhibitory effects on soil organisms (3). A result of the pest-induced thatch was a higher incidence of leaf spot disease during midspring. In a similar study, bandane-treated plots of Kentucky bluegrass and red fescue were severely diseased with stripe smut after five applications of the herbicide over seven years (4). Thus, careful consideration should be given to both acute and chronic effects of pesticides if pest problems, associated with their use, are to be avoided.

In conclusion, the turfgrass manager has many cultural tools at his disposal which he can use for establishing turf and sustaining it at an acceptable level of quality. The misuse of these tools, however, can result in pest problems that are beyond his ability to control. Ultimately, his success may depend upon his knowledge of the environmental adaptation of specific turfgrasses, proper establishment procedures, and the multiplicity of practices that in the aggregate, constitute an intelligent cultural program.

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UNDERSTANDING HOW TURFGRASSES GROW*

*V. B. Youngner***

"'The grass plant is remarkably simple in structure compared to many higher plants. In the vegetative phase the grass stem is a short, extremely compact structure located just above the soil surface. At this stage the stem consists of a series of nodes from which the leaves arise. New

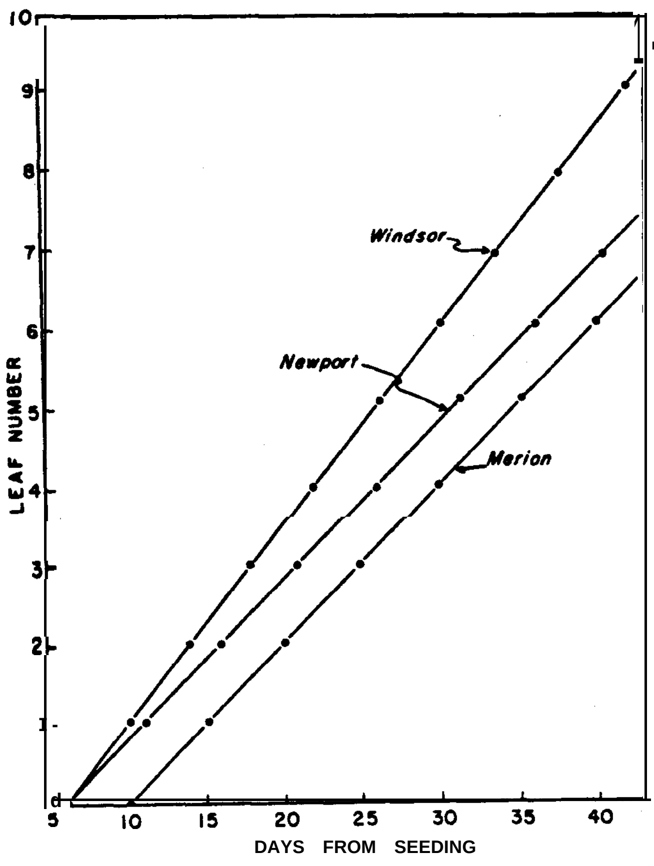

Fig. 1. Leaf emergence rates on main shoot.

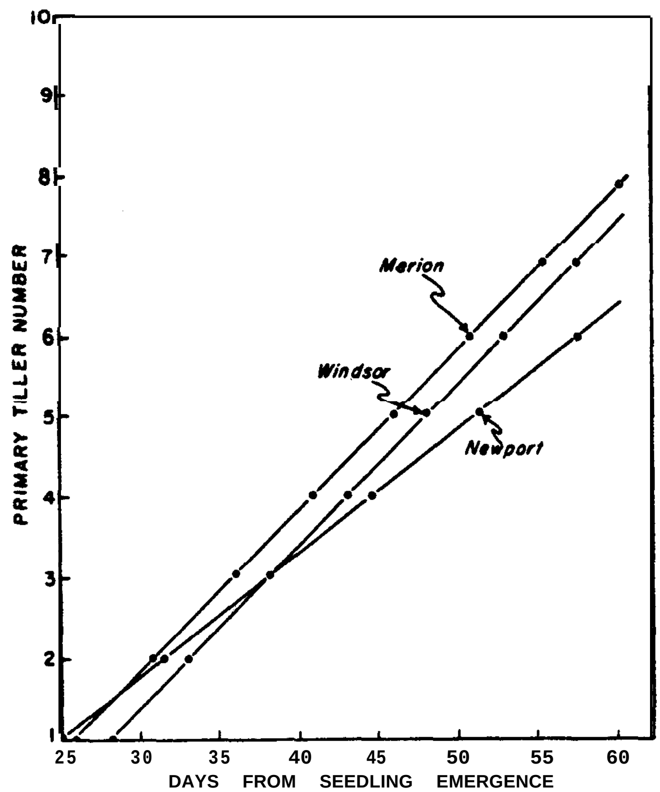

Fig.2. Rates of primary tiller emergence.

*From : Proceedings of the 1976 Turf and Landscape Institute, pp 1-7.

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shoots (tillers, stolons or rhizomes) arise in the axils of these leaves and the fibrous root system is produced from the lower nodes. This entire structure may be only a few millimeters high in many turfgrasses.

Growth of these organs is influenced by a myriad of natural and manmade enviromental factors. Moreover, these factors interact among themselves to affect the turfgrass plant in an infinite number of ways. Thus, though the plant itself may be comparatively simple, the growth process is extremely complex. In this paper we will summarized only a few important aspects of turfgrass growth as demonstrated by recent University of California research.

Tillering and leaf emergence are two aspects of grass growth of fundamental importance to density and per-

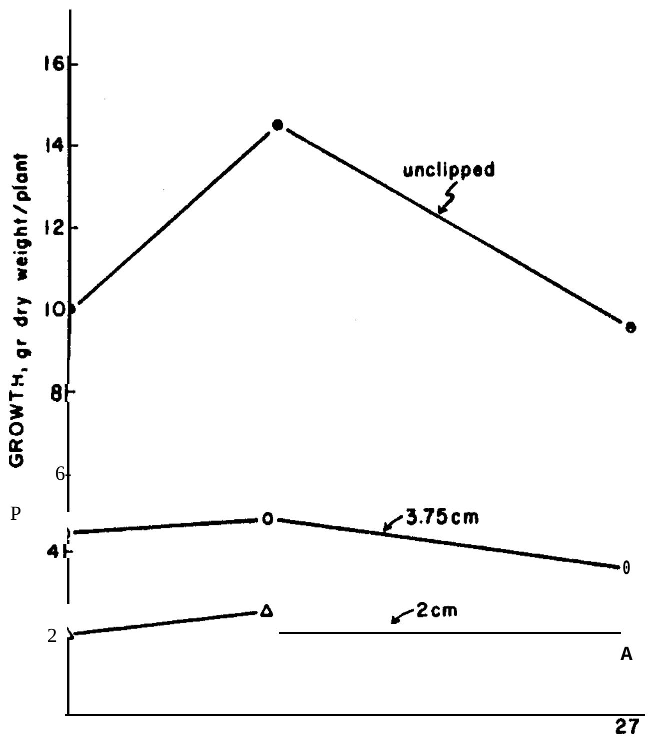

Fig. 3. Effects of soil temperature and clipping height on top growth of Merion Kentucky bluegrass.

sistance of the stand. Cultivars may be expected to differ in respect to these characteristics and to differ in their responses to various environmental factors in respect to these characteristics.

Studies on Kentucky bluegrass have shown that under fairly constant environmental conditions leaf emergence on a single shoot will proceed at a constant rate which is characteristic for a particular cultivar (Figure 1). Old leaves senesce and die also at a fairly constant rate under uniform conditions. Thus, each shoot will have a specific maximum number of viable functioning leaves at any given time.

Similarly, new tillers emerge from the main shoot at a constant rate if all environmental conditions are constant (Figure 2). Emergence of new shoots from rhizomes does not occur until the plant has become quite well established and consists of a fairly large number of tillers. Thus, the early establishment of a sod from a new seeding is largely by tillering. Rhizomes do not play an important role until later in the establishment period.

Clipping studies on Kentucky bluegrass have shown that leaf emergence rates are not readily affected by quite

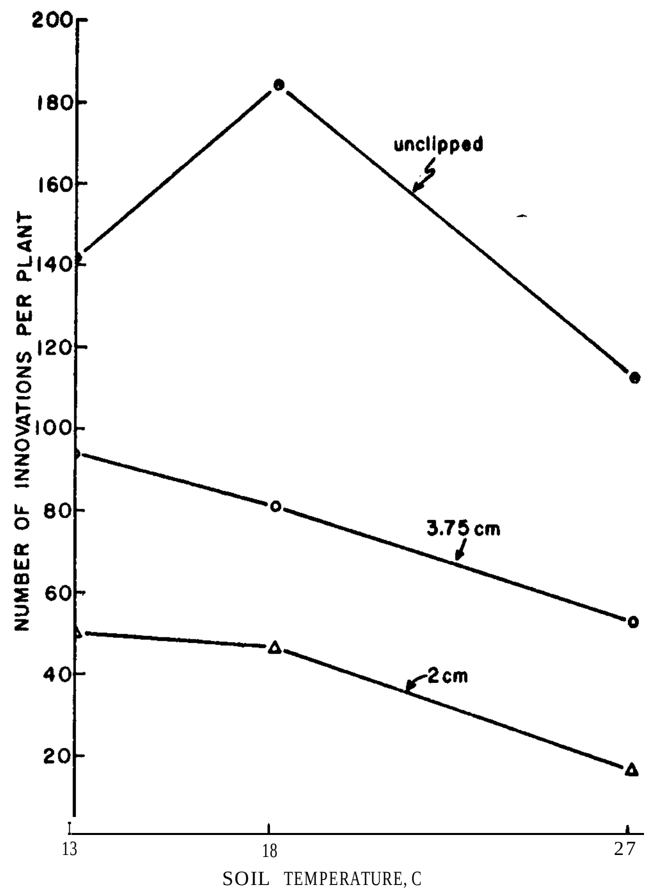

Fig. 4, Effects of soil temperature and clipping height on total number of innovations (tillers and emerged rhizomes) produced during a 14-week period.

intense leaf removal (Table 1) . On the other hand, tiller emergence rates may be reduced; some cultivars being more easily affected than others even if the amount of leaf tissue removed is very similar. A possible explanation for this difference among cultivars is shown in Table 2. Merion Kentucky bluegrass has a significantly higher total plant and leaf sheath net photosynthesis than does Newport which shows the greatest reduction in tillering by clipping. If a plant is photosynthetically more efficient than another, especially in the leaf sheaths which remain after clipping, it will have more carbohydrate to translocate to develop tillers.

TABLE 1. Effects of Defoliation on Leaf and Tiller Emergence Rates on Main Shoot.

Cultivar	Treatment	Days Between Emergence Leaves	Tillers
Windsor	Unclipped	4.0	5.5
	Clipped	4.0	6.5*
Merion	Unclipped	5.0	5.5
	Clipped	5.0	5.5
Newport	Unclipped	5.0	6.5
	Clipped	5.0	a.0*

*Significantly different from the unclipped treatment for the same cultivar at P=0.05.

TABLE 2. Mean Rate of Net Photosynthesis for Two Cultivars of Kentucky Bluegrass.

Cultivar	Total Plant	Leaf Blade	Leaf Sheath	Weighted Mean
		mg CO_2 dm^{-2} hr^{-1}		
Merion	37.4 a*	39.0 a	31.9 a	37.0 a
Newport	29.3 b	33.3 a	22.9 b	29.3 b

*Means in same column followed by the same letter are not significantly different at P=0.05 (t test).

Early studies have shown that tillering of cool season grasses is favored by relatively short days and cool to moderate temperature. Thus, maximum tiller development will take place in fall and spring. Root growth of cool season grasses is also at its maximum when temperatures are cool. The optimum temperature for root growth is several degrees lower than that for top growth. The root system of these grasses is therefore developed in the fall, winter and spring. During hot summer weather there will be no root growth and even death of existing roots.

Recent studies at UCR have examined the effects of soil temperature, distinct from air temperature, on Kentucky bluegrass top, root and tiller growth and accumulation of nonstructural carbohydrates. In general, the pattern of responses is similar to that for air temperature but with lower optimums in all cases.

Top growth is reduced by clipping at all root temperatures studied; the more intense the defoliation the greater the reduction in top growth. Moderate soil temperature (18°C or 65°F in these studies) produces the maximum total weight of top growth when the plants are unclipped (Figure 3) . However, clipping almost completely negates the superiority of this temperature. As might be expected, tillering responses are similar ot those for top growth production (Figure 4).

As with top growth and tillering, moderate soil temper-

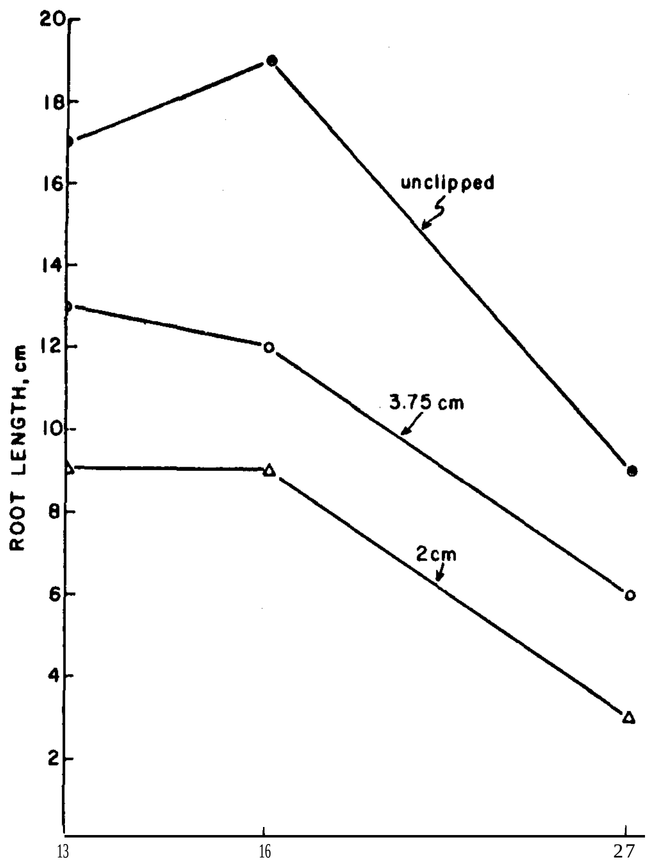

Fig. 5, Effects of soil temperature and clipping height on length of root system.

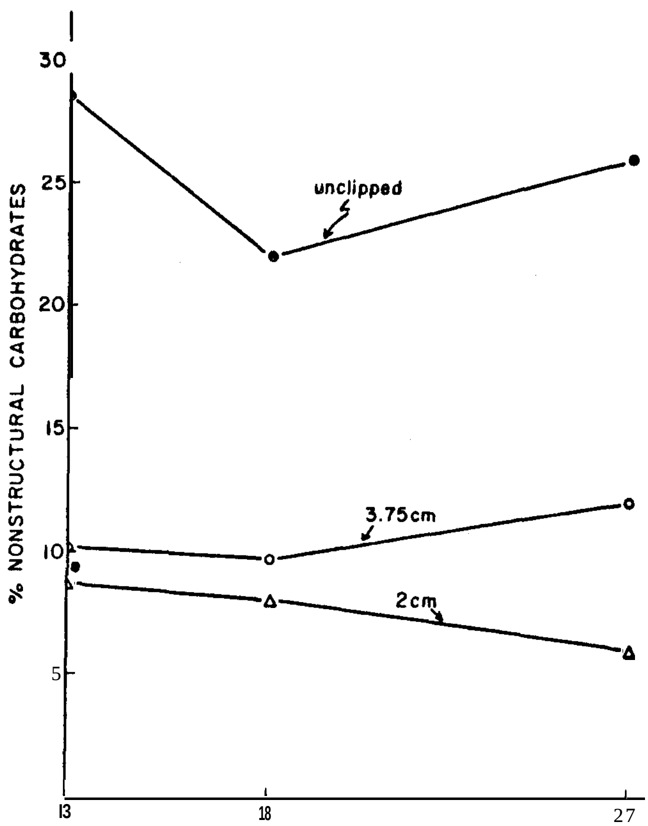

Fig. 6. Effects of roil temperature and clipping height on per. cent total nonstructural carbohydrate&

atures are optimum for root growth (Figure 5). Warm soil temperatures severely restrict root development. When intense clipping is imposed on the plants at warm soil temperature the root system becomes extremely short (3 cm or 1 3/8 in. in these studies). This clearly demonstrates the importance of maintaining as high a cutting height as possible on these grasses, especially during hot weather.

Nonstructural carbohydrates (reserves), in general, accumulate and are stored at temperatures which are. favorabie for photosynthesis but not optimum for production of structural tissues (leaves, stems and roots). In the UCR studies the highest percentages were at temperatures both below and above the optimum temperature for growth (Figure 6). But, since the high temperatures reduced the weight of stems and roots, the actual amount of carbohydrates was highest at the cool temperature. Intense clipping prevents any significant amount of carbohydrate storage.

What is the significance of these growth responses to the turfgrass manager? The better he understands how the grass plant grows and how it responds to environmental conditions and cultural practices the better will he be able to manage his turf for optimum growih.

Frequent mowing which makes a stand of grass a turf by reducing the plant's ability to photosynthesize reduces nonstructural carbohydrate accumulation and restricts all aspects of growth. As mowing intensity is increased it becomes the overriding influence reducing or negating the effects of favorable temperatures and intensifying the effects of unfavorable temperatures. If the turfgrass manager understands this he can do much to prevent unnecessary loss of turf.

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UC TURF CORNER

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TWO PROBLEMS OF *POA ANNUA* TURF

During the past couple of years, damage to *Poa annua* golf course fairways caused by the grub stage of a small black beetle, *Ataenius spretulus,* has been reported in 12 states from Illinois to Connecticut.

Little work has been done on this insect's biology, because, until recently, it hasn't been considered a pest of any consequence. It doesn't even have a common name. Currently, no insecticide is specifically labclled or approved for use against *A. spretulus.*

Research at the Ohio Agricultural Research and Development Center at Wooster has confirmed the suspicion that the insect is resistant to the cyclodience insecticides. Three organophosphate insecticides labelled for control of other species of grubs were tested against *A. spretulus.* None proved very effective. Thatch apparently interferes with the penetration of two of the insecticides tested, diazinon and chlorpyrifos. However, recent studies at Ohio have shown that the addition of wetting agents to the spray tank markedly improve the effectiveness of these two materials. The third material tested, trichlorfon, isn't readily bound on thatch and has been shown to be somewhat more effective against *A. spretulus* grubs than the other organophosphates.

A. spretulus larvae feed on turf roots. The first symptoms of injury observed in Ohio occurred in June, when the turf in fairways wilted despite regular irrigation. Under continued stress from summer heat and from larvae, the turf died in irregular patches.

Observations in Connecticut tend to corroborate Ohio findings that *A. spretulus* has two complete generations each year in these locales and over-winters in the adult stage. A detailed description of this pest's life cycle as well as color photographs of its larval and adult stages appear in the publication referenced at the end of this article.

Anthracnose disease, caused by the fungus *Colletotrichum graminicola,* apparently is not always a minor prob lem in *P. annua* as commonly thought, according to a researcher at Michigan State University.

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He reports that this fungus appears to be a weak pathogen that causes serious damage to *P. annua* only when the grass is growing under heat stress. Nitrogen fertility may correct an anthracnose problem at low temperatures. However, his studies indicate that nitrogen makes the problem worse when applied just before the arrival of warm weather. The benzimidazole systemic fungicide gives the best control of anthracnose, according to the Michigan researcher, but should not be used exclusively because resistance can develop.

Anthracnose appears as irregularly shaped patches from six inches to several feet in diameter, frequently covering an entire fairway. Anthracnose produces acervuli, the black fruiting bodies of the fungus. The bodies have protruding spines, called setae, and are present in the infected tissue of the plant. Acervuli can be found in green or chlorotic tissue when the disease is moving rapidly during warm weather. They are even more commonly found in the dead tissue.

("A New Grub Problem in Golf Course Turf," by H. D. Niemczyk, and "Disease Poses Threat to Annual Bluegrass," by J. M. Vargas, Jr., The Golf Superintendent, March 1976.)

CONTROL OF CORTICIUM RED THREAD

Several fungicides will control corticium red thread disease, caused by *Corticium fuciforme* (Berk.) Wakef., a major turf problem in the Pacific Northwest. It always has been the most serious pathogen attacking fescues and ryegrasses. Recently, it has become more widespread on bentgrasses and is occasionally found on bluegrasses.

Two commonly available materials, Dyrene and Tersan 75, give good control under severe disease pressure and produce excellent turf, according to researchers at Washington State University. They add that one of the most effective new fungicides is Rhodia RP-26019, which also appears promising against *Fusarium nivale* (Fr.) Ces.

("Fungicidal Tests for Control of Corticium Red Thread in the Pacific Northwest," by C. J. Gould, R. L. Goss and W. E. Vassey, The Journal of The Sports Turf Research Institute, No. 51, 1975.)

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