Sod Production on Guam

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Interest in commercial sod production has risen due to increased demand for an instant turf by many building contractors and their customers. Sod production involves growing a solid stand of desirable grass species and then harvesting it intact with a thin layer of soil and roots attached to it. Most sod operators on the Mainland USA also ship the product to market and many offer custom installation. As with any new enterprise, cost and profit potential must be weighed before investing in equipment, land, and labor for production. The purpose of this publication is to list and discuss basic cultural practices and equipment required to produce quality sod.

SITE SELECTION

The ideal site for a sod farm will be based on several criteria: location, accessibility to major roads, available water quantity and quality, soil type, land costs and preparation requirements.

Sod that is stacked on pallets should be unstacked and laid within 72 hours after harvest, preferably within 24 hours. This is especially critical during dry months. Sod on pallets waiting to be loaded or unstacked should be kept as cool as possible. Placing pallets in a shaded environment such as under trees or under a canopy prolongs the sod's life.

Production practices are divided into several areas: establishment, primary cultural practices, pest management, and harvesting. Establishment involves land preparation, soil improvement, irrigation installation and turf planting.

Land Preparation

Prior to planting, the new turfgrass site should be prepared to correct any present problems and to avoid harvesting difficulties. Preparation includes land clearing, removal of trash, land leveling, tilling, installation of drainage and irrigation systems, roadway and building site selection, soil fumigation, and land rolling. The cutter blade on the sod harvester rides on a roller, allowing the unit to bridge the little hills, valleys, and holes in the field. However, if the surface irregularities left by poor soil preparation are too severe, the blade will not uniformly cut the sod; therefore, the yield will be reduced. Proper soil preparation also eliminates layers or hardpans, provides better air and water movement, and enhances deep rooting. Some sites may have poor drainage, therefore, extensive leveling, drainage ditch digging, and installation of drainage tile may be required.

Soil testing is necessary for the area under consideration to determine lime and fertilizer nutrient requirements. Apply and incorporate these amendments prior to turf establishment. Usually, land is subsoiled to break up any hardpans and then plowed with either a moldboard or chisel plow to a depth of ten inches. This practice of breaking the subsurface hardpan should not be followed if subsurface irrigation is being used. Follow subsoiling with soil incorporation of preplant fertilizer, or as in southern

Guam, liming material. Firm the seedbed with a cultipacker roller. The surface must be as smooth and uniform as possible so maintenance and harvesting problems are minimized. The field should be planed in several directions to eliminate as many surface irregularities as possible. After planing, dry soil is considered too fluffy if footprints are more than 1 inch deep. In this case, the field should be firmed by rolling. Preplant fumigation is strongly recommended where previous weed, disease, and nematode problems existed. Major weeds in sod production include common bermudagrass, nutsedge, and crabgrass. Preplant fumigation will be discussed in the Pest Management section.

Soil Improvement and Drainage

Clay soils are the least desirable, however, the most common soil type on Guam. Sod producers will likely experience difficulties in water, traffic, and harvest management. Clay soils do not drain well and therefore, stay wet for extended periods. Precious harvest days may be lost due to wet ground. Also, due to these soils moisture-holding capacities and their high bulk densities, clay soils are heavy to haul.

Loam soils, not common on Guam, have good moisture-holding capacity, drain well, are easy to work, and are relatively light in weight for transport. These contain approximately 40 percent silt and 20 percent clay. Loam soils are most desirable as growing media. Ideally, these soils should have at least 5 percent organic matter and 15 percent or less clay. Sandy loams are desirable because of their good drainage; therefore, traffic and harvest operations may be performed sooner after water application.

Sod production is not recommended for deep, pure sandy soil (beach type) due to the difficulty of maintaining adequate soil moisture and nutrient levels. Furthermore, such soils typically have high levels of nematodes, which adversely affect soil quality and handling.

Proper soil water management is an important key to successful (and profitable) sod production. Poorly drained fields are unsuitable for competitive sod production. These fields often remain saturated, thus unworkable, for extended periods following substantial rainfall. Fields that are poorly drained need to be designed so that individual beds are crowned before planting. Lateral drain lines or ditches also need to be installed to intercept this surface drainage and to lower the water table to manageable levels.

Irrigation

Irrigation is required for quality sod production. Ample water of good quality should be a priority during the planning stage. Water sources include wells, sink holes, ponds, streams and canals.

Irrigation systems normally involve center-pivots, lateral pivots, walking or traveling guns, or subirrigation (raised water tables). Consider the size and location of your operation, and the availability of a reliable mechanic, plus backup pumps and accessories when choosing a particular system.

In subirrigation, water is applied beneath the ground surface, rather than on it. Usually by creating and maintaining an artificial water table at some predetermined depth. This artifical water table is created over a natural barrier located one to several feet below the soil profile that prevents deep percolation. The barrier may be a relatively impervious layer in the substratum or a permanently high natural water table on which an artifical table can be built.
The water table is kept at a fixed depth, usually 12 to 30 inches below the surface, by ditches surrounding the sod field. Moisture then reaches the plants through capillary action. The topography must be

nearly level and smooth. The soil immediately below the soil surface must be sufficiently permeable to permit the free and rapid movement of water laterally and vertically. The distribution system must consist of a well planned system of main ditches, field laterals and structures, which will permit the water table to be raised to a uniform depth below the ground surface over the entire region. Ditches are typically 40 to 60 feet apart. An adequate outlet for drainage of the irrigated area must be available or provided for.

Principles involved in subirrigation are the same in all areas, although the means of introducing water into the soil profile may differ. Water is usually introduced into the soil profile through open ditches. However, water injection through pressurized pipes is sometimes necessary.

Turf Selection and Planting

Several turfgrass species can be produced on Guam. Determining which one is best for a particular situation is based on several factors. If properly maintained, St. Augustinegrass provides deep rooting and therefore increased drought resistance. If the purchaser is willing to allot more time, energy and economic resources to turf maintenance, a finer-textured species is suggested, such as one of the burmudagrass or zoysiagrass cultivars. In addition, centipedegrass is available for those regions with heavier soils, and for those persons with less resources and time available for upkeep. Other considerations for selecting a grass species include insect and disease resistance, nematode susceptibility, seedhead/shoot growth rate, and shade tolerance.

Currently on Guam, these species include the St. Augustinegrass varieties and centipedegrass. Bermudagrass and zoysiagrass are also possible.

It is suggested that new growers develop a nursery of the grasses intended to be grown. Growers typically establish 1 to 2 acre plots from which sprigs are obtained to increase acreage. The average quantity of stolons or sprigs harvested from an area will plant an area of twenty times that size. When planting sprigs or stolons, the objective is to distribute these uniformly and cover them with soil. These can be distributed either by hand or with a manure-type spreader and then run over with a light disking or cultipacking. Several passes over an area may be necessary but the grass should not be planted deeper than two inches. Bahiagrass and centipedegrass may also be established from seed. Use certified seed to ensure variety characteristics, germination, and prevention of weed seed introduction. A minimum of 10 to 12 pounds of centipedegrass seed may be planted per acre, but faster stands will be obtained if 50 to 100 pounds of seed are used per acre. In most cases, cost will dictate which rates are used. Centipedegrass seed is also established by spreading seed mixed with fertilizer and then cultipacking.

After planting, irrigate immediately and keep the area moist until the sprigs have rooted (approximately 7 to 14 days) or until the seedlings are 1 to 2 inches high. At this time, reduce watering to 1.5 to 2 inches per week, including rainfall, until complete ground cover is achieved. Ideally, on established fields, irrigation amount is based on evapotranspiration (ET) information from a nearby weather station. Weather patterns such as rain or dry winds would require application of more or less water. For those growers without ET information, fields are typically irrigated 2 to 3 times per week with 0.5 to 0.75 inch each time.

A soil probe is a very useful tool in irrigation management. The depth the soil is dry or wet can easily be measured with this and irrigation scheduling adjusted accordingly. Tensiometers are soil moisture sens-

ing devices, which measure the suction created by drying soil. If used correctly, the data gathered from these instruments' gauges can be used to determine irrigation scheduling. Remember that after the grass is planted, irrigation becomes the most important single factor for successful stolon establishment. It is critical not to plant more area than can easily be irrigated at one time.

PRIMARY CULTURAL PRACTICES

Fertilization

Proper fertilizing for sod production normally reflects the need for grass re-growth following establishment or cutting of the previous crop. Nitrogen is the most important nutrient regulating this regrowth. Generally, higher rates and frequencies of nitrogen application reduces the production time for a crop. However, excessive nitrogen rates force excessive topgrowth at the expense of the roots, thus reducing the "liftability" of the sod. Economics also dictate, to an extent, the amount and frequency of nitrogen use. A balance needs to be maintained between all major and minor elements since the unavailability of any nutrient may weaken or delay the production process. Sod managers should test all fields before planting and yearly thereafter to regulate pH and nutrient levels and needs of the particular grass being grown.

Many soils naturally provide adequate phosphorous and soil pH levels. Apply phosphorous and liming material (if necessary) prior to planting. Phosphorous is available as Super Phosphate (0-18-0) or Triple Super Phosphate (0-45-0). Growers commonly use one fertilizer containing both nitrogen and phosphorous. Examples of such sources include 16-20-0 or 11-48-0. The optimum soil pH for St. Augustinegrass, bermudagrass, and zoysiagrass is approximately 6.0 to 6.5. Centipedegrass has an optimum soil pH of 5.0 to 5.5. But it does well on higher pH soils too.

Following the first mowing, apply fertilizer at the rate of 40 to 45 pounds of actual nitrogen per acre. A fertilizer with a nitrogen:potassium ratio of 2:1 should be used to increase the turf's stress tolerance level and promote better rooting. Subsequent fertilizer applications should be made following the second mowing. Continue fertilizing every 4 to 6 weeks until the grass develops a complete ground cover.

Scheduling and Rates

Once the sod has covered, fertilizer scheduling is largely dictated by economics. Obviously, if sod orders are strong, the grass needs to be aggressively fertilized to minimize production time. If sales are slow, sod should be fertilized less to save on fertilzer and maintenance costs such as mowing and watering. Bermudagrass and zoysiagrass respond exceptionally well to ample fertilization. The quickest turn-around of these grasses occurs with monthly nitrogen application at the equivalent of 50 lbs N / acre per application. A 2:1 or 1:1 ratio of nitrogen to potassium fertilizer should be used with each application to encourage strong rooting. Phosphorous should be applied as suggested by a yearly soil test.

St. Augustinegrass is normally fertilized every 6 to 8 weeks during the growing season. As with bermudagrass and zoysiagrass, St. Augustinegrass should be fertilized with a 2:1 or 1:1 nitrogen to potassium ratio fertilizer and phosphorous added as suggested by a yearly soil test. If over-fertilized with quickly available nitrogen sources, St. Augustinegrass becomes more susceptible to chinch bug

infestation and grey leaf-spot disease. Using slow- (or controlled) release nitrogen sources and supplemental iron applications can minimize these problems. These are discussed below.

Centipedegrass has a very specific fertilization schedule. (Centipedegrass is fertilized less than the other sod-grown grasses.) If over-fertilized with long-term nitrogen, centipedegrass will develop thatch, decreased winter survival and reduced rooting. The end result, referred to as "centipedegrass decline," is characterized as dead or extremely weak spots roughly 2 to 20 feet in diameter that develop as the grass resumes growth in spring. Normally, centipedegrass decline does not develop until several years after establishment. Therefore, sod managers should fertilize centipedegrass similarly to St. Augustinegrass for one year after establishment. If the grass is not harvested within 18 months after establishment, then the fertility rate needs to be reduced to minimize the occurrence of centipedegrass decline. Established centipedegrass should be fertilized only 2 to 3 times yearly with 23 to 45 pounds of actual nitrogen per acre. Again, supplemental iron or manganese application may be needed if unacceptable leaf clorosis forms.

Fertilizer Sources

Several forms of nitrogen are available for growers. Examples of quickly available forms include urea (45-0-0), ammonium sulfate (21-0-0), ammonium nitrate (33-0-0), and calcium nitrate (15-0-0). These forms respond in several days but do not last very long (approximately 3 to 4 weeks). However, they are the least expensive forms.

Slow-release nitrogen fertilizers are also available. Examples include isobutylidine diurea (IBDU), sulfur-coated urea (SCU), milorganite, manure, sewage sludge, ureaform (ureaformaldehyde) and resin-coated fertilizers. Manures and sewage sludge are low in nitrogen and, because of handling costs and the potential of introducing weed seeds, are not used widely. The other slow-release sources last for 2 to 3 months but costs are generally higher.

Some soils are low in micronutrients. If recommended by soil testing, at least two applications of micronutrients are suggested per year, but more may be required. Several iron products are used. The least expensive and most commonly used source is ferrous sulfate. Ferrous sulfate contains 21 percent iron and is quick-acting, but color enhancement lasts only 3 to 4 weeks. Chelated iron products are more expensive but have been formulated to hold their greening effect for a longer period of time. A chelated iron source, plus a manganese (e.g. manganese sulfate) source, should be applied in spring and again in fall to correct any observed deficiencies (e.g. excessive yellowing).

Iron should be sprayed on most turfgrasses to enhance color, especially near harvesting time. These are often injected into the irrigation system but may also be applied in a dry or spray solution form. Application of 20 to 40 pounds of elemental iron (e.g. 100 to 200 lbs of ferrous sulfate) may be timed approximately 1 to 2 weeks prior to harvesting to enhance color. To prevent burn, irrigation must be applied immediately after iron application during periods of high temperature.

Liquid fertilizers are often used by injecting them into the irrigation system. Ammonium nitrate is the primary nitrogen source used for this. The major problems with using fertilizer in irrigation systems involves difficulties in maintaining uniform distribution and concerns with possible fertilizer leaching.

Mowing

After irrigation, mowing is perhaps the second most important turfgrass cultural practice for sod producers. Mowing helps control turfgrass growth and many undesirable weeds that are intolerant to close mowing. Sod fields require a mowing schedule similar to a well-maintained home lawn.

Two basic mower types include reel and rotary. A reel mower is most desirable because the highest possible mowing quality is achieved due to a cleaner cut. Rollers on a reel-type mower also help smooth the sod field for easier, more uniform harvesting. Reel mowers should always be used the last 4 or 5 mowings before harvest. This produces the finest cut available, and therefore maximizes sod quality. Rotary mowers are acceptable for St. Augustinegrass, and centipedegrass production if blades are properly sharpened and balanced.

Always keep mower blades maintained and sharpened. Dull blades reduce turf quality by leaving grass tips shredded and bruised. Shredded tips dry easily, leaving brown tissue that grows slowly, especially in hot weather. Also remember that mowers are big, heavy pieces of equipment. Grooves, which cause harvest losses, may develop if these machines are used when soils are too wet.

New sod fields are generally mowed once every 1 to 2 weeks until complete coverage is obtained, depending on grass growth and weed encroachment. Mowing frequency will vary for established sod, depending on the fertility level, season of the year, species, and seedhead production. Establish a mowing frequency to ensure no more than one-third of the leaf area is removed at any one mowing. Maintaining this schedule will allow for clipping return to the field for nutrient recycling.

An example of proper mowing frequency is a grass that is normally mowed at a height of one inch. In order not to remove more than 1/3 of the leaf area, it should be mowed before exceeding 1.5 inches. If that growth occurs in 3 days, then the field should be mowed every 3 days; if the growth requires 2 weeks, then that should be the mowing frequency. Established bermudagrass and zoysiagrass sod fields typically are mowed once every 3 days, while centipedegrass, St. Augustinegrass and bahiagrass are mowed once every 7 to 10 days. Grass clippings may or may not be picked up. If removed, sweepers and vacuums are used. The purpose of removing clippings is to prevent them from filtering down into the turf stand and turning brown. When the sod is delivered, the presence of these brown clippings may cause the sod to appear to have less density than it really has. Clipping disposal is a major problem. With restrictions on burning, dumping in landfills, and problems with odor, disposal is a problem to many producers. If clippings are removed, it is suggested that the removal begin during the 1 or 2 months before harvest. This timing will help prevent the browning effect clippings may impose and prevent having disposal problems throughout the entire growing life cycle.

PEST MANAGEMENT

Preplant fumigation with materials such as methyl bromide, dazomet (Basamid), or metam-sodium (Vapam) may be required when sod farms are established on land previously used for row crop farming. Fumigating will reduce perennial weed species such as bermudagrass, nutsedge, torpedograss, and sprangletop. Soil sterilization will also reduce nematode populations that are difficult to control once the grass is established. It is recommended that the sod field be fumigated at least every 5 years to help control weeds, nematodes and other pests.

Methyl bromide is expensive (approximately $1,000/acre) due to the plastic cover required to ensure activity and may only be applied by a certified applicator. This material provides better pest control and the treated area can be planted within 48 hours after the cover is removed.

Metam-sodium or dazomet do not require a cover, but a certain amount of efficacy is sacrificed. If a cover is not used, metam-sodium, once applied, requires incorporation into the soil. Incorporation is achieved by rolling, irrigation, and/or tilling the material to the depth of desired control (usually 6 to 8 inches). Poor performance will result if this incorporation is not performed. A minimum waiting period of 14 to 21 days is required before planting in metam-sodium or dazonet treated soil.

Weed Control

If preplant fumgation is not feasible, the use of a nonselective herbicide such as glyphosate is required on weed infested fields. Weed infested sod will reduce the salability of the product. Three applications of glyphosate spaced 4 to 6 weks apart are necessary for postemergence control of perennial weeds such as bermudagrass. If spray applications cannot be made prior to field establishment, spot treatments of competitive weeds such as bermudagrass will be required thereafter.

Weeds can be introduced into a field in many ways. Irrigation water from open canals, ditches, or ponds often contain weeds. Soil introduced during soil preparation, such as a landplane pulling untreated soil into a field, leaves weeds. Birds, wind, soil erosion, and man also deposit weed seeds. Good housekeeping by keeping ditches and fence rows clean and by washing equipment before entering a weed-free field does benefit the sod producer.

Once the grass is established, weed management involves proper mowing, cultural practices to promote turf competition, and use of herbicides. Many upright growing broadleaf weeds can be controlled effectively through the use of continuous mowing. These include ragweed, pigweed, cocklebur, and morning glory. Mow these prior to seedhead emergence to help prevent reinfestation from seed.

Grassy weeds, which are a problem in sod production, include annual bluegrass, crabgrass, goosegrass, vaseygrass, signalgrass, sprangletop, torpedograss, and bermudagrass. Broadleaf weeds include purslane, betony, pusley, pennywort (dollarweed), oxalis, and spurge. Purple, yellow, annual, globe, cylindrical, and Texas nutsedges are also weed problems.

Immature weeds (seedlings) are most susceptible to herbicides, and certain turf varieties can be damaged when air temperatures exceed 80 to 85 F at the time of herbicide application. The turf should not be under moisture or mowing (scalping) stress when treated with an herbicide. Always read and follow all pesticide labels before use.

Insect Control

Insect pests are generally grouped into three categories: shoot feeding, root feeding, and burrowing. Southern chinch bugs, spittlebugs, grass scales, and bermudagrass mites suck plant juices. Chinch bug damage is normally associated with St. Augustinegrass. Chinch bugs on Guam are still not a major problem, however they may have 10 generations per year. Damage is apparent as yellowish to brown patches in turf and appears sooner on turf under moisture and/or heat stress. The cultivars Floralawn, FX-10 and Floratam, provide some degree of resistance to chinch bugs.

Insect shoot feeders, which eat grass leaves, include sod webworms and armyworms. Armyworms feed during the day, while sod webworms feed at night. Injured grass has notches chewed in leaves, and grass has an uneven appearance.

Root feeding and burrowing insects include mole crickets, white grubs, and billbugs. Mole crickets injure the turf through their extensive tunneling which loosens soil, allowing desiccation to occur quickly. Mole crickets may be flushed out by applying water with 2 teaspoons of household soap per gallon per two square feet on fresh tunnels. If present, crickets will surface and die within several minutes. White grubs and billbugs are root feeders and are typically C-shaped. Grub damage is erratic with patches of turf first showing decline and then yellowing. Under severe infestation, sod may actually be removed by hand. Monitoring these insect populations involves cutting 3 sides of a sod piece and laying this back. If there is an average of three or more grubs per square foot, an insecticide is needed. Other insect pests which disrupt the sod surface or are a nuisance to man include ants, fleas, and ticks.

Disease Control

Disease development requires three simultaneous conditions: a virulent pathogen, a susceptible turfgrass, and favorable environmental conditions. Environmental conditions which favor incidence of most turf diseases include periods of high humidity, rain, heavy dews or fogs, and warm temperatures (but not always). Turf, which is fast growing and succulent from nitrogen overfertilization, is typically more susceptible to disease and other pest invasion. Ideally, irrigate early in the day to minimize the time in which turfgrass remains moist. Do not overfertilize with nitrogen.

If a disease problem is suspected, contact UOG/CALS Extension Service and prepare a sample for laboratory diagnosis. For these situations, do the following:

1. sample the affected area before fungicide application
2. sample from marginal turf areas between diseased and healthy turf
3. cut a 3 to 4 inch plug from each area with symptoms
4. place these in paper bags or cardboard boxes and do not add water
5. submit the sample to UOG/CALS.

The major diseases that occur in sod-grown grasses are dollar spot on bermudagrass and bahiagrass, and grey-leaf spot on St. Augustinegrass. Dollar spot disease forms brown patches approximately the size of a silver dollar. On bahiagrass, dollar spot disease is generally more localized on individual leaves. Normally, dollar spot disease can be eliminated by a light nitrogen fertilization to encourage turf plants to outgrow the disease symptom. Grey-leaf spot disease of St. Augustinegrass normally occurs during hot, humid weather. The use of excessive quick-release nitrogen or the use of atrazine or simazine during these conditions encourages this disease. If fertilized during the summer, use lower quick-release nitrogen rates or use a slow-release nitrogen source on St. Augustinegrass. Foliar applied iron also promotes desirable turf color without overstimulating disease occurrence.

Sometimes Pythium and brown patch disease affect St. Augustinegrass. Both diseases reduce rootingand turf appearance. Pythium normally occurs in poorly-drained areas where water stands. Brown patch also occurs in wet areas and is most pronounced in spring and fall months when grass growth is slow.

Nematode Damage

Nematodes are small, microscopic worms, which normally feed on or in plant roots. If populations become severe plants wilt under moderate moisture stress, are slow to recover after rain or irrigation, and gradually decline or "melt out." Turf roots often become stubby, shortened, and turn black. Due to extensive root damage, plants are not able to withstand stresses such as drought, insect, or disease invasion. Sampling the soil for a nematode assay is the only sure way to determine if they are in high enough populations to cause damage. Prepare soil samples and submit them to UOG.

Control begins with those management practices which favor good turf growth. These include proper watering, fertilization, and mowing practices. Few nematicides are available. Proper turf management is becoming increasingly important to mask nematode presence. Follow label recommendations explicitly.