Virginia Cooperative Extension

PUBLICATION 460-127

POWELL RIVER PROJECT

RECLAMATION GUIDELINES FOR SURFACE-MINED LAND

Establishment and Maintenance of Quality Turfgrass on Surface-Mined Land

John R. Hall III, Professor Emeritus, Crop and Soil Environmental Sciences, Virginia Tech
Michael Goatley, Associate Professor, Crop and Soil Environmental Sciences, Virginia Tech
C. E. Zipper, Extension Specialist, Crop and Soil Environmental Sciences, Virginia Tech

Introduction

Flat land surfaces for homes and recreational use are rare in the coalfields of southwestern Virginia. As a result, there is always interest in putting flat land into productive use. Once surface-mined land has been designated for home development or recreational use, there is often a desire to establish a quality turfgrass surface around the house, just as for homes on nonmined land. Most of the minesoils in Southwest Virginia are low in organic matter, moderately acidic, low in nitrogen and phosphorus, rocky, and prone to drought. This makes the establishment process risky and increases the necessity to closely follow recommendations to ensure success. Recommendations for successful turfgrass establishment and maintenance have been developed from research conducted at the Powell River Project Research and Education Center site near Norton, Va., over a period of more than 15 years, from 1980 through the mid-1990s.

Establishment Procedures

Many factors need to be considered in the process of making decisions about turfgrass establishment on drastically disturbed soils. Considerations include:

- Turfgrass selection;
- Method and time of establishment;
- Soil testing and corrective nutrition;
- Amendments for surface-mined soils;
- Preplant soil preparation;
- Selection of a mulch; andPostplant concerns.

Turfgrass Selection

Several types of grass can survive on surface-mined soils in Southwest Virginia. Kentucky bluegrass, tall fescue, perennial ryegrass, creeping red fescue, Chewings fescue, bermudagrass, zoysiagrass, and several mixtures of these grasses have been extensively tested at the Powell River Project research site. These studies indicate that tall fescue, Kentucky bluegrass, zoysiagrass, and bermudagrass – as well as combinations of 85 percent Kentucky bluegrass and 15 percent perennial ryegrass, 90 percent tall fescue and 10 percent Kentucky bluegrass, and 85 percent Kentucky bluegrass and 15 percent creeping red fescue or Chewings fescue – have the greatest potential for producing the highest-quality turfgrass under the climatic and edaphic conditions that exist on drastically disturbed, surface-mined soils.

Tall fescue is a moderately coarse-textured, olive-green turfgrass tolerant of a wide range of management and climatic extremes. It performs best on well-drained soils. It has good drought tolerance and provides moderate-to-good levels of turfgrass quality with limited maintenance required. The new "turf-type" tall fescue varieties are more dense and finer bladed than the

www.ext.vt.edu

Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2010

Box 1. Recommended Establishment Practices for Tall Fescue

Seed with tall fescue alone or mixed with Kentucky bluegrass (90-99% tall fescue and 1-10% Kentucky bluegrass), using varieties recommended by Virginia Cooperative Extension (VCE). See *2008-2009 Virginia Turfgrass Variety Recommendations* (Goatley and Askew 2008) or most recent recommendations.

Seeding rate: 4-6 pounds per 1,000 square feet

Seeding dates: August 15 to September 30, or March 15 to April 30

traditional K-31 tall fescue and have provided higher turf quality in full sun or in light-to-moderate shade.

Tall fescue can be established from seed or sod and is well suited for use on lawns or moderately trafficked athletic fields. It is not particularly tolerant of heavy traffic and tends to be susceptible to Rhizoctonia brown patch in wet, hot summers. When used in areas where moderate-to-heavy traffic is expected, it is advisable to include 10 percent Kentucky bluegrass in the seed mixture for lateral healing potential.

Kentucky bluegrass is a medium-textured, blue-green turfgrass best suited to well-drained or moderately well-drained soils and moderate-to-high levels of sunlight. It responds well to high levels of management and has the potential to provide a higher level of turf quality than tall fescue. In heavily trafficked areas, it shows better persistence than tall fescue.

On newly disturbed minesoils, a lack of earthworms and the microbial inactivity contribute to increased rates of thatch buildup in Kentucky bluegrass. It generally has more insect problems than tall fescue.

The fine texture of Kentucky bluegrass makes coarse grass contaminants – such as orchardgrass and tall fescue, which are common on surface-mine sites – more objectionable. Over the years, many southwestern Virginia coal-mine operators have used tall fescue in reclamation seedings; therefore, the potential for tall-fescue contamination of seeded Kentucky bluegrass is high. Selective removal of tall-fescue clumps from Kentucky bluegrass stands is possible with a herbicide called chlorsulfuron. Kentucky bluegrass can be established from seed or sod. Sodding minimizes the potential for coarse grass contamination.

Box 2. Recommended Establishment Practices for Kentucky Bluegrass

Seed using varieties recommended by Virginia Cooperative Extension. See *2008-2009 Virginia Turfgrass Variety Recommendations* (Goatley and Askew 2008) or most recent recommendations. In acidic, droughty, shady, or heavily trafficked areas, Kentucky bluegrass can be seeded in a mixture with perennial ryegrass or fine fescue (see below) using varieties recommended by VCE.

Seeding rate: 1.5-2.5 pounds per 1,000 square feet

Seeding dates: August 15 to September 30, and March 1 to April 15

Hybrid bermudagrass selected for cold tolerance has potential for use on surface-mined land. Bermudagrass is a warm-season grass that persists under lower mowing heights than tall fescue and Kentucky bluegrass. It has good drought tolerance and insect and disease resistance and is best suited to athletic field or golf course fairway use at lower elevations in Southwest Virginia.

Box 3. Recommended Establishment Practices for Bermudagrass

Establish using sprigs of varieties recommended by Virginia Cooperative Extension See *2008-2009 Virginia Turfgrass Variety Recommendations* (Goatley and Askew 2008) or most recent recommendations.

Sprigging rate: 7-10 bushels per 1,000 square feet

Sprigging dates: May 15 to July 15

It has good summer and early fall traffic tolerance and midsummer recuperative potential. Bermudagrass is prone to severe injury if it is heavily trafficked in early spring or late fall. It lacks shade tolerance and goes dormant, turning brown after the first frost in the fall. It will remain brown from the first hard frost in the fall until late April or early May in southwestern Virginia.

Because of this, bermudagrass is not particularly well suited to home lawn situations. The hybrid bermudagrasses cannot be seeded and are established by planting sod, vegetative sprigs, or plugs. Irrigation is necessary to ensure successful sod or sprig establishment.

Zoysiagrass is an olive-green, warm-season grass of fine-to-medium texture that turns brown with the first hard frost in the fall and turns green in late April. It is an extremely low-maintenance grass with good insect and disease resistance.

Zoysiagrass can be established from seed, sod, sprigs, or plugs. Seed is scarce and expensive and is extremely difficult to successfully germinate. Sprigs or plugs of zoysiagrass are much more readily available. They are generally slow to establish, requiring two to three growing seasons for complete groundcover. Its slow recuperative potential makes it generally undesirable for athletic fields unless they are lightly trafficked. This grass has more shade tolerance but less recuperative potential than bermudagrass. It is most suitable for home lawns, cemeteries, and low-maintenance sites.

Box 4. Recommended Establishment Practices for Zoysiagrass

Establish using sprigs of varieties recommended by Virginia Cooperative Extension. See *2008-2009 Virginia Turfgrass Variety Recommendations* (Goatley and Askew 2008) or most recent recommendations. Two-inch diameter plugs should be planted on 6-inch to 12-inch centers.

Sprigging rate: 7-10 bushels per 1,000 square feet

Sprigging dates: May 15 to July 15

Perennial ryegrasses have been evaluated for turfgrass establishment on surface-mined soils in Southwest Virginia; in this use, their long-term performance in pure stands has been unacceptable. They are susceptible to winter brown blight, Helminthosporium leaf spot, and Rhizoctonia brown patch disease activity. Perennial ryegrasses are not recommended in pure stands except on heavily trafficked athletic fields where annual reseeding is necessary. On sites where Kentucky bluegrass is the grass of choice and a potential for erosion exists, they can be beneficially included with bluegrass at 10 percent to 15 percent of the mixture.

Creeping red fescue and Chewings fine fescue are acidic, shade- and drought-tolerant turfgrasses that have been tested in Powell River Project research. These grasses rapidly developed thatch under all soil amendments tested. This thatch led to turf quality decline in pure stands of these grasses within two to three years. Our research provided 3 pounds of nitrogen per 1,000 square feet, per year, to the grasses. This may have aggravated the development of thatch in this species. These grasses are not recommended in pure stands on surface-mined soils at this time. They are best used as companion grasses with Kentucky bluegrass, in mixtures containing 85 to 90 percent Kentucky bluegrass and 10 to 15 percent fine fescue.

Method and Time of Establishment

Choosing the proper **method of establishment** is important. Kentucky bluegrass and tall fescue are commonly seeded; however, improved bermudagrass and zoysiagrass are not available as seed. Sod is available for all the species that are recommended on surface-mined soils in southwestern Virginia. Sprigging and plugging are viable methods of establishment for bermudagrass and zoysiagrass. Sprigging involves the planting of shredded, vegetative pieces of crowns, stolons, and rhizomes. Plugging is the planting of small, individual plugs of grass, with soil attached, in holes spaced on 6-inch to 12-inch centers.

Each method of establishment has advantages and disadvantages. Seed is generally cheaper to plant than sod, sprigs, or plugs. Seed, sprigs, and plugs all require early establishment of weed control and variable amounts of time for complete groundcover development. Mature stands of tall fescue and Kentucky bluegrass generally require six to nine months from seed. Sprigged bermudagrass requires 45 to 60 days to provide 100 percent groundcover. However, sprigged stands of bermudagrass should not be considered mature until the end of the second growing season. Zoysiagrass is likely to require two full growing seasons to provide 100 percent groundcover from sprigs and three full growing seasons to provide total cover from plugs planted on 12-inch centers.

Where immediate erosion control or the need for mature turf is a major concern, sodding is certainly the best alternative. Irrigation is a necessity for successful sodding, sprigging, and plugging.

If seeding is the method of establishment chosen, either hydraulic seeding or traditional seeding may be used. Hydraulic seeding is ideally suited to situations where the slope of the land is severe. It involves spraying the seed on the soil surface in a water, fertilizer, lime, and mulch slurry. It is not conducive to maximum seedling survival because the seed is seldom in complete contact with the soil; however, it is popular on surface-mined land because new rocks are not brought to the surface

in the planting process. Traditional seeding methods involve prior incorporation of recommended nutrients and lime into the soil, followed by incorporation of the seed into the soil surface with mechanical planters or by raking. Traditional seeding, including nutrient incorporation, is much preferred on surface-mined soils because phosphorus and lime incorporation is important to rapid and deep correction of these common deficiencies. However, the rocky nature of surface-mined soils often makes fertilizer incorporation difficult, as every tillage procedure tends to bring new rocks to the surface. When soil tests indicate extreme phosphorus and lime requirements, soil incorporation of the nutrients and lime is beneficial.

An important key to success with all methods of establishment is the purchase of quality plant material. Insist on seed certified by the Virginia Crop Improvement Association (VCIA), sod, or sprigs in all instances. VCIA labels ensuring certification will be affixed to the seed package or delivered with sod, sprigs, or plugs.

Time of establishment can often affect the selection of turfgrass and the method of establishment. Kentucky bluegrass and tall fescue are best established in the fall between August 15 and the end of September. The second-best time for establishment of these grasses is in the spring between March 15 and May 1. Bermudagrass and zoysiagrass are most successfully established from May 1 to July 15.

Time delays in construction often necessitate establishment outside the desirable period. In these instances, it may be wise to switch the type of turfgrass or method of establishment to maximize chances for success. For instance, delays necessitating late-fall or winter establishment may justify switching Kentucky bluegrass or tall fescue from seed to sod. Delays necessitating summer establishment may justify switching from Kentucky bluegrass and tall fescue to bermudagrass or zoysiagrass. Delays from early summer to late summer may justify switching from sprigs of bermudagrass or zoysiagrass to sod.

Preplant Soil Preparation

Most minesoils in southwestern Virginia are quite rocky, having been formed from sandstone, siltstone, and shale overburden materials. As such, their stony properties are not ideal for turfgrass establishment. If a sufficient quantity of natural soil materials that is not excessively stony is available, these can be spread on the area to be turfed in order to improve the surface properties. In doing so, it is essential that the underlying minesoil materials have not been excessively compacted by mining or construction equipment so that the interface between the two types of soil materials forms a barrier to soil and air movement that is required for healthy rooting by the turfgrass crop. If the underlying minesoil does provide such a compacted barrier and is to be covered with natural soil, it is best to cover the underlying minesoil to a depth of several feet so as to provide enough depth for rooting by the turfgrass species. If the amount of natural soil material for such a depth is not available, the underlying soil surface should be broken up prior to applying the natural soil cover. Depending on the nature of the underlying material, this can done using a backhoe bucket or similar device. Be sure to loosen these materials to a sufficient depth, rather than scraping the surface. If you are able to move the minesoil material with a hand shovel without exerting excessive effort, it is probably loose enough for roots, water, and air to penetrate.

Without the availability of natural soil for application – if the plan is to establish turfgrass directly in the minesoil – it will be necessary to ensure that the material is not compacted or to loosen it, as described above. In that case, some effort to locate and remove the larger rocks from the surface will help to assure a higher-quality turf in the long run. In that situation, bringing in some organic amendments, as described below, can help to create a growth medium and surface that is conducive to better-quality turf.

Establishing adequate drainage on the site is essential to the production of quality turfgrass and should be accomplished prior to incorporating nutrients and planting. Because of the rocky nature of surface-mined soils, the installation of internal drainage is extremely difficult. Therefore, surface drainage is the most desirable alternative for accomplishing adequate water movement from the site. In all cases, areas to be planted should be sloped a minimum of several percent so as to move water rapidly away from structures and off the turfed area.

Prior to seeding, remove rocks, wood, and debris larger than 2 inches in diameter from the site. If any undesirable plant material exists in the area to be planted, it should either be physically removed or controlled with a nonselective herbicide such as glyphosate.

After incorporation of fertilizer, lime, and soil amendments and prior to planting the grass, it is important to make final preparations for planting. Do not plant when the soil is excessively wet or dry. The soil should have a blocky, granular structure and not be powdery or contain large clods.

Prior to making the final purchase of materials or contracting to have the work done, measure areas to be planted to make sure that material requirements or bids have been properly calculated. In situations where irrigation will be necessary for establishment, confirm irrigation capability so that areas to be planted are not larger than what can be adequately irrigated.

Organic Amendments for Surface-Mined Soils

Powell River Project research has demonstrated that modification of surface-mined soils with organic amendments is often beneficial to the production of quality turfgrass. Unamended minesoils are drought-prone, and organic matter amendment improves water retention, aeration porosity, nutrient retention, microbial activity, and nutritional status. Composted sewage sludge has proven to be an excellent modifying medium. Dried, processed sewage sludge will provide similar benefits but it is more difficult to distribute uniformly. Well-decomposed sawdust and other types of organic matter such as composted leaves, peat moss, or rotted farm manure are also beneficial. They are more stable than undecomposed forms of organic matter, so they require less additional nitrogen application in the establishment process. Over time, sawdust and composted leaves will tend to increase the acidity of the mixture. Fresh sawdust can be used, but it will require significantly larger amounts of nitrogen than aged sawdust. Work at the Powell River Project research center has demonstrated that a 2-inch layer of incorporated, raw sawdust required a total of 10 pounds of nitrogen per 1,000 square feet in the first year following establishment to avoid chlorosis caused by microbiological tie-up of the nitrogen. Table 1 provides recommended application rates for various materials.

Table 1. Original soil amendments and recommended application on surface-mined soils.

Material	Volume per 1,000 sq ft (cubic yards)	Depth of material before incorporation to 6-8 in (inches)
Sawdust[1, 3]	3-6	1-2
Composted sludge[2, 3]	3-6	1-2
Composted leaves[3]	3-6	1-2
Peat or sphagnum[3]	3	1
Rotted farm manure[2]	3	1

1. Additional nitrogen will be required with the use of sawdust. Incorporate 1.5 pounds of nitrogen/1,000 square feet in addition to the amounts recommended for standard surface-mine establishment. Additional nitrogen applications will be necessary in the first year of establishment.
2. Composted sewage sludge and rotted farm manure provide adequate nitrogen and phosphorus. No establishment nitrogen or phosphorus will be needed at these levels of incorporation.
3. Soil test six months after incorporation and adjust accordingly.

Soil Testing and Corrective Nutrition

Because minesoils are often moderately acidic and deficient in phosphorus, it is extremely important that they be tested for nutritional status. Collect samples from the area to be planted, giving adequate time to receive the recommendations and make the corrective applications. Sample several areas to a 6-inch depth and mix the soil in a bucket. Areas that are obviously different in appearance and texture should be sampled separately.

Special interpretation of tests is required for surface-mined soils, so be certain the lab chosen can interpret the results. Tests for surface-mined soils are available through Virginia Cooperative Extension offices in each county. The exact amounts of lime, phosphorus, and potassium required for establishment will be indicated by the laboratory.

Nitrogen requirements for establishment vary with season and method of establishment as well as type of turfgrass. Warm-season grasses such as bermudagrass and zoysiagrass are normally established in early summer, whereas cool-season grasses such as tall fescue and Kentucky bluegrass are established in spring and fall. If lime, phosphorus, and potassium requirements are being met, incorporation of nitrogen at the rates indicated in table 2 should be adequate.

Table 2. Amounts of soluble nitrogen recommended for turfgrass establishment at various times for cool-season and warm-season turfgrasses on surface-mined soils.

Season	Turf-grass type[1]	Method of Establishment			
		Seed	Sod	Sprigs	Plugs
		lb nitrogen/1,000 sq ft[2]			
Fall	Cool season	2.5	2.5	NA[3]	NA
Spring-summer	Cool season	1.5	1.0	NA	NA
	Warm season	2.5	2.0	2.5	2.5

1. The fescues, Kentucky bluegrass, and perennial ryegrass are cool-season grasses. Bermudagrass and zoysiagrass are warm-season grasses.
2. Due to the rockiness of surface-mined soils, it is often difficult to properly incorporate fertilizers. The nitrogen recommendations are based on the assumption that the material can be incorporated to a 6-inch depth. If incorporation is only possible to a 3-inch depth or less, or if surface application is necessary, cut the rates in half. Begin normal maintenance fertilization 60 to 90 days after establishment.
3. NA = Not appropriate time to establish by this method, or sprigs/plugs not available.

Selecting a Mulch

Mulches are extremely beneficial in seedling establishment under hostile environmental conditions. In all cases, they are applied after seeding except where the seed is being applied in slurry with the wood-fiber mulch. They improve infiltration rates, reduce evaporation, prevent soil crusting, and reduce soil temperature variability – improving the chances for seedling survival. It is especially beneficial to mulch late-spring or late-fall seedings, south-facing slopes, and erosion-prone areas where there is a high probability of seedling failure. Straw and wood or paper-cellulose-fiber mulches are most commonly utilized in turfgrass establishment.

Straw mulches usually come from wheat or oats and may be spread by hand or machine. Normal rates of straw application provide 1.5 to 2.0 bales of straw per 1,000 square feet (1.5 to 2.0 tons of dry straw per acre). Straw can be windblown, so it should be tacked down with either wood-fiber mulch or with a mulch-anchoring tool. A mulch-anchoring tool is a tractor drawn, disc-like implement with a dull, serrated edge that punches the straw into the surface of the soil. The rocky nature of surface-mined soil reduces the effectiveness of these mulch-anchoring tools. However, straw mulch can also be anchored with liquid mulch binders such as asphalt. Asphalt is applied at the rate of 10 gallons per 1,000 square feet. In residential areas where asphalt may not be desirable, straw can be secured with chemical binders, pegs and twine, or lightweight plastic or paper nets stapled over the straw.

Wood- and paper-cellulose-fiber materials are applied in a water slurry through a hydroseeder. These materials provide adequate mulching in normal seeding situations. However, when seeding where the seedling environment will be hostile due to slope, time of seeding, or soil texture, straw mulch anchored with wood-fiber mulch provides the best overall seedling environment. Turf areas to be mowed normally have a slope of three-to-one or less; therefore, mulching rates providing either wood-fiber mulch alone at 1,000 to 2,000 pounds per acre or a combination of 3,000 pounds of straw plus 750 pounds of wood-fiber mulch per acre have proven to be adequate. If straw is used at the above-mentioned rates, it will not have to be raked out of the seeding after germination unless it was not uniformly distributed.

Erosion nets and mats are increasingly popular in areas where extreme erosion potential exists. Jute nets are installed either alone or on top of the mulch. Excelsior mats may be used alone or incorporated with seed. In instances where the seed is incorporated in the excelsior mat, it is important to be aware of the long-term quality potential of the species and varieties in the mat.

Postplanting Concerns

Maximum success in turfgrass establishment is ensured with regular water applications, especially in the weeks following seeding (irrigation). In most establishment situations, a commitment to 30 days of irrigation should be planned. Sodded and plugged areas normally require irrigation every second or third day for at least four weeks. When sodding, sprigging, or plugging is done during periods of hot, dry weather, daily irrigation may be necessary until roots penetrate the soil. Each irrigation should wet the soil to a depth of 2 to 3 inches below the surface to ensure adequate root development. Seeded and sprigged areas require more frequent, light irrigations to ensure successful establishment. During excessively warm periods, two or three light irrigations per day may be necessary to ensure success.

Rolling all newly planted turfgrass areas with a weighted roller at the time of seeding speeds up germination and increases seedling survival. In sodded and plugged areas, it removes air pockets between the sod and soil and improves rooting.

In spring seedings where crabgrass control is desired in association with the seeding, siduron pre-emergence herbicide should be applied immediately after seeding and prior to mulching or irrigating. This material is available in a sprayable, wettable powder or in dry, granular formulations.

Broadleaf weeds in newly seeded turfgrass areas can be most effectively controlled after the second or third mowing using traditional broadleaf herbicides, such as 2,4-D, dichlorprop, mecoprop, Triclopyr, dicamba, or combinations of these materials. In all cases where a decision is made to use herbicides, **read and closely follow the label directions**.

Mowing practices during the establishment stages are critical. Begin mowing with a sharp mower when the grass is one-third higher than the height at which you intend to mow. Continue to mow with a frequency that never removes more than one-third of the existing green tissue. Alternate mowing patterns to minimize the negative effect of compaction on the young seedlings. Kentucky bluegrass and tall fescue turf should be maintained at mowing heights of 1.5 to 2.5 inches. Bermudagrass and zoysiagrass can be maintained at mowing heights of 0.75 to 1.5 inches.

Normal maintenance fertilization practices should begin 60 to 90 days after establishment.

Summary of Establishment Procedures

In summary, there are many things to consider in the process of establishing turf on surface-mined land. The soil conditions are hostile and therefore considered abnormal. Greater-than-normal care must be taken to ensure success. Any decision to exclude steps in the process will diminish the likelihood of success. The chronological step-by-step procedure for successful establishment of turfgrass on surface-mined soil should include the following:

1. Decide on the type and variety of turfgrass.
2. Determine the time and method of establishment.
3. Establish surface drainage on the site to be planted.
4. Soil-test the area to be planted.
5. Remove large rocks and debris.
6. Incorporate the organic matter amendment.
7. Apply and incorporate lime and fertilizer.
8. Remove small rocks and debris from the site.
9. Fine-rake the surface to be planted.
10. Plant the turfgrass and roll it.
11. Apply crabgrass control if deemed necessary.
12. Mulch the area if seeded.
13. Irrigate the newly planted area.
14. Begin postplanting maintenance.

Turf Maintenance

Maintenance of turfgrass on surface-mined land is slightly different from maintenance on traditional soils. Consideration must be given to the fact that surface-mined soils are highly variable in nutritional and physical character. Nutritional concerns center around the fact that the soils are low in organic matter and phosphorus availability and in some cases may have a very low soil pH. These factors create an above-average need for nitrogen, phosphorus, and lime. The highly variable physical nature of surface-mined soils often creates situations where poorly drained areas may exist adjacent to areas that do not retain adequate moisture. This obviously complicates irrigation management considerations.

Most newly surface-mined lands are low in microbiological activity, and our research indicates extremely high rates of thatch buildup in those species that are thatch-prone. This tendency must be dealt with by selecting varieties that are not thatch-prone or by utilizing establishment, cultivation, or management practices that maximize the potential for microbiological activity. The tall fescues and perennial ryegrasses have shown considerably less tendency to produce thatch on surface-mined soils than the Kentucky bluegrasses, creeping red fescues, and Chewings fescues. Establishment procedures that include organic-matter amendment of surface-mined soils generally increase microbiological activity and can be beneficial. Cultivation practices such as core aerification and topdressing can improve

thatch decomposition rates. Management programs that include moderate levels of nitrogen, proper mowing frequency, and selective and judicious use of pesticides can minimize potential rates of thatch buildup.

The major considerations in setting up a turfgrass management program on surface-mined soils in southwestern Virginia include:

- Fertilization and liming;
- Mowing;
- Irrigation;
- Cultivation; and
- Weed and pest control.

Fertilization and Liming

Because of the nutritional concerns inherent on surface-mined soils, it is important that frequent soil testing be a cornerstone of the maintenance program. In normal situations, soil testing every three to four years would be considered adequate. On newly established surface-mined soils, it is advisable to test soil every year for the first three years. The soil-test results will prescribe adequate corrective phosphorus, potassium, and lime. It is particularly wise to separately test those areas where grass has been difficult to establish. Small "hot spots" or areas of extreme acidity can occur that require large amounts of lime for correction.

Nitrogen fertilization is critical to maintenance of quality turfgrass on surface-mined soils. Cool-season grasses such as tall fescue, Kentucky bluegrass, and perennial ryegrass respond best to fertilization in the fall. Bermudagrass and zoysiagrass are warm-season grasses that respond best to summer applications of nitrogen. Fertilization programs outlined in tables 3 and 4 will provide adequate amounts of nitrogen in most years. In years when rainfall is above normal and where surface-mined soils are well-drained, utilization of the higher levels of nitrogen would be advisable.

Important Comments About the Fertilization Programs

1. **Application priority**: The priority of each application is listed for those not wanting to make all applications. For instance, for those who want to make only one application on a cool-season grass (table 3), October is the best time.

Table 3. Fertilization program for Kentucky bluegrass and tall fescue lawns using water-soluble fertilizers.

Time	Nitrogen (lb per 1,000 sq ft)	Application Priority
September	1	2nd
October	1	1st
November or December	1	3rd
May 15 to June 15	0-0.75	4th
Total	3-3.75	

Table 4. Fertilization program for bermudagrass and zoysiagrass lawns.

Time	Nitrogen (lb per 1,000 sq ft)	Application Priority
April	1	1st
May	1	2nd
July	1	3rd
Total	3	

2. **Sources of nitrogen**: Soluble sources of nitrogen may burn leaf tissue if applied when temperatures are high or when there is moisture on the leaf blades. Water the lawn after fertilization to wash particles off blades. This is particularly important when using urea or ammonium nitrate. Slow-release fertilizers containing more than 50 percent water-insoluble nitrogen may require slightly higher application rates to get a response equivalent to water-soluble materials. Slow-release nitrogen sources should be used on sandy soils to reduce the potential for nitrate leaching.

3. **Use lower amounts of nitrogen**: In heavily shaded areas, it may be beneficial to reduce fertilization rates by cutting application rates in half. Reduction in nitrogen levels on cool-season grasses can be effectively achieved by not starting the fertilization program until the leaves have been collected in the fall. Established zoysiagrass lawns require less nitrogen than bermudagrass lawns. As a lawn matures, its

nitrogen requirement decreases; therefore, use the lower rates on older lawns or even consider skipping one or two of the applications in some years. If clippings are being returned to the lawn, the above recommendations can be reduced by approximately one-third.

4. **Use more frequent and lower rates of nitrogen**: When using a water-soluble nitrogen source and where soils are sandy, irrigation is used extensively, the growing season is extended or short-term recuperative potential is needed.

5. **Late fall applications on cool-season grasses**: The November-December application should be made after the last mowing in the fall. It is important that the grass not go into winter with excessively long foliage.

Mowing

Mowing management factors are not greatly altered because the turf is on surface-mined land. The major factors include mower type, cut height, mowing frequency, and mower sharpness.

Reel mowers provide the highest quality of cut and should be utilized in those situations where the highest quality turf is desired. Rotary mowers are cheaper to purchase and maintain. They have the advantage of providing closer trimming capability and are best suited to rough terrain mowing.

The proper height of cut is important as it has a direct relationship upon the potential to develop a root system. Kentucky bluegrass, tall fescue, perennial ryegrass, the fine fescues, and mixtures of these grasses should be mowed at a height between 1.5 and 3.0 inches. Bermudagrass and zoysiagrass is best maintained between 0.75 and 1.5 inches. The higher mowing height in these ranges will produce healthier turfgrass plants with greater root systems and less predisposition to disease. The higher mowing heights are particularly beneficial where the surface is rough and during periods of heat or drought stress.

Mowing frequency is very important, as it has been shown that improper mowing frequency will actually reduce root growth. Proper mowing frequency is determined by the rate of growth. A lawn should be mowed with a frequency that ensures that no more than one-third of the existing green tissue is removed at any one time. For instance, if a lawn is being mowed at a 2-inch mowing height, it should be mowed before it reaches 3 inches in height. If lawns are being mowed with the proper mowing frequency, it should not be necessary to collect clippings. If clippings collect in piles on a lawn, they should be raked out to prevent overheating and shading of the grass underneath.

Maintaining a sharp mower is extremely important as it minimizes the damage associated with mowing. When a grass plant is mowed, wound hormones and stored food reserves are mobilized to heal the wound. The more severe the wounds, the more of these materials are utilized. These stored food reserves provide energy for the production of roots, leaf tissue, stolons, and rhizomes. Therefore, it is not efficient to waste this energy on healing wounds caused by a dull mower.

Clippings should be returned to the lawn because they provide significant nutritional value to the lawn. It is estimated that this management practice will reduce fertilizer requirements on the average lawn by one-third. In addition, researchers have noted that returning clippings promotes increased earthworm populations, which aerate the soil and reinoculate the thatch with soil, aiding in thatch decomposition.

Irrigation

In most years, watering is necessary in order to produce year-round, quality turf in Virginia. The proper philosophy for irrigating turf is to water infrequently but heavily. Frequent, light irrigations are not recommended because they tend to promote the development of a shallow root system. Surface-mined lands show great textural variability and have an abundance of buried rock. They are therefore prone to developing dry spots that require localized attention. Some buried rock can restrict root growth to the point that the only reasonable solution is removal of the rock. If a commitment is made to keep an area green through the summer, constant vigilance will be necessary to prevent drying out of the texturally coarse areas.

Areas needing water will show a blue-green cast associated with the early stages of wilt. Once turf develops this color, it will require water within 12 hours or it will go into the browning stage. Areas can be tested for water need by forcing a screwdriver into the soil. If it requires a great deal of force to get the screwdriver into the soil, it most likely needs water.

It is best to irrigate turfgrasses in the early morning. Late afternoon or early evening irrigation is not advisable as it leaves the foliage wet going into the evening.

This condition promotes maximum disease activity and should be avoided. However, when wilt injury is imminent, do not delay irrigation.

Turfgrasses will normally require 1.0 to 1.5 inches of water every week that passes without rainfall. Determination of how much water is being applied in irrigation is easily done by placing low-profile flat pans in the irrigated area and measuring the depth of the water in them following timed periods of irrigation. The water-delivery rate can then be determined in inches of water delivered per hour.

Cultivation

Lawn cultivation practices include core aerification, topdressing, and vertical mowing. These supplementary practices are utilized to reduce thatch and damage associated with compaction.

Lawns newly established on surface-mined land will be prone to the development of heavy thatch layers in the first three to five years. This is primarily due to the fact that these soils are inherently low in microbiological and earthworm activity. The addition of organic matter soil amendments during establishment may increase microbiological activity. However, the simplest way to avoid a thatch problem is to utilize turfgrass species that are not prone to thatch development and to develop a turf management program that does not promote thatch.

Tall fescue and perennial ryegrass do not tend to produce heavy thatch. Some varieties of Kentucky bluegrass, creeping red fescue, bermudagrass, and zoysiagrass are capable of excessive thatch development under intense management. Turf management programs with moderate levels of fertilization, proper mowing practices to include returning clippings to the lawn, and periodic aerification will minimize the rate of thatch buildup. Earthworms have a significant role to play in thatch decomposition, and most insecticides and some fungicides have a deleterious effect on earthworm populations. Therefore, judicious use of these materials is advised in situations where thatch buildup is a concern. Insecticides containing Carbaryl, ethoprop, and bendiocarb are particularly harmful to earthworm populations and should be applied judiciously.

Core aerification is the practice of removing plugs of soil from the turf. It is difficult to effectively accomplish core aerification on surface-mined soils because its rocky nature. However, because surface-mined soils are prone to compaction, the practice is very important, especially on heavily trafficked turf. Aeration is normally done with a tractor-drawn device with revolving hollow tines on a rotating spindle. Some designs utilize a piston-type core-removal system. In either case, tines penetrate the lawn and remove soil cores. These cores fall on the surface of the lawn; through rainfall, irrigation, or dragging, the soil is worked into the turf. The soil serves to reinoculate the thatch layer with microorganisms and create an environment that is conducive to the thatch decomposition. This practice also alleviates the negative impact associated with excessive compaction. It is best done when the turf is actively growing to minimize the time that the turf is damaged by the operation. For cool-season grasses, the best time to do this is in the spring when the turf is actively growing. Early fall is also an acceptable time; however, turfgrass leaf growth is not as great in the fall and the healing process is slower. Warm-season grasses are best aerified in early summer when they are most actively growing.

Topdressing is the practice of applying a 0.125-inch to 0.25-inch layer of soil material on the surface of the lawn. This practice protects the growing crowns and increases the rate of thatch decomposition. It is a laborious and costly process that is not commonly practiced by homeowners. Similar results can be achieved through intensive aeration.

Vertical mowing involves the use of a machine with blades that are perpendicular to the ground and rotate in a manner that removes dead debris and thatch from the turf. These pieces of equipment are often called "dethatchers." Vertical mowing provides for immediate removal of considerable amounts of thatch and is a curative approach to a thatch problem. Core aerification, on the other hand, is thought of as a preventive approach to thatch management. Vertical mowing should be done during periods when the turfgrass is actively growing to minimize the time required for healing.

Requirements for cultivation will vary greatly between species of turfgrass. Core aeration will be beneficial to all turfgrasses; however, its impact will be greatest on compacted lawns. Topdressing and vertical mowing will not likely be necessary on tall fescue or perennial ryegrass lawns but may be beneficial to those lawns developing excessive thatch.

Weed and Pest Control

Weeds, insects, and disease can always create problems for individuals trying to produce quality turf. There is no evidence from our research that there will be any

pests uniquely associated with lawns grown on surface-mined lands in southwestern Virginia. Standard procedures of pest control should be applied in instances where pests reduce turf quality. This should include: (1) identification of the pest, (2) determination of the best method and time for control, and (3) strict adherence to the procedures outlined for the control method. All Virginia Cooperative Extension offices have Pest Management Guides available that provide recommendations for controlling all pests common to turfgrass in Virginia.

Keys to the Proper Use of Pesticides

1. Read the label on each pesticide container before each use. Follow the printed instructions to the letter, heed all cautions and warnings, and note precautions about residues.

2. Store pesticides in the containers in which you bought them. Put them where children and animals cannot get to them – preferably locked up and away from food, feed, seed, and other materials that may be harmful if contaminated.

3. Dispose of empty pesticide containers in the manner specified on their labels.

See your physician if symptoms or illness occur during or after use of pesticides.

Additional Information

Additional Information on turfgrass management in Virginia is available from Virginia Cooperative Extension (VCE) at *http://pubs.ext.vt.edu/*.

Goatley, J. M., and Shawn Askew. 2009. *Maintenance Calendar for Cool-Season Turfgrasses in Virginia*. VCE publication 430-523.

Goatley, J. M., and Shawn Askew. 2009. *Maintenance Calendar for Warm-Season Turfgrasses in Virgini*a. VCE publication 430-522.

Goatley, J. M., Shawn Askew, David McCall, and Peter Schultz. 2009. *Spring and Summer Lawn Management Considerations for Cool-Season Turfgrasses*. VCE publication 430-532.

Goatley, J. M., Shawn Askew, David McCall, and Peter Schultz. 2009. *Spring and Summer Lawn Management Considerations for Warm-Season Turfgrasses*. VCE publication 430-533.

Goatley, J. M., Eric Day, and David McCall. 2009. *Pest Monitoring Calendar for Home Lawns in Virginia*. VCE publication 430-524.

Goatley, J. M., Greg Mullins, and Eric Ervin. 2009. *Soil Testing for the Lawn and Landscape*. VCE publication 430-540. An online presentation accessible from

Goatley, J. M., and Whitnee Askew. 2008. *2008-2009 Virginia Turfgrass Variety Recommendations*. VCE. (Note: This publication is updated annually; the 2008-2009 recommendations are located at *www.pwcgov.org/docLibrary/PDF/007049.pdf*.)