



United States
Department of
Agriculture



Soil
Conservation
Service

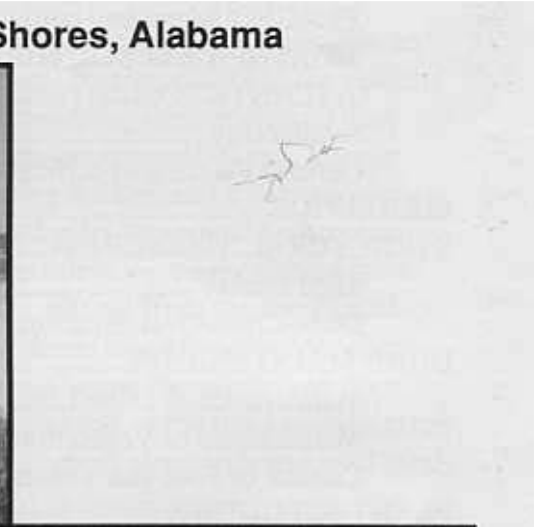
Americus Plant Materials Center
Americus, Georgia

August 1992

Measures for Stabilizing Coastal Dunes

-Alabama-Georgia-

Gulf Shores, Alabama



Tybee Island, Georgia

TABLE OF CONTENTS

INTRODUCTION	1
VEGETATIVE MEASURES	2
Sea oats	2
'FLAGEO' Marshhay cordgrass	3
'NORTHPA' and 'SOUTHPA' Bitter panicum	3
'ATLANTIC' Coastal panicgrass	4
Availability	4
General Planting Specifications	5
IRRIGATION	6
STRUCTURAL MEASURES	7
Sand Fences	7
Dune Cross-Over Structures	8
DUNE MAINTENANCE	9
Maintenance of Dune Line	9
Maintenance of Vegetation	9
Control of Foot and Vehicular Traffic	9
PLANTING GUIDES	10
Sea oats	10
'FLAGEO' Marshhay cordgrass	11
'NORTHPA' and 'SOUTHPA' Bitter panicum	12
'ATLANTIC' Coastal panicgrass	13
REFERENCES	14

Prepared by Donald Surrency
Plant Materials Specialist
USDA, Soil Conservation Service
Athens, Georgia

All USDA services and programs are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

INTRODUCTION

Dunes are reservoirs of sand formed by waves and wind that help keep a seashore intact. They provide a flexible barrier to the movement of high tides and waves into low-lying areas behind a beach, reducing erosion. When they give way to storm winds and water, these shifting mounds of sand will soon reappear. Dunes are not effective, however, when permanent changes in a shoreline cause persistent shore recession.



-Dune Vegetation-

When unstable, dunes are extremely vulnerable to the forces of wind and water. They can be stabilized with vegetative and structural measures, including grasses and woody plants adapted to a coastal environment.

Dunes stabilized with grasses provide an interesting natural barrier, reducing the velocity of waves and absorbing their energy. These stabilizing plants are tolerant of salt, intense heat, soils lacking humus, and a limited water supply. As sand piles up around beachgrass plants, new roots develop on the buried stems and new shoots emerge from the sand's surface. The result is a dense mat of vegetation which anchors the dune below its surface and traps more windblown sand. Structures such as cross walks and sand fences also catch and hold sand, and either build or repair dunes.

Dune stabilization projects usually require a combination of vegetative and structural measures. They include planting adapted dune grasses, providing adequate moisture during the first growing season (often with an irrigation system), and constructing cross walks or cross-over structures to prevent pedestrian traffic from destroying dune vegetation.

This booklet provides guidance on how to stabilize coastal sand dunes using both vegetative and structural measures.

VEGETATIVE MEASURES

There are only a few plant species that are tolerant of the stresses of the beach environment. These plants must be able to survive being buried by blowing sand, sand blasting, salt spray, saltwater flooding, drought, heat, and low nutrient supply. Perennial grasses are effective under these conditions.

From 1984 to 1989, the USDA, Soil Conservation Service Americus, Georgia, Plant Materials Center (PMC) evaluated sea oats, marshhay cordgrass, and bitter panicum for dune stabilization on Tybee, Jekyll, and St. Simons Islands in Georgia, and at Gulf Shores, Alabama. The Cape May, New Jersey, Plant Materials Center evaluated coastal panicgrass. As a result, the Americus PMC recommends the following plant materials for coastal dune stabilization:

Sea oats

(Uniola paniculata)

'FLAGEO' Marshhay cordgrass

(Spartina patens)

'NORTHPA' Bitter panicum

(Panicum amarum)

'SOUTHPA' Bitter panicum

(Panicum amarum)

'ATLANTIC ' Coastal panicgrass

(Panicum amarum var. amarulum)

Sea oats

Sea oats, a warm-season dune grass ranging throughout the Gulf and south Atlantic regions from southeastern Virginia to Mexico, is vigorous, drought- and heat-tolerant, and relatively free of pests. This perennial is the most important and widespread grass on southern coastal dunes.

The leaves are narrow and pale green, and in northern locations, they die back close to the ground each winter. Seed heads mature in the fall and are compressed spikelets that develop at the end of stiff stems 3 feet long or more.

Sea oats are established by digging and dividing native plants, or from commercially available small potted plants grown from seed. Under natural conditions, seed germination is not high and seedling survival is low. When replanting seedlings, set the stock at least a foot deep into the sand and pack it tightly.



-Sea oats (*Uniola paniculata*)-

'FLAGEO' Marshhay cordgrass

'Flageo' marshhay cordgrass, a new plant for stabilizing coastal areas, was cooperatively released in 1990 by the USDA, Soil Conservation Service (SCS) plant materials centers in Americus, Georgia and Brooksville, Florida and by Fort Valley State College in Fort Valley, Georgia.

This perennial occurs on dunes throughout the south Atlantic and Gulf regions and in Puerto Rico. Along the Atlantic coast of northern Florida, marshhay cordgrass is the dominant plant on dunes composed mostly of broken shell and coquina rock. This grass is especially salt tolerant.

The stems of marshhay cordgrass are slender and grow 2 to 3 feet tall, and the leaves roll inward, resembling rushes. Seed heads are composed of two or more compressed spikes attached at nearly a right angle to the culm. These plants spread by a network of slender rhizomes.

Planting vegetative material in early spring can be successful. For large plantings, bare root stock is recommended. Stems rooted at the base, preferably with a section of rhizome attached, can be planted at a depth of 4 to 5 inches.



*'Flageo' marshhay cordgrass foundation field
at Americus, GA, Plant Materials Center-*

'NORTHPA' and 'SOUTHPA' Bitter panicum

'NORTHPA' and 'SOUTHPA' Bitter panicum varieties were released by the Brooksville, Florida, Plant Materials Center in 1992. Vegetative plant material is commercially available.

Bitter panicum is a perennial grass found on dunes throughout the south Atlantic and Gulf regions. It is most common in southern Florida and Texas.

These plants grow to an average height of 3 to 4 feet. The leaves are smooth and bluish green and seed heads are narrow, compressed, and generally sparsely seeded. Plants spread from an aggressive, scattered system of stolons and rhizomes, but the stands are rather open.

Bitter panicum produces few viable seed, and is better adapted for transplanting from established stands or from commercially available potted material. It can be propagated from a stem with part of the rhizome attached or from an 8- to 12-inch length of rhizome without any above-ground parts. Harvest the rhizomes after the seed has matured, and plant 4 inches deep in early spring, spaced no more than 3 feet apart.

Another method of propagation is to snap off robust stems at ground level and plant them at a 45-degree angle so that several nodes are buried.

'ATLANTIC' Coastal panicgrass

'ATLANTIC' coastal panicgrass (*Panicum amarum* v. *amarulum* [A. Hitchc. & Chasel P. G. Palmer]) was released by the Cape May, New Jersey, Plant Materials Center. Its origin is Princess Ann County, Virginia. Seed is commercially available.

'ATLANTIC' coastal panicgrass is a somewhat dense, upright perennial bunchgrass found on coastal dunes throughout the south Atlantic and Gulf regions. It is a dominant plant at many locations, especially in west Florida, Alabama, and Texas.

The stems are coarse, straight, stiff, and grow up to 4 feet tall. Partially compressed seed heads produce moderate amounts of viable seed each fall. The crowns enlarge slowly from short, almost vertical tillers.

Plant the seed at a rate of 15 pounds per acre drilled or sown, 1 to 3 inches deep in dune sand. For best results, mulch the area. Seedling survival depends on adequate rainfall after germination. Clumps of coastal panicgrass can be dug, divided, and planted during the summer with good results if adequate moisture is available.

Availability

Not all cultivars listed are commercially available at this time. Limited quantities of foundation seed and vegetative material are available to commercial nurseries and potential growers. For complete information on commercial availability, contact:

**Plant Materials Specialist
USDA, Soil Conservation Service
Federal Building, Box 13
355 E. Hancock Avenue
Athens, Georgia 30601**

Telephone: 706/546-2114

GENERAL PLANTING SPECIFICATIONS

Plant Materials

Obtain viable seed or planting stock from an established stand or commercial nursery. Use freshly dug bare root tillers, rooted stem cuttings, or potted material. Bare root stock dug from vigorous stands and planted when fresh gives survival and growth rates equal to potted materials.

Pots of 2 to 4 inches are generally adequate for most stabilization and building work. Liners (1-inch pots) can be used on sites with ideal planting conditions, or when using irrigation. Pots larger than four inches are necessary only where aesthetics or traffic control is important, or erosion is severe.

Site Preparation

Tillage and liming are not required for planting on beach sand. Install irrigation systems and structural measures, such as sand fences and dune cross-over structures, prior to planting.

Planting Dates

Plant vegetative material in late winter or early spring. March 1 to June 1 is suitable when using irrigation.

Planting Depth

When available, seed should be sown or drilled at a rate of 15 pounds per acre (20 lbs/acre broadcast), 1 to 3 inches deep. Stolons or rhizomes should be planted 4 to 12 inches deep, or deep enough to have adequate soil moisture at the time of planting. Cut stems should be planted at a 45-degree angle deep enough to bury several growth nodes.

Use a tree dibble or spade to plant the vegetative material. Large, flat sites can be planted more economically using a tractor-drawn transplanter with planting plows that create furrows 8 to 15 inches deep.

Spacing

Vegetation must be planted to a width of at least 10 feet. Wider areas may be required on severely eroded sites. Plant spacings range from 1 to 3 feet, but are typically 18 inches for 1- to 4-inch potted stock or bare root plugs and stolons of the same size.

Fertilization

Initial fertilization is best done at planting with a complete slow release fertilizer, such as **Osmocote* 14-14-14, placed under the plant at a rate of one ounce per plant. Initial fertilization may also be provided with 200 to 300 pounds of mineral 10-10-10 per acre broadcast six weeks after planting. Second year fertilization is recommended in June of the following year at a rate of 400 pounds of 10-10-10 per acre.

Maintenance fertilization should be provided twice annually during the growing season with 400 pounds of 10-10-10 per acre split into two applications and applied before September 1. Fertilization is recommended until the plants spread to provide complete cover and stands achieve complete vigor after storm damage.

Mulching

Mulching helps protect the soil between the plants from wind erosion and reduces evaporation of moisture available to plants. Common mulches, such as hay, straw, netting, peg and twine, and asphalt, are not recommended due to the difficulty in applying and anchoring the mulch to dune areas, and its untidy appearance. Woodchips and compost are recommended mulches and can be applied to the soil surface to a depth of 4 inches, or incorporated into the soil to a depth of 6 inches. Ligin soil stabilizers are recommended for surface stabilization, and should be applied at the manufacturer's recommended rates and concentration.

* Other commercial fertilizers of the same analysis and with a slow release formulation may also be used.

IRRIGATION

Irrigation is required on all dune plantings to provide adequate moisture during the initial establishment period. The irrigation system will consist of mains and laterals, control zones, supports, control valves, fittings, and related hardware that is capable of applying 1/2-inch of water over the entire zone in an 8-hour period.

Irrigation lines should be located on the windward edge of the planting to compensate for the effect of the wind. Low pressure irrigation systems (20 to 50 pounds per square inch, or *psi*, household pressures) should have the sprinkler heads and irrigation lines spaced no further than 20 feet apart to minimize wind spray. Designs at higher pressures should be field tested in winds to plan the spacing.



-Dune Irrigation System-

SPECIFICATIONS

1. Irrigation Pipe

Irrigation pipe should be PVC with approved ratings for irrigation use. Use PVC pipe mains and laterals that meet the minimum class standards shown below:

MAIN - 2-inch class 160 SDR 26
LATERALS - 3/4-inch class 200 SDR 21
1-inch class 200 SDR 21
1 1/2-inch class 160 SDR 26

2. Fittings

Use fittings that meet the minimum standards for irrigation use.

3. Sprinklers

Use plastic rotary impact sprinklers rated at 1.5 gallons/minute and spaced about 20 feet apart.

4. Application Rate

Irrigation should be applied on a budget using the consumptive use figures of pasture grass. Planting areas should be irrigated to field capacity prior to planting.

When there has been no rain, irrigation intervals should be daily the first month, every other day the second month, every third day the third month, and according to the budget thereafter, using a 36-inch root depth.

STRUCTURAL MEASURES

Sand Fences

A sand fence is an artificial barrier of evenly spaced wooden slats or approved fabric erected perpendicular to the prevailing wind and supported by posts. It reduces wind velocity at the ground surface and traps blowing sand. These fences are used primarily to build frontal ocean dunes to control erosion and flooding from wave overwash. Use of sand fences is more effective than using vegetation alone, and although fencing may be more expensive than building dunes vegetatively, it is less expensive than the use of machines.

Erect the sand fences a minimum of 100 feet (horizontal distance) from the mean high tide (MHT) line in two parallel lines 30 feet apart. The fences should be parallel to the water line and at a right angle to the prevailing winds.

As the fences fill with sand, additional sets of fencing can be placed over the original ones until the barrier dune has reached a protective height. To widen an old dune, fencing should be set seaward, 15 feet from the base of the old dune.



-Sand Fencing-

SPECIFICATIONS

1. Use standard commercial 4-foot high sand fences that consist of wooden slats wired together with spaces between the slats and supported by wooden posts. The fence should be free of decay, broken wire, and missing or broken slats.
2. The fence should be made from Grade A (or better) spruce with slats 1 1/4 inches wide and spaced 1 1/4 inches apart. The 4-foot high fence should be constructed with at least five 2-wire copper-bearing galvanized cables woven around the slats. The slats or laths should be hot dipped in a red oxide weather resistant stain.
3. Wooden posts are used for fence support, and may be made of pressure-treated yellow pine or untreated black locust, red cedar, white cedar, or other wood of equal life and strength. They should be standard fence posts at least 7 feet long, with a minimum diameter of 3 inches, and should be set at least 3 feet deep into the sand, no further than 10 feet apart. Four wire ties should be used to fasten the fence to the wooden posts. Weave the fence between posts so that every other post will have fencing on the ocean side of the posts. Tie wires should be no smaller than 12-gauge galvanized wire.

Dune Cross-over Structures

A dune protection system requires the construction of wooden dune cross-over structures. These structures control pedestrian traffic and allow the dune grasses to take hold and protect the dunes from erosion.

Elevated walks, semi-permanent paved paths, and portable roll-up walkways are all satisfactory cross-over structures. These walkways should be curved to reduce wind erosion.



-Dune Cross-Over Structure-

SPECIFICATIONS

1. Construct cross-over structures at locations according to landscape plans and engineering drawings for the identified coastal areas.
2. All lumber should be pressure-treated #2 yellow pine in accordance with American Wood Preservers Association Standard C-2. Treatment should be to 0.40 lbs CCA per cubic foot, or greater.
3. All connections to the posts should be made by bolts.
4. All nuts, bolts, washers, nails, and other hardware should be hot dipped galvanized metal.
5. Any bolts used in the handrails should have the nut end aiming toward the post. Countersink the nut and bolt so they do not project beyond the post, and trim off the excess metal after fastening.

DUNE MAINTENANCE

Well stabilized dunes will not remain that way unless a reasonable maintenance program is followed. Major considerations include maintaining the dune line and vegetation, and controlling foot and vehicular traffic.

Maintenance of Dune Line

A dune system, like a chain, is no stronger than its weakest point. Consequently, to receive maximum protection from wind and water, a strong and uniform dune line must be maintained. Blow-outs, wash pits, and other natural or human-produced damage must be repaired quickly to prevent weakening of the entire protective dune system.

Blow-outs in a dune system can be repaired by placing sand fences between existing dunes and tying the ends of the fence into these dunes. Maintain the sand fences and erect additional ones as needed, until the eroded area has been permanently stabilized, or until the dune has reached the desired height and is properly vegetated.

Maintenance of Vegetation

Maintain dune plantings by applying fertilizer as needed to keep a desired density. At a minimum, apply 50 pounds per acre of an inorganic nitrogen fertilizer annually. Sparse areas should be replanted.

Control of Foot and Vehicular Traffic

The primary dune is intolerant of trampling. Therefore, traffic must be prohibited. The inland, or secondary dune, must also be protected from pedestrian and vehicular traffic. Since dunes must be crossed to reach the beach, mechanical cross-overs can be installed at selected sites to provide access. These cross-over structures should be properly maintained and any loose or damaged boards repaired or replaced.



-Evaluation of Dune Vegetation at Gulf Shores, Alabama-

PLANTING GUIDE

Sea oats (*Uniola paniculata*)

Description: Perennial, erect, strong, rhizomatous, colonizing grasses native to the coastal sands and dunes of Florida and the southeastern United States. This grass forms in dense, rather stiff bunches 40 to 60 inches tall and 30 to 120 inches in diameter. Leaves are less than 1/2-inch in width, 16 to 28 inches long, and are usually flat. Leaves are rolled or involute on drying. Panicles of the seedhead are 8 to 12 inches long with numerous spikelets less than 1-inch long, each having 8 to 15 florets. Very little to no seed is produced by most seedheads and is readily eaten by birds. Only rarely is reproduction by natural germination of seed observed. Lateral spread and colony increase is accomplished by moderate to strong rhizome development.



Sea oats

- **Native Habitat and Range:** Sand dunes from southern Virginia to Florida and Texas.

- **Conservation Use:** Critical area stabilization of saline coastal sands and sand dunes.

- **Site Preparation:** Generally none required.

- **Plant Material:** Potted plants and bare root stock are available commercially and from vigorous stands. Use transplants with a minimum 30-inch stem height.

- **Time of Planting:** Late winter to early spring, and at the beginning of the rainy season in Florida.

- **Spacing:** Place plants 12 to 36 inches apart, depending on the pot size and severity of the site. Use 18-inch spacing for an average site using 2- to 4-inch pots.

- **Depth:** Place plants 8 to 12 inches, or deeper, in moist soil.

- **Fertilizer:** Place one ounce of slow release fertilizer such as **Osmocote* in each hole as material is planted, or apply 200 to 300 pounds of 10-10-10 per acre 3 to 4 weeks after planting. To maintain and/or develop the stand, apply 200 to 300 pounds of 10-10-10 (or equivalent) per acre annually June 1 to June 15 and repeated August 1 to August 15.

- **Maintenance:** Minimize foot traffic and remove debris from planting.

* Other commercial fertilizers of the same analysis and with a slow release formulation may also be used.

PLANTING GUIDE

'FLAGEO' Marshhay cordgrass (*Spartina patens*)

Description: Perennial, warm season grass with erect stems, mostly less than 40 inches tall. It spreads by long slender rhizomes. Leaves are less than 1/8-inch wide and are sometimes flat, but usually roll inward from the edges with the upper surface inside. There are 2 to 7 spikes on the seedhead. These 3/4- to 2-inch spikes are born against or away from the stem.

- **Native Habitat and Range:** Salt marshes and sandy meadows from Quebec, Canada to Florida and Texas, and saline marshes inland from New York to Michigan.

- **Conservation Use:** Saltmeadow cordgrass is used for coastal erosion control in backdune areas, along tidal river banks, and on salt marshes above the high tide line. Inland uses include stabilizing waterways, gullies, roadsides, and minespoil and saline oil seep areas. The 'salt hay' is used as a mulch and fed to cattle.

- **Site Preparation:** None required, but removal of trash on tidal areas will prevent burial of plants.

- **Plant Material:** Potted plants or bare root stock are available commercially and from vigorous stands. Use transplants that have 5 to 10 stems each.

- **Time of Planting:** Late winter and early spring, and at the beginning of the rainy season in Florida.

- **Spacing:** Place plants 12 to 24 inches apart, depending on severity of site.

- **Depth:** Plant 4 to 8 inches, or deeper, in moist soil.

- **Fertilizer:** On critical area plantings, place one ounce of slow release fertilizer such as **Osmocote* per plant at planting, or apply 200 to 300 pounds of 10-10-10 per acre several weeks after planting. Apply 200 to 300 pounds of 10-10-10 per acre annually in June until the stand fills in the spacing. Do not fertilize rangeland plantings.

- **Maintenance:** Minimize foot traffic and remove debris from planting.

* Other commercial fertilizers of the same analysis and with a slow release formulation may also be used.

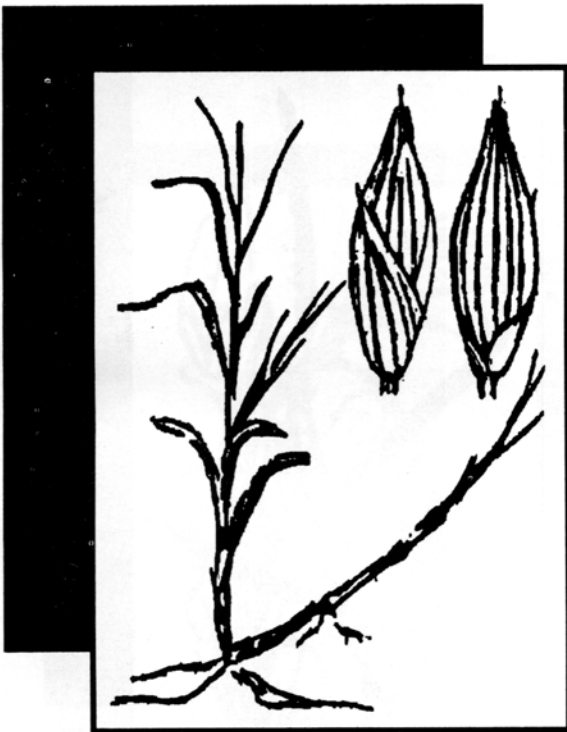


Marshhay cordgrass

PLANTING GUIDE

'NORTHPA' and 'SOUTHPA' Bitter panicum (*Panicum amarum*)

Description: Perennial, warm season grass growing to a height of 7 feet with a growth habit ranging from erect to prostrate. The leaves are 1/4- to 1/2-inch wide, 7 to 20 inches long, smooth without hair, and bluish in color. This robust grass spreads slowly from short, strong rhizomes, forming open clumps. Small quantities of poor quality seed are produced on compact panicles 6 to 12 inches long and 2 to 4 inches wide.



Bitter panicum

- **Native Habitat and Range:** Coastal dunes and sandy shores from New Jersey to Florida and Texas.

- **Conservation Use:** The principal use is in coastal dune erosion control and it may have a role in stabilizing other dry, sterile areas such as roadsides and minespoils.

- **Site Preparation:** Generally none required.

- **Plant Material:** Potted and bare root plants are available commercially. Freshly dug bare root tillers, rooted stem cuttings, and unrooted stem cuttings can also be obtained from vigorous stands.

- **Time of Planting:** Late fall with stem cuttings; late winter or early spring with potted plants; late spring with young tillers (when it coincides with the rainy season).

- **Spacing:** Plant potted and bare root material in a grid pattern 2 feet apart in 2 to 3 foot staggered rows. Plant stem cuttings three to a hole 2 feet apart in 2 to 3 foot staggered rows.

- **Depth:** Place plants 4 to 10 inches, or deeper, in moist soil. Plant stem cuttings at a 45-degree angle, deep enough to bury several nodes and leaving the top 6 to 10 inches of stem exposed.

- **Fertilizer:** Place one ounce of slow release fertilizer such as **Osmocote* in each hole as material is planted, or apply 200 to 300 pounds of 10-10-10 per acre 3 to 4 weeks after planting. Apply this same rate annually in June and repeat in August, until the stand fills in the spacing.

- **Maintenance:** Restrict traffic and livestock. Overgrazing and high palatability were responsible for the decrease of this plant in the 19th century.

* Other commercial fertilizers of the same analysis and with a slow release formulation may also be used.

PLANTING GUIDE

'ATLANTIC' Coastal panicgrass (*Panicum amarum* var. *amarulum*)

Description: A strong, perennial, short rhizomatous, salt-spray tolerant grass with numerous medium textured, erect stems 3 to 7 feet or more in height. Produces moderate to abundant numbers of medium textured bluish-green leaves 3/4 to 1 inch wide by 12 to 20 inches long. Radial lateral spread is 4 to 8 inches annually. Seedheads 4 to 8 feet in height are produced in late July through August or September. The seed is eagerly sought by doves and quail. Volunteer seedlings occasionally occur when the soil is undisturbed.

- **Native Habitat and Range:** Coastal dunes throughout the south Atlantic and Gulf regions.

- **Conservation Use:** Coastal panicgrass is used primarily in coastal dune stabilization, but has shown promise in vegetating other droughty, sterile areas such as sandpits and minespoils.

- **Site Preparation:** To prepare a seedbed, the soil should be plowed, disked, and packed. Bare soil can be broadcast seeded followed by harrowing or light disking to cover the seed. Vegetative plantings into bare soil can be made using a shovel or dibble.

- **Plant Material:** Freshly dug bare root tillers (sprigs) or seed are available commercially.

- **Time of Planting:** Plantings should be made November 1 to March 1, or June 1 to September 1 when it coincides with the rainy season.

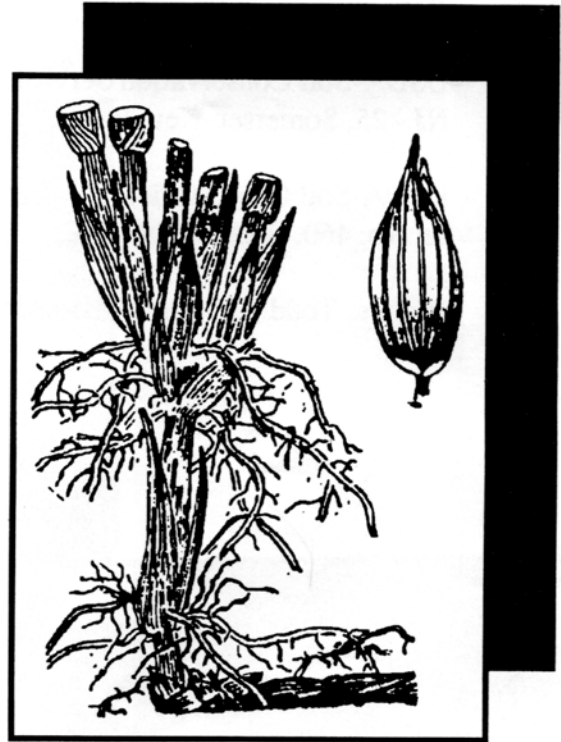
- **Spacing and Seeding Rates:** Tillers (sprigs) should be planted in rows 6 to 8 feet apart and spaced about 18 inches apart in the rows. About 5,000 tillers per acre are required for this type of planting. Use 10 to 15 pounds of seed per acre drilled or 20 pounds per acre broadcast.

- **Depth:** Seed at 1 to 3 inches depth. Plant tillers so the roots are well distributed in moist soil and the crowns are covered with 1/2- to 1-inch soil. Pack firmly.

- **Fertilizer:** Fertilize winter plantings at planting time. Apply 400 pounds of 10-10-10 per acre or equivalent, plus minor elements, in the spring. Repeat this fertilization in mid- to late summer. For summer plantings, place one ounce of slow release fertilizer such as **Osmocote* in each hole as material is planted, or apply 200 to 300 pounds of 10-10-10 per acre 3 to 4 weeks after planting. Apply the same rate and kind June 1 through 15 and August 1 through 15, annually, until the stand fills in the spacing.

- **Maintenance:** Minimize foot traffic and remove debris from planting.

* Other commercial fertilizers of the same analysis and with a slow release formulation may also be used.



Coastal panicgrass

REFERENCES

Proceedings of the Florida State Horticultural Society, Coastal Dune Vegetation, Vol. 87, 1974.

USDA-Soil Conservation Service, Guide for Dune Protection in New Jersey, Technical Note NJ - 25, Somerset, New Jersey.

USDA-Soil Conservation Service, Plants for Coastal Dunes, Agricultural Information Bulletin No. 460, Washington, D.C.

Walton, Todd L., Jr. and Thomas C. Skinner, Beach Dune Walkover Structures - SGR-48.