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EVALUATION OF Bermudagrass Varieties FOR GENERAL-PURPOSE TURF

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By F. V. JUSKA
and A. A. HANSON

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Bermudagrass (*Cynodon dactylon* (L.) Pers.) is a major forage and turf species in the Southern United States. Its prominence in this region is similar to that of Kentucky bluegrass (*Poa pratensis* L.) in the northeastern and north-central regions. Bermudagrass was introduced into North America during the colonial period, presumably from India or Africa. The earliest introductions were not recorded, but bermudagrass is reported to have been brought to Savannah, Ga., in 1751 by Gov. Henry Ellis. It is listed as one of the principal grasses in the Southern States in Mease's Geological Account of the United States published in 1807.

The distribution of bermudagrass extends from New Jersey and Maryland southward to Florida and westward to Kansas and Texas, as shown in figure 1. It is not well adapted in the southern Appalachian highlands, but its distribution extends westward under irrigation to southern New Mexico, Arizona, and to most of the major valleys in California. Limited plantings of improved bermudagrass varieties for turf have been made as far north as Long Island, N.Y., and south-central Indiana and Illinois. In addition, isolated plants have survived, possibly under very favorable conditions, at locations as far from this zone of adaptation as southern Michigan and the Puget Sound area of Washington State.

Interest in bermudagrass for turf has been increasing near its northern distributional limits. This interest may be attributed in part to the availability of winter-hardy varieties, which tolerate low temperatures and compete satisfactorily with the cool-season turfgrasses. In addition, the bermudagrasses offer a possible alternative to Kentucky bluegrass, red fescue (*Festuca rubra* L.), and the bentgrasses (*Agrostis* spp.), where their growth and persistence are limited by high temperatures, disease, heavy traffic, or saline soils. In this northern distributional zone primary consideration has been given to planting bermudagrass on athletic fields, golf fairways and tees, and as a lawn grass around summer homes. Special uses include the stabilization of steep banks and waterways in recreational areas, cemeteries, and highway rights-of-way.

Adaptation of bermudagrass to the northern limits of its distribution is largely dependent on cold hardiness. Information has not been readily available, however, on the relative cold hardiness of

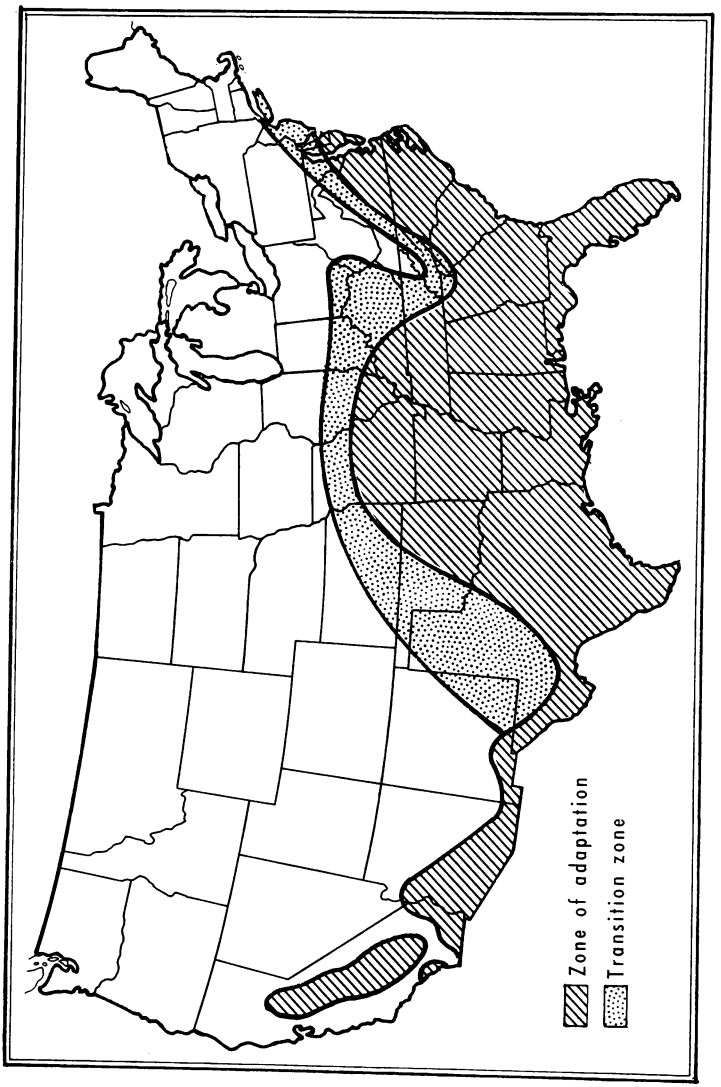

FIGURE 1.—Distribution of bermudagrass in the United States.

many named varieties and selections. In order to meet this need, comparative tests were conducted at the Plant Industry Station, Beltsville, Md., to evaluate bermudagrasses for winter survival and turf quality. Varieties, introductions, and selections were compared under all combinations of two mowing heights and two levels of nitrogen.

Performance data obtained at Beltsville are reported, together with information accumulated at other locations. Data submitted by several agricultural experiment stations are included for comparative purposes only, because results from most of these locations are not extensive enough to justify conclusive statements on the merits of specific varieties and selections.

ADAPTATION

Bermudagrass is a warm-season perennial that initiates growth in the spring and continues to grow when moisture is adequate until the first heavy frost in the fall. Dormant grass is a light straw color. In warm, frost-free areas bermudagrass remains green throughout the year, but growth is reduced with the onset of lower temperatures and cool nights. It makes its best growth when average daily temperatures are above 75° F., but grows very little when they drop to 60°–65°. In general, 27°–28° will kill leaves and stems back to ground level.

Bermudagrass grows on a wide range of soils, from heavy clays to deep sands provided soil fertility is not a limiting factor. It grows satisfactorily on both acid and calcareous soils and is very tolerant to saline conditions. The nitrogen requirement of bermudagrass is relatively high. Although this grass often grows without applied nitrogen, substantial amounts are required to produce good-quality turf and high yields of quality forage. Application of up to 200 pounds of nitrogen per acre is recommended for growing improved forage varieties, but under some circumstances twice this amount may be required to produce good-quality turf. The equivalent of 800 pounds of nitrogen per acre is sometimes used in maintaining bermudagrass turf.

Bermudagrass tolerates flooding, but will not thrive on waterlogged soils. Although it is drought resistant in humid areas, it cannot be grown in arid regions without supplementary water. Bermudagrass does not persist under heavy shade. Differences in shade tolerance exist among varieties, but the range in reaction to shade is relatively narrow.

CENTER OF ORIGIN

It is assumed that bermudagrass originated in tropical Africa (*5*).[1] Stephens [2] found that it was most prevalent there in the Union of South Africa, Tanganyika, Kenya, and Ethiopia on the better soils. In general, bermudagrass may be said to follow man, depending on him to furnish suitable growing conditions, e.g., clearing land of trees and enriching and stirring the soil. Man's gardening or farming ac-

[1] Italic numbers in parentheses refer to Literature Cited, p. 34.

[2] STEPHENS, J. L. FIELD OPERATIONS IN EAST AFRICA, FEBRUARY–JUNE, 1955. Unpublished report of east African plant exploration trip.

tivities furnish ideal conditions for bermudagrass, especially in the absence of thorough cultivation, which is lacking in primitive agricultural communities.

Ants and bermudagrass are closely associated. Most ant hills are covered with either trees or bermudagrass. In tsetse fly areas where there are no cattle and few people, most ant hills have trees, but where cattle graze, bermudagrass is common on ant hills. It apparently thrives there, because ant hills are relatively high in nitrogen and calcium and the soil is stirred and aerated. Furthermore, cattle graze the bermudagrass very closely, thereby preventing the encroachment of trees and other plants.

Stephens observed that a few exceptions to the interrelationship of man, ants, and bermudagrass are found in parts of northwest Tanganyika, at Navisha, Kenya, and near Sciasciamanna, Ethiopia. These locations appear to have the following characteristics in common: All of them are in the Great Rift Valley; the bermudagrasses are of the stoloniferous type; the soil is comparatively rich, with a slow buildup of soil layers by wind or water; trees, if present, are small, scattered, and with open-type foliage; the soils are relatively high in calcium and are not compacted, consisting mostly of a friable mixture of clay and sand; and grazing is extremely heavy in all three areas.

Stephens [2] reached the following tentative conclusion on the basis of these observations: "In ruminating over the home of origin of *Cynodon* about all one can do is to picture a natural environment having the greatest number of suitable requirements in combination in one place for this grass. That place might be the *Great Rift Valley.*"

CLASSIFICATION

The genus *Cynodon* was classified by Hurcombe (*8, pp. 36–47*) and modified slightly by Chippindall (*5*). These reports have been followed in summarizing the major distinguishing characteristics of the *Cynodon* species.

The *Cynodon* species are separated into two broad categories, based on the number of spikes and their arrangement on the central axis.

Group 1.—Spikes 7 to 20 in 2 to 3, more rarely 4, whorls on short central axis—*C. dactylon* (L.) Pers. and *C. plectostachyus* K. (Schum.) Pilg.

Group 2.—Spikes 2 to 10, usually 2 to 7, in single whorl at top of culm (digitate)—*C. dactylon, C. transvaalensis* Burtt-Davy, *C. magennisii* Hurcombe, *C. bradleyi* Stent, *C. hirsutus* Stent, and *C. incompletus* Nees.

Group 1.—*C. dactylon* types are assigned to both categories. However, robust strains of *C. dactylon* may be distinguished from *C. plectostachyus* as follows:

Spikes up to 10, usually 7 to 9, in two whorls, creeping rhizomes present, glumes one-half to three-fourths, more rarely one-third, as long as spikelet; palea with keel glabrous ..... *C. dactylon*

Spikes up to 20 in 2 to 4 whorls, creeping rhizomes absent, glumes seldom exceeding one-fourth length of spikelet; palea with keel hairy ..... *C. plectostachyus*

See footnote on p. 3.

Group 2.—The species in this category are subdivided on the basis of vernation (leaves folded or rolled in bud shoot) and the presence or absence of rhizomes. Unfortunately the separation may not be absolute, judging from conflicting statements that have appeared in print. Carrier (*3*) and Phillips (*9*) reported that the leaves of *C. dactylon* are rolled in the bud shoot, whereas according to Hurcombe (*8*) and Bennett et al. (*1*) the leaves are folded.

A Leaf blades folded in bud shoot; creeping rhizomes present
  B Leaf blades up to 1.5 mm. wide; glumes one-fourth to one-third length of spikelet ---------- *C. transvaalensis*
  BB Leaf blades up to 5 mm. wide; glumes from one-half to as long as spikelet
    C Both surfaces of leaf tubercled and sparsely hairy, blade less than 2 mm. wide; glumes one-half as long as spikelet; fine grass ---------- *C. magennisii*
    CC Lower surface of leaf not distinctly tubercled, usually glabrous, blade more than 2 mm. wide; glumes often more than one-half as long as spikelet; relatively coarse grasses ---------- *C. dactylon*
AA Leaf blades rolled in bud shoot; creeping rhizomes absent
  B Keel of lemma not winged; rachilla sometimes produced ---------- *C. bradleyi*
  BB Keel of lemma winged; rachilla not produced
    C Leaves densely hairy on both surfaces; ligule up to 2 mm. long; glumes about equal, half as long as spikelet ---------- *C. hirsutus*
    CC Leaves loosely hairy on upper surface, loosely to densely hairy on lower surface; ligule up to 1 mm. long; glumes unequal, less than half as long as spikelet ---------- *C. incompletus*

DESCRIPTIONS OF SPECIES

C. dactylon (L.) Pers.—The common names with many variations include bermudagrass, wiregrass, couchgrass, Bermuda couch, Indian couch, scutchgrass, quickgrass, kweek(gras), devilgrass, doobgrass, doabgrass, and creeping fingergrass (Chippindall *4*). The plethora of common names given this species attests to its wide distribution and to the fact that it has been the object of abuse and scorn.

C. dactylon is a variable, long-lived perennial, which spreads by rhizomes, stolons, and seed. The culms range from 8 to 40 and rarely to 90 cm. in height. The leaves may be pubescent or glabrous. There are 3 to 7 spikes, rarely 2, which are usually 3 to 6 cm. long and in one whorl. In robust forms there may be up to 10 spikes, sometimes in two whorls. In common with other *Cynodon* species, the leaves are borne on stems, which produce long internodes alternating with one or more very short internodes. This characteristic gives the impression that the species has multiple-leaved nodes, as reported by Francis and Baird (*7*) and more recently by Duell (*6*). Observations on leaf patterns suggest, however, that irregularity in internode length is the most acceptable explanation for the so-called multiple-leaved characteristic in *Cynodon*. *C. dactylon* includes both diploids (2n=18) and tetraploids (2n=36).

Giant bermudagrass, a naturalized form of *C. dactylon* found in irrigated fields in the Southwestern United States, is a diploid (2n=18). This highly fertile rhizomatous form may be distinguished from common tetraploid bermudagrass by its vigor, height, lack of pubescence, and seed characteristics. In the Southeastern United States giant bermudagrass is an undesirable contaminant when found in common seed lots, because it does not persist and the turf produced from mixtures has an uneven appearance.

C. dactylon var. *densus* Hurcombe ('Hall's Selection') and C. *dactylon* 'Royal Cape' were recognized by Hurcombe (*8*) in her taxonomic treatment of *Cynodon*. However, these two grasses are similar to *C. dactylon*, differing only in size and growth form.

C. plectostachyus (K. Schum.) Pilg.—Stargrass. Tufted perennial; diploid (2n=18); creeping by means of dense network of stolons; culms 60 to 100 cm. high; pubescent leaves; spikes numerous, up to 8 cm. long, rarely more; spikelets 2.5 to 3 mm. long. Distinguished from robust strains of *C. dactylon* by relative length of glumes.

C. transvaalensis Burtt-Davy.—Transvaalensis or floridagrass. Fine diploid (2n=18); culms up to 10 cm. high; leaf blades up to 1.5 mm. wide, hairy, soft; spikes 1 to 3, usually 2, 1 to 2 cm. long; spikelets 2 to 2.5 mm. long.

C. magennisii Hurcombe.—Magennis. Triploid (2n=27); culms 3 to 6 cm. high; spikes 3 or 4, 1.5 to 2.5 cm. long; spikelets 2 mm. long. Does not set seed. Derived from natural cross between *C. dactylon* and *C. transvaalensis*. Resembles *C. transvaalensis* very closely in growth form and leaves.

C. bradleyi Stent.—Bradley. Diploid (2n=18); stoloniferous; pubescent leaf blades up to 2.5 mm. wide; spikes 2 to 4, 2 to 3 cm. long; spikelets 2.5 mm. long. Distinguished from *C. transvaalensis* and *C. magennisii* by absence of rhizomes.

C. hirsutus Stent.—Hairy couch. Diploid (2n=18); pubescent leaf blades 1.5 to 3 cm. long and up to 4 mm. wide; spikes usually 3 to 5; spikelets 2 to 2.5 mm. long. Distinguished from *C. dactylon* by absence of rhizomes.

C. incompletus Nees.—Diploid (2n=18); creeps by means of stolons only; spikes 3 to 6, usually 3, 1.2 to 2.7 cm. long; spikelets 2.5 to 3 mm. long. Similar to *C. hirsutus*; leaves less hairy and glumes shorter than those of *C. hirsutus*.

DESCRIPTIONS OF VARIETIES, SELECTIONS, AND INTRODUCTIONS

Stolons from some South African varieties have been introduced under two or more numbers. These accessions should be identical, but there is always a possibility that they may differ, because either the foreign name was applied to a class of bermudagrass types or the accessions were contaminated with other strains. It is difficult to confine bermudagrasses to small plots, and therefore one cannot ignore the possibility of contamination either from adjacent plots or from volunteer seedlings at the location where the vegetative material was collected. This may explain discrepancies noted in the appearance of different accessions of the same vegetative source. Reference should always be made to the original accession number in studying

the performance of introductions that have been named and released in the United States.

Original descriptions of named varieties are presented, together with available information on the origin and characteristics of numbered accessions. Information is included on several South African varieties, some of which if brought into this country have not been introduced by name. Plant Industry (P.I.) numbers are assigned to material received by the New Crops Research Branch, Crops Research Division.

Barberspan (*C. dactylon*).—Collected on shores of Lake Barberspan in western Transvaal, South Africa. Relatively coarse, low growing, dense. (Introduced as P.I. 183555 and P.I. 213382.)

Bayshore (Gene Tift) (*Cynodon* sp.).—Selected at Bayshore Golf Club, Miami Beach, Fla. Light green, fine texture, some resistance to leaf spot diseases. Considered to be a hybrid between *C. dactylon* and *C. transvaalensis*. Adapted for use on putting greens in southern Florida.

Bloupan (*C. dactylon*).—Selected at Jan Smuts Airport, Johannesburg, South Africa. Fine leaves, resembles *C. transvaalensis* in appearance. Planted on airfield and on numerous golf courses and bowling greens. (Introduced as P.I. 213383.)

Bradley (*C. bradleyi*).—Collected by W. Bradley from veld near Johannesburg, South Africa, prior to 1910. Medium fine, shallow rooted, quick growing; tendency to "brown-off" during hot, dry weather; gray green; hairy leaves. Used rather extensively for lawns and greens in South Africa. Popularity declined owing to its susceptibility to insects and nematodes.

Brunswick (*C. dactylon*).—Collected and increased at Sea Island Golf Club, Sea Island, Ga.

Burning Tree (*C. dactylon*).—Selected at Burning Tree Country Club, Bethesda, Md., and received at Plant Industry Station, Beltsville, Md., in July 1959. Vigorous, rapid spreading, cold hardy; broad leaves, dark green. May have some promise for use on fairways and as general-purpose turf.

Elliot (*Cynodon* sp.).—Considered to be "one of their best" lawn grasses at Frankenwald Turf Research Station, Johannesburg, South Africa. Fine grass, good putting surface with little "nap," little tolerance to low temperatures, slow regrowth in spring, shorter and broader leaves than *C. transvaalensis*, winter-dormant turf reddish. (Introduced as P.I. 224146.)

Everglades 1 (*Cynodon* sp.).—Selected at Bayshore Golf Club, Miami Beach, Fla. Dark green, fine texture, close growing, vigorous; putting-green type. Considered to be a hybrid between *C. dactylon* and *C. transvaalensis*. Much superior to common in turf quality and resistance to foliar diseases. Adapted throughout Florida.

Florida 8 and **50** (*Cynodon* sp.).—Experimental selections from Florida Agricultural Experiment Station, Gainesville.

Franklin (*C. dactylon*).—Collected and multiplied at Mount Edgecombe Golf Course, Natal, South Africa. Slightly coarser than *C. transvaalensis*. Found on golf green that had been severely damaged by mealybug *Antonina indica* Green. (Introduced as P.I. 213385.)

Germiston (*Cynodon* sp.).—South African, similar to *C. transvaalensis* in appearance, behavior, and color.

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Hall's Selection (*C. dactylon* var. *densus*).—Collected from green of Germiston Golf Course in 1933 by T. D. Hall and established at Frankenwald Turf Research Station, Johannesburg. Dark green; dense, wear-resistant sod; relatively slow spread; similar to Royal Cape. Popular lawn grass in South Africa. (Introduced as P.I. 183557, P.I. 213384, and P.I. 224149.)

Harrismith (*Cynodon* sp.).—South African, similar to *C. transvaalensis* in appearance, behavior, and color. (Introduced as P.I. 224141.)

Kansas selections (*Cynodon* spp.).—Series of numbered and lettered clones, identified as Kansas; derived from vegetative selections and polycross progenies of common and introduced bermudagrasses. Material selected at Manhattan and at Hays Branch of Kansas Agricultural Experiment Station. Relatively fine to coarse texture, fair to excellent cold tolerance.

Kansas 1–51 (*C. dactylon*).—Collected from campus at Kansas State University, Manhattan. Fine leaves.

Kansas 1–52 (*C. transvaalensis*).—Hardy, drought resistant, aggressive spread.

Kansas 23–54 (*C. dactylon*).—Collected from campus at Kansas State University, Manhattan. Medium texture, hardy.

Kansas 24–54 (*C. dactylon*).—Collected from campus at Kansas State University, Manhattan. Hardy.

Magennis (*C. magennisii*).—Named for magistrate, who in 1922 first selected this grass from patch of *C. transvaalensis*. Relatively slow growing, fine lawn grass. Considered to be a hybrid between *C. transvaalensis* and a local strain of *C. dactylon*. Once established, it requires careful management to maintain good-quality turf. Popular in South Africa. (Introduced as P.I. 184339 and P.I. 213390.)

Murray (*C. dactylon*).—Found in experimental green of Hall's Selection at Frankenwald Turf Research Station, Johannesburg, South Africa. Named in honor of C. M. Murray. Fine leaves. (Introduced as P.I. 213386.)

Ohio (*C. dactylon*).—Selected at country club near Cincinnati, Ohio. Medium to coarse texture, rapid spreading, appeared very winter hardy.

Ormond (*C. dactylon*).—Selected from long-established fairway at Ellinor Village County Club, Ormond Beach, Fla. Attractive, blue green, vigorous, relatively prostrate growth habit, medium texture, some tolerance to leaf diseases, susceptible to dollar spot, lacks cold tolerance. Well adapted in Florida for use on lawns, golf tees, fairways, and recreational areas.

Royal Cape (*C. dactylon*).—Selected in about 1930 on Royal Cape Golf Course near Mowbray, South Africa, by C. M. Murray. Important economically in South Africa for use on home lawns and athletic fields. Prized in that country for superior texture, ability to withstand wear, good spring and fall color. P.I. 224147 cooperatively released as 'Royal Cape' by Crops Research Division, Agricultural Research Service, and California Agricultural Experiment Station in 1960 for use in hot desert areas of Lower Colorado River Basin. Released on basis of late-fall and early-spring growth; good color, texture, vigor, and spread; tolerance to saline soils; and limited

production of seed heads. (Introduced as P.I. 183559, P.I. 213387, and P.I. 224147.)

Skaapplaas Fine (*Cynodon* sp.).—Collected near water's edge around several "pans" near Wolwehoek in Orange Free State, South Africa. Selected and used on two Vereeniging golf courses by D. Lorentz in about 1935. Fine grass, grows rapidly, forms close cover, more drought tolerant than either Elliot or Transvaalensis, under normal conditions is midgreen. (Introduced as P.I. 224145.)

Sunturf (*C. magennisii*).—Released cooperatively by Alabama, Arkansas, Oklahoma, and South Carolina Agricultural Experiment Stations in 1956. Direct increase of P.I. 184339 (*C. magennisii*). Fine leaves, dark green, rapid spread, few seed heads, sometimes has rust. (See also Magennis, P.I. 184339, and P.I. 213390.)

Texas 8 and **22** (*C. dactylon*).—Experimental selections from Texas Agricultural Experiment Station, College Station.

Texturf 1F (*C. dactylon*).—Selected as T35A at Texas Agricultural Experiment Station, College Station, and released in 1957. Fine texture, light green, recovers rapidly in spring, produces relatively few seeds heads, susceptible to leaf diseases. Because of disease susceptibility, plantings in Gulf Coast and eastern Texas not recommended.

Texturf 10 (*C. dactylon*).—Selected as T–47 at Texas Agricultural Experiment Station, College Station, and released in 1957. Medium texture, dark green,. early-spring recovery. Slower growing than common bermudagrass, but superior in fall color and in resistance to leaf diseases.

Tiffine (*Cynodon* sp.).—Selected as Tifton 127 at Georgia Coastal Plain Experiment Station, Tifton, and released in 1953 by Georgia Agricultural Experiment Station and Crops Research Division, Agricultural Research Service. Represents F_1 hybrid between *C. dactylon* and *C. transvaalensis* from East Lakes Golf Course, Atlanta, Ga. Lighter green, more disease resistant, much finer texture than common bermudagrass. Used for putting greens and fine lawns.

Tifgreen (*Cynodon* sp.).—Selected as Tifton 328 at Georgia Coastal Plain Experiment Station, Tifton, and released in 1956 by Georgia Agricultural Experiment Station and Crops Research Division, Agricultural Research Service. Best of several F_1 hybrids between *C. dactylon* and diploid accession from Africa. Darker green and superior for putting surface than Tiffine. Also used for fine lawns.

Tiflawn (*Cynodon* sp.).—Selected as Tifton 57 at Georgia Coastal Plain Experiment Station, Tifton, and released in 1952 by Georgia Agricultural Experiment Station and Crops Research Division, Agricultural Research Service. Represents F_1 hybrid between two selections from pasture-breeding research. Spreads faster, denser weed-free turf, more disease- and frost-tolerant, requires less fertilization, and more wear resistant than common bermudagrass. Particularly well suited as heavy-duty turf.

Tifway (*Cynodon* sp.).—Selected as Tifton 37 and 419 at Georgia Coastal Plain Experiment Station, Tifton, and released in 1960 by Georgia Agricultural Experiment Station and Crops Research Division, Agricultural Research Service. F_1 hybrid between *C. transvaalensis* and *C. dactylon*. Found in seed lot of *C. transvaalensis* supplied by D. Meredith of Johannesburg, South Africa, in 1954. Dark green;

stiff leaves; equal or superior to Tiffine and Tifgreen in disease resistance, density, weed resistance, seed-head production, and rate of spread. Well suited for use on fairways, tees, and home lawns.

Transvaalensis (or Florida in South Africa) (*C. transvaalensis*).—Found growing near Johannesburg, South Africa, in about 1907. Is midgreen under normal conditions. Widely used for lawns and putting and bowling greens. Unless carefully managed, greens develop considerable "nap." Requires abundant water and nutrients for satisfactory growth. (Introduced as P.I. 213391.)

Tufcote (*C. dactylon*).—Selected at National Plant Materials Center, Beltsville, Md., and released as "Tuffy" in 1962 by Soil Conservation Service National Plant Materials Center, Maryland Agricultural Experiment Station, and Crops Research Division, Agricultural Research Service. Renamed 'Tufcote' in 1963. Vegetative increase of surviving plant from one of three introductions—P.I. 142278, P.I. 142280, and P.I. 142281. Introductions received in 1942 from Gen. Jan Smuts, Pretoria, South Africa. Stiff leaves, relatively rapid spread, few seed heads. Released on basis of winter hardiness and wear resistance for use in conservation plantings and on athletic fields.

U–3 (*C. dactylon*).—Selected as "Hall's Superior" by D. Lester Hall, greenkeeper, Savannah Golf Club, near Savannah, Ga., in 1936 from long series of fine-strain selections on basis of cold hardiness, color, durability, and insect and disease resistance. Increased at Plant Industry Station, Beltsville, Md. Released cooperatively in 1957 by U.S. Golf Association Green Section and Crops Research Division, Agricultural Research Service. Moderately fine leaves, rapid spreading, durable turf under wide range of soil and climatic conditions. Adapted for use on lawns, parks, golf tees, and fairways.

Uganda (*C. transvaalensis*).—Fine leaves, low growing, very fine texture, relatively slow spreading, tends to assume reddish-purple cast after first cool nights in fall. Suitable for putting greens and tennis courts. (Introduced as P.I. 183551 and increased as Uganda.)

Vereeniging-Tomsett (*C. dactylon*).—Collected near Vereeniging on Veal River, South Africa. Fine leaves, good texture, similar to *C. transvaalensis*.

Waverly (*Cynodon* sp.).—South African, similar to *C. transvaalensis* in appearance, behavior, and color.

Windsor (*Cynodon* sp.).—South African, similar to *C. transvaalensis* in appearance, behavior, and color.

P.I. 183551 (*C. transvaalensis*).—'Uganda' from Egypt. Stolons presented by John Plant, Gezira Sporting Club, Cairo. Received at Beltsville, Md., July 6, 1949.

P.I. 183555 to **P.I. 183559**.—From South Africa. Stolons presented by J. L. Dougherty, agricultural attaché, Pretoria, Transvaal. Received July 7 and 12, 1949.

P.I. 183555 (*C. dactylon*).—'Barberspan.'

P.I. 183556 (*C. dactylon*).—'Friel's Selection.'

P.I. 183557 (*C. dactylon* var. *densus*).—'Hall's Selection.'

P.I. 183558 (*C. dactylon*).—From Iscor Golf Course.

P.I. 183559 (*C. dactylon*).—'Royal Cape.'

P.I. 184339 (*C. magennisii*).—From South Africa. Stolons presented by Mildred Wilman, Kimberly, Cape Province. Received September 1949. (See also Magennis and Sunturf.)

P.I. 210837 (*C. dactylon*).—From Iran. Collected from lawn in Tehran. Presented by agricultural attaché, American Embassy, Tehran. Received December 2, 1953.

P.I. 210979 (*C. dactylon*).—Collected from Middle East Hotel Garden, Tehran, Iran. Stolons presented by Maurice E. Heath. Received September 25, 1953.

P.I. 213382 to **P.I. 213391.**—From South Africa. Stolons presented by African Explosives and Chemical Industries, Ltd., Johannesburg, Transvaal. Received February 18, 1954.

P.I. 213382 (*C. dactylon*).—'Barberspan.'

P.I. 213383 (*C. dactylon*).—'Bloupan.'

P.I. 213384 (*C. dactylon* var. *densus*).—'Hall's Selection.'

P.I. 213385 (*C. dactylon*).—'Franklin.'

P.I. 213386 (*C. dactylon*).—'Murray.'

P.I. 213387 (*C. dactylon*).—'Royal Cape.'

P.I. 213388 (*C. dactylon*).—'Skaapplaas.'

P.I. 213389 (*C. dactylon*).—'Vereeniging-Tomsett.'

P.I. 213390 (*C. magennisii*).—'Magennis.'

P.I. 213391 (*Cynodon transvaalensis*).—'Florida.'

P.I. 213457 and **P.I. 213458.**—From India. Stolons collected by H. S. Gentry at Aarey Dairy Colony, Bombay, India, December 19, 1953. Received January 7, 1954.

P.I. 213457 (*C. dactylon*).—Fine leaves, lawn grass, heavily manured, green all year.

P.I. 213458 (*C. dactylon*).—Fine leaves, endemic.

P.I. 218006 (*C. dactylon*).—From Iran. Plugs presented by American Embassy, Tehran. Received June 1, 1954. Fine leaves.

P.I. 224131 (*C. dactylon*).—From South Africa. Collected by J. L. Stephens at Riteondale Experiment Station, Pretoria, March 1, 1955. Said to have escaped from experimental plots. Fine leaves, dense sod.

P.I. 224139 to **P.I. 224141** and **P.I. 224143.**—From South Africa. Stolons obtained from Pretoria Botanic Garden by J. L. Stephens, March 2, 1955. These four strains collected originally by L. E. Codd.

P.I. 224139 (*Cynodon* sp.).—'Skaapplaas-Macaulei.' Very fine leaves, dense sod.

P.I. 224140 (*Cynodon* sp.).—'Reitz.' Fine leaves, good color, dense sod.

P.I. 224141 (*Cynodon* sp.).—'Harrismith.' Fine leaves, good color, dense sod.

P.I. 224143 (*Cynodon* sp.).—Rapid spreading, long stolons.

P.I. 224145 to **P.I. 224149** and **P.I. 224151.**—From South Africa. Stolons obtained from Frankenwald Turf Research Station, Johannesburg, by J. L. Stephens, March 3, 1955.

P.I. 224145 (*Cynodon* sp.).—'Skaapplaas Fine.'

P.I. 224146 (*Cynodon* sp.).—'Elliot.'

P.I. 224147 (*C. dactylon*).—'Royal Cape.'

P.I. 224148 (*Cynodon* sp.).—'Macaulei.' Medium to coarse lawn, fairly dense sod.

P.I. 224149 (*C. dactylon* var. *densus*).—'Hall's Selection.'

P.I. 224151 (*Cynodon* sp.).—Local strain, rapid spread, dense sod.

P.I. 224569 (*Cynodon* sp.).—From Southern Rhodesia. Local selection obtained from campus of Tobacco Research Station, Salisbury,

by J. L. Stephens, March 21, 1955. Fine, short leaves; fairly rapid spread; good sod.

P.I. 224691 (*C. dactylon*).—From Northern Rhodesia. Collected from lawn of Victoria Falls Hotel by J. L. Stephens, March 28, 1955. Short, dense sod; numerous seed heads.

P.I. 224694 (*C. dactylon*).—From Northern Rhodesia. Obtained from Mt. Makula Experiment Station, Lusaka, by J. L. Stephens, March 29, 1955. Originally collected at Fort Jamison. Dense sod, lawn type. Identified as No. 1.

P.I. 225126 (*Cynodon* sp.).—From Tanganyika. Collected from lawn at Dar-es-Salaam by J. L. Stephens, April 1955. Aggressive; tight, compact sod when mowed. Identified locally as "Sudan-grass."

P.I. 225595 (*Cynodon* sp.).—From Tanganyika. Obtained from Mpwapa Experiment Station by J. L. Stephens, April 17, 1955. Originally planted on clubhouse lawn. Short, fine leaves.

P.I. 225809 (*Cynodon* sp.).—From Kenya. Collected from border of kikuyugrass lawn at Lincoln Hotel, Eldoret, by J. L. Stephens, April 27, 1955. Very small; delicate, fine stems and leaves.

P.I. 258846 (*Cynodon* sp.).—From South Africa. Stolons presented by African Explosives and Chemical Industries, Ltd., Johannesburg, Transvaal. Received July 1959.

ESTABLISHMENT AND MAINTENANCE OF BERMUDAGRASS TURF

The improved varieties of bermudagrasses are among the finest of the southern grasses in both texture and quality. Choice of variety, however, is of prime importance in the production of high-quality turf. Varieties must be adapted to local environmental conditions and meet the needs and requirements for which the turf is intended, whether for lawns, fairways, tees, putting greens, or general-purpose turf. They vary in winter hardiness, disease resistance, texture, quality, color, rate of spread, and amount of maintenance required. Although the improved bermudagrasses provide one of the most beautiful lawns in the South, they also require the most maintenance. It is generally impracticable to choose a fine-textured variety with a high-maintenance requirement for use in a location where the turf will be neglected. If the improved varieties are neglected and not properly maintained, it is doubtful whether they are more desirable than common seeded bermudagrass.

Establishment

A bermudagrass turf can be established from vegetative planting more rapidly than any other permanent grass—within 2 to 4 months under favorable conditions.

The improved varieties must be propagated vegetatively, as many of them produce little or no seed, and the seed does not run true to type. Thus plants grown from U–3 seed are much coarser than the original U–3 variety, as shown in figure 2. The turf may be established vegetatively from (1) sprigs, (2) plugs or cores, (3) small pieces of sod, and by (4) sodding.

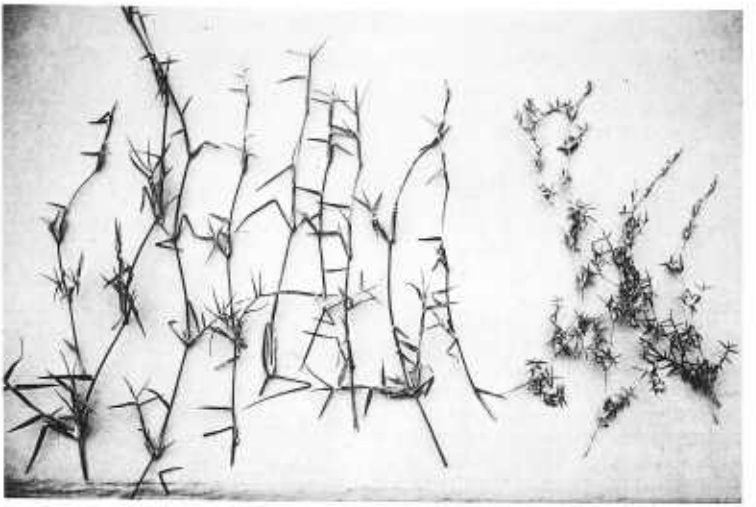

FIGURE 2.—Stolons from seeded U–3 bermudagrass (left) as compared with stolons from U–3 variety (right).

Sprigs are stolons or rhizomes or both. They are obtained by shredding sod into individual stems or plants. One square yard of sod, or 1 bushel of sprigs, will usually contain from 2,000 to 4,000 sprigs and will provide sufficient material to plant from 2,000 to 4,000 square feet of area on 12-inch centers. Sprigs may be planted in holes made by a sharp tool, in a slit made by a spade, or on a prepared seedbed in a shallow furrow. They should be covered with one-half to 1 inch of soil, which should be pressed firmly around the sprigs and watered. For larger areas, sprigs may be broadcast and disked. Disk blades should be set straight to press the sprigs into the soil, and the soil should be cultipacked so that it is firm around the sprigs. Frequently sprigging machines are used on a contract or rental basis for parks, industrial areas, and golf courses.

Turf may be established from sod plugs 2 or more inches in diameter or pieces of sod cut into 2- to 3-inch squares. Both methods are similar. Plugs or pieces of sod are planted even with the soil surface in checkrows 12 to 18 inches apart and pressed into place.

Sodding is the most rapid method of establishing turf, but it is also the most expensive. It is one of the most practical ways to get turf established on steep slopes and terraces. To avoid delay, putting-green turf is frequently established by sodding.

In the Deep South bermudagrass may be established from sprigs or by sodding anytime during the growing season if moisture conditions are suitable or if water is available. In the transition zone bermudagrass can be planted anytime after the last frost in the spring until early August. Poorly established turf is subject to winter damage, and for that reason it is generally advisable to plant as soon as possible after the last frost in the spring.

Fertilization

Frequency of application and quantity of fertilizer required for a satisfactory bermudagrass turf are dependent on several variables—

1. Location in the bermudagrass region determines the length of the growing season. In the Deep South more fertilizer will be necessary for the production of an acceptable turf than in the transition zone, which has a much shorter growing season.

2. Some soils are inherently low in fertility and thus require complete fertilizers, higher levels of nitrogen, and perhaps an occasional application of minor elements. Sandy soils are usually low in organic matter, have a low base exchange, and are more subject to leaching of fertilizer nutrients.

3. Named varieties differ with respect to their nitrogen requirements and, in general, need to be maintained at a higher level than common bermudagrass. A level of fertility that does not meet the needs of a variety frequently results in a low-quality turf characterized by poor color, excessive seed heads, slow growth, and an open sod that is subject to weed encroachment.

4. Frequency and quantity of fertilizer applied at any one time are dependent largely on the source of nitrogen. Fertilizer with inorganic sources of nitrogen must be applied more frequently and in smaller amounts than fertilizer in which the source of nitrogen is largely organic. Organic nitrogen, either alone or in combination with inorganic sources, is frequently used to produce uniform growth—an important consideration on putting greens. Although bermudagrass can utilize large amounts of nitrogen, overstimulation of the turf may result from heavy application of nitrogen. Overstimulation with high rates of nitrogen fertilizer may increase top growth at the expense of root growth, with a consequent reduction in carbohydrate reserves. Succulent turf is also more susceptible to disease and to scalping.

5. The standard of perfection desired for turf regardless of its use will determine the quantity of fertilizer used annually. Good-quality turf requires high maintenance and adequate levels of soil fertility, but lower levels of maintenance may be in order, depending on the use and the turf quality desired.

6. Irrigation must be considered. Turf that receives supplemental irrigation throughout the growing season will have a higher annual fertilizer requirement than turf that is allowed to become dormant or semidormant. In addition, excessive use of water will leach more nutrients from the soil. On alkaline soils in irrigated areas of the West and Southwest, quantity and choice of a fertilizer are important. Excessive amounts of inorganic fertilizer may raise the salt content of the soil to the detriment of the turf. Fertilizers, such as ammonium sulfate, with an acid reaction are preferred for alkaline soils.

7. Removal or nonremoval of clippings affects the annual quantity of fertilizer required in the turf program. Grass clippings contain nitrogen, phosphorus, and potassium in a ratio of approximately 4–2–3, respectively. Clippings are almost always removed after each mowing from turf under high maintenance, frequently from turf under medium maintenance, and seldom from turf under low maintenance. Clippings allowed to remain on adequately fertilized turf increase

thatch buildup and provide a favorable medium for the development of disease. (Thatch refers to the accumulation of stems and leaves on the soil surface.)

8. Quantity and frequency of fertilizer application are closely tied to the purpose for which turf is intended. Turf on roadbanks, median strips, and some playgrounds is generally fertilized infrequently. At the other extreme, putting greens may receive as much as 36 pounds of elemental nitrogen per thousand square feet each year, with applications divided into weekly or biweekly increments. Turf for lawns and fairways falls in between these two extremes. The quantity of nitrogen and the frequency of applications often used on turf grown for various purposes are shown in table 1.

TABLE 1.—*Quantity and frequency of nitrogen application on turf grown for various purposes*

Turf use and level of maintenance	Total nitrogen per 1,000 square feet	Applications
	Pounds	*Number*
Road right-of-way, playgrounds, and nonuse areas; low	0–3	0–2
Lawns, parks, fairways, athletic fields, cemeteries; medium	4–9	3–8
Putting and bowling greens, tennis courts, tees; high	10–30	10–30

In the fertilizer program a complete fertilizer such as a 10–10–10 or similar analysis should be incorporated in the schedule once or twice a year to supply phosphorus and potassium, after which nitrogen alone will generally prove adequate. Additional phosphorus is seldom needed, because this element is fixed by the soil colloids and is not readily leached from the soil. On putting greens and other high-maintenance turf, soil tests frequently indicate very high amounts of available phosphorus because of prolonged use of complete fertilizers. In such cases, nitrogen and potassium only need be applied.

Bermudagrass turf should be fertilized when growth begins in the early spring and during the growing season whenever a slight loss in color is observed. One or two pounds per application of a quickly available nitrogen is adequate. Fertilize according to the needs of the grass and the degree of perfection desired. Adequate amounts of nitrogen applied at regular intervals will aid in maintaining a uniform rate of growth. This growth can be removed by mowing at regular intervals.

Mowing

Turf is mowed to make it attractive and to produce a dense sod for a specific purpose. Proper mowing management requires that grass be cut at an optimum height frequently enough to avoid excessive removal of top growth at any one time. Turf should be mowed at an interval that will not necessitate removing more than one-half or less of the upright leaf area at one time. Frequent mowing at the proper

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height is less injurious to the plant than removal of tall growth less often.

Mowing higher than the optimum level may reduce vigor and performance of the grass. Thatch builds up more rapidly, appearance declines, and weed invasion may increase. The quality of the finer textured bermudagrasses depends on continuous growth. If grass is permitted to grow above the recommended height, older grass, which is less functional, masks and retards new growth. Mowing should start in the spring soon after grass breaks dormancy and continue at regular intervals consistent with top growth. Putting-green turf is usually mowed daily at a height of three-sixteenths to one-fourth inch. Frequent regular mowing is essential for excellent turf, and the shorter the grass is mowed the oftener it should be mowed to avoid excessive injury. Turf for other purposes is mowed at a height of ½ to 1¼ inches at less frequent intervals—perhaps two or three times weekly.

Owing to thatch buildup and other factors such as infrequent mowing, it may become necessary to raise the height of mowing slightly during the growing season because of stemmy or scalped turf. Setting the mower to cut at a height of one-half to three-fourths inch in the spring will permit raising the mower two or three times during the growing season to overcome this condition without exceeding an acceptable mowing height. Thatch may be decomposed by cultivation and light top dressing with soil. Its removal by raking or mechanical treatments is often required to avoid excessive accumulation. Thatch should be removed in the spring or during the summer when grass is growing rapidly. Severe mechanical treatments should be used well in advance of the time when the turf will become dormant, so that the grass will recover fully before the onset of low temperatures.

BERMUDAGRASS EVALUATION IN THE TRANSITION ZONE

Climatological Data

Average maximum, average minimum, and extreme temperatures and degree-days during 1960 and 1961 and 6 months of 1962 for Beltsville, Md., are listed in table 2. The lowest temperature, −14° F., for this period occurred in January 1961 and the highest, 95°, in August 1960 and May 1962.

The following data (*10*) include some average temperatures over a 40-year period and the average dates for killing frosts over a 37-year period for College Park, Md., about 3 miles south of Beltsville:

Temperature	°F.
January average	34. 1
July average	75. 9
Maximum	107. 0
Minimum	−26. 0
Frost	*Date*
Last spring	Apr. 28
First fall	Oct. 15

TABLE 2.—*Temperatures at Beltsville, Md., 1960–62* [1]

Month	Average maximum	Average minimum	Highest	Lowest	Degree-days [2]
1960					
	°F.	°F.	°F.	°F.	*Number*
January	43. 5	25. 8	57. 0	11. 0	932
February	44. 6	26. 7	66. 0	6. 0	844
March	41. 6	21. 4	79. 0	2. 0	1, 030
April	71. 1	40. 7	93. 0	20. 0	304
May	71. 3	47. 9	85. 0	28. 0	187
June	82. 6	56. 5	90. 0	39. 0	19
July	84. 6	60. 6	94. 0	49. 0	0
August	86. 0	64. 3	95. 0	50. 0	1
September	78. 1	57. 1	89. 0	43. 0	41
October	66. 8	42. 6	82. 0	25. 0	317
November	58. 3	31. 6	71. 0	18. 0	593
December	38. 4	13. 0	68. 0	−7. 0	1, 211
1961					
January	36. 7	12. 9	53. 0	−14. 0	1, 235
February	45. 6	24. 0	71. 0	−7. 0	838
March	55. 4	32. 8	78. 0	14. 0	643
April	59. 4	36. 2	88. 0	24. 0	520
May	70. 1	47. 3	86. 0	31. 0	218
June	82. 1	57. 7	92. 0	44. 0	23
July	86. 7	62. 9	94. 0	50. 0	0
August	84. 3	62. 4	92. 0	49. 0	1
September	84. 1	59. 5	94. 0	35. 0	47
October	69. 6	42. 1	88. 0	28. 0	283
November	57. 7	37. 9	81. 0	20. 0	522
December	42. 4	23. 8	61. 0	9. 0	980
1962					
January	41. 8	21. 8	60. 0	3. 0	1, 021
February	39. 1	22. 7	66. 0	−4. 0	946
March	50. 8	28. 6	76. 0	10. 0	776
April	64. 6	39. 2	88. 0	22. 0	416
May	77. 6	51. 5	95. 0	29. 0	112
June	81. 7	59. 3	93. 0	50. 0	3

[1] Elevation 100 feet.
[2] Sum of negative departures of daily temperatures from 65° F.

The growing season averaged 170 days for the 37-year period.

As essential as winter temperatures are to the survival of many grasses, research workers indicate that cold, drying winds on exposed sites in late winter or early spring may be as injurious as extreme low winter temperatures.

Morphological Characteristics

Several *Cynodon* species have been described (*8*), but little published information is available on the morphological characteristics of named varieties, introductions, and selections. The data in table 3 characterize several bermudagrasses that have been evaluated under similar

TABLE 3.—*Morphological characteristics*

Varieties, introductions, and selections	Leaf				
	Texture	Color	Pubescence		
			Blade	Sheath	Collar
Bayshore	Medium coarse.	Dark green	Glabrous	Glabrous	Profuse
Everglades 1	Medium	do	do	do	Medium
Ormond	Medium coarse.	Very dark green.	do	do	do
Royal Cape [1]	Very fine	Dark green	Medium	do	do
Sunturf	Medium	Very dark green.	Slight	Slight	do
Texturf 1F	do	Medium green.	do	Glabrous	Profuse
Tifgreen	do	Dark green	Glabrous	do	Slight
U–3	Medium coarse.	do	do	do	do
Uganda	Very fine	Medium green.	Medium	do	Medium
P.I. 210979	Fine	Light green	Slight	do	do
P.I. 213386	do	do	Glabrous	do	Slight [3]
P.I. 213388	do	Medium green.	Slight	do	Slight
P.I. 213390 [4]	Medium	Very dark green.	do	Slight	Medium
P.I. 213391	Fine	Medium green.	do	Glabrous	Slight
P.I. 213457	Medium	Dark green	Glabrous	do	do
P.I. 218006	Very fine	Medium green.	Slight	do	Medium
P.I. 224139	Fine	do	do	do	Slight
P.I. 224140	do	do	do	do	do
P.I. 224141	do	do	do	do	do
P.I. 224143	Medium coarse.	do	Medium	do	Medium
P.I. 224145	Fine	do	do	do	do
P.I. 224146	do	do	do	do	do
P.I. 224151	do	do	do	do	Slight
P.I. 225809	Very fine	Light green	Slight	do	do
C. bradleyi	Medium coarse.	Medium green.	Profuse	Medium	Profuse
Florida 8	Medium	Dark green	Glabrous	Glabrous	Medium
Florida 50	Medium coarse.	Medium green.	Slight	Slight	Profuse
Kansas 1–51	do	do	Glabrous	Glabrous	Medium
Kansas 23–54	Medium	Dark green	do	do	do
Kansas 24–54	Coarse	Medium green.	do	do	Profuse
Ohio	do	Dark green	do	do	do
Texas 8	Medium	do	Slight	do	do
Texas 22	Coarse	do	Glabrous	do	do
Common	Very coarse.	Medium green.	Medium	Slight	Very profuse.

[1] P.I. 224147.

[2] Largely green with purple or brownish tinge at or near node.

of several bermudagrasses

Leaf—Con.	Stolon			Rhizome		
Width	Internode length	Color	Texture	Quantity	Size	Flower stigma
Mm.	*Mm.*					
1. 5–2. 0	28–31	Purple	Fine	Medium	Medium	Purple.
1. 5–2. 0	27–39	do	Medium	Few	Large	Do.
1. 5–2. 2	23–31	do	do	do	Medium	Do.
. 7–1. 5	18–21	do	Fine	do	Fine	Dark purple.
1. 2–2. 0	20–32	do	Medium	Medium	Medium	Do.
1. 2–2. 0	30–43	Dark purple.	do	Few	do	Do.
1. 2–1. 5	21–29	Purple	do	do	Fine	Do.
1. 2–2. 0	27–41	Green [2]	Medium	do	Large	Do.
. 7–1. 2	18–21	do	Fine	Many	Medium	Do.
. 7–1. 2	13–17	Light brown.	do	do	Medium	Do.
1. 0–1. 2	24–28	Purple	do	Medium	do	Do.
1. 1–1. 5	21–25	do	Fine	Many	do	Do.
1. 5–2. 0	26–35	do	Medium	Medium	do	Purple.
1. 0–1. 5	8–19	do	do	do	do	Dark purple.
1. 0–1. 2	17–30	do	Fine	Many	do	Do.
. 7–1. 5	16–20	Brown	do	Medium	do	Do.
1. 0–1. 5	16–32	Purple	Medium	do	do	Do.
. 7–1. 2	18–24	do	Fine	Many	Fine	Do.
1. 1–1. 5	28–32	do	do	Few	do	Light purple.
1. 2–2. 0	32–51	do	Coarse	do	Large	Dark purple.
1. 0–1. 2	17–27	Light purple.	Fine	Many	Medium	Do.
1. 2–1. 5	13–25	Purple	Medium	do	do	Do.
1. 0–1. 5	20–27	do	do	do	do	Do.
. 7–1. 0	12–19	do	Fine	Medium	do	Do.
1. 2–2. 0	28–35	do	do	Very few	Fine	Do.
1. 2–2. 2	19–29	do	Medium	Few	Medium	Purple.
1. 0–1. 7	25–38	do	do	Medium	do	Dark purple.
1. 5–2. 1	30–40	Light brown.	do	Many	Large	Do.
1. 5–2. 0	30–41	Purple	do	Medium	Medium	Do.
1. 5–2. 2	23–30	Green [2]	Coarse	do	do	Do.
1. 5–2. 5	28–38	Green [2]	Medium	Few	do	Do.
1. 5–1. 7	29–45	Purple	do	Medium	Large	Light purple.
2. 0–3. 0	29–47	do	do	do	do	Dark purple.
3. 0–4. 0	45–60	Green [2]	Very coarse.	Many	do	Do.

[3] Largely absent.
[4] Another source of Sunturf.

environmental conditions at Beltsville. All the observations and measurements were obtained from field plots and represent either average ratings or the range based on several independent observations. Rhizomes were examined in either two or three sod samples of approximately 1 square foot each. As would be expected, the sampling error for most of these observations is very large.

It is evident from a comparison of several entries that identification of many varieties, introductions, and selections would be especially difficult. Nevertheless, these data serve as a general guide to the appearance of the bermudagrasses evaluated in this study. In addition, the results provide some indication of the wide range in morphological characteristics found within turf-type bermudagrasses and may help in identifying varieties or offtypes within varieties. However, many characteristics will vary with changes in environmental conditions, including soil fertility and mowing height and frequency.

TESTING PROCEDURE

Thirty-three varieties, introductions, and selections of bermudagrass were compared at two levels of nitrogen application in a randomized split-plot design with four replications. The experiment was started on July 3, 1958, with two replications sodded and two established by planting four 4-inch sod plugs in each plot. The bermudagrass entries were confined to 5- by 10-foot plots, as shown in figure 3, each of which was divided into two 5- by 5-foot subplots, for the application of two levels of nitrogen. Individual plots were separated by 2-foot borders, which were kept free of weeds and bermudagrass stolons, as shown in figure 4. The borders were sprayed three or four times annually with a mixture of 1 pint of DNBP (4,6-dinitro-*o*-*sec*-butylphenol) to 4 gallons of fuel oil. Silt loam soil of the experimental area had a pH of 5.8 and tested very high in phosphorus, medium in potassium, and very high in magnesium.

During the year of establishment 1 pound of nitrogen as urea was applied per 1,000 square feet at 2- to 3-week intervals. Differential levels of 10 and 20 pounds of nitrogen as urea per 1,000 square feet

FIGURE 3.—General view of experimental bermudagrass area.

FIGURE 4.—A 5- by 10-foot plot of Royal Cape bermudagrass surrounded by borders.

were used from the spring of 1959 through 1962. Nitrogen was applied at 1- and 2-pound rates at intervals of 2 to 3 weeks until each plot received a total of 10 or 20 pounds per 1,000 square feet annually. In general, the last application was made during the first week of August. In addition to nitrogen, potassium as muriate of potash was broadcast over the plots at the rate of 1.8 pounds per 1,000 square feet in 1959 and again in 1960. In 1959 and 1960 ground dolomitic limestone was applied at 2 tons per acre.

Plots were maintained at a height of 1 inch and mowed three times weekly; the clippings were removed. Watering included supplemental irrigation two or three times annually during the summer dry periods. Thatch was removed in August of 1960 and 1961 with a vertical mower set to enter the soil to a depth of 1 inch.

During the growing season entries were scored for early-spring growth, spring recovery (winter hardiness), disease resistance, seedhead formation, and turf quality.

Plots in the two replications established from sod plugs were used to obtain data on ground cover, or rate of growth. A wire grid, 2 feet square with wires 1 inch apart, was placed over each plug 2 months after planting, and ground cover was recorded in square inches.

The reliability of ratings assigned in observational tests varies with the magnitude of the differences present when observations are taken and with the reproducibility of the scoring system. At each rating period a trial run was used to establish the range and to develop a scoring pattern. All notes were obtained with two operators, with questionable scores rechecked at the time of rating. Results are reported only for those years and seasons when reliable and meaningful data were obtained.

RESULTS

Ground Cover and Early-Spring Growth

The amount of ground cover recorded was based on two replications in 1958. Ground-cover notes were taken on August 21, at which time a grid was placed over each plug and each square inch was counted only if fully covered with bermudagrass. The bermudagrasses differed appreciably in the nature of spread. Some entries tended to send out a limited number of rapidly growing stolons, which did not provide complete ground cover. Conversely, ground-cover estimates would tend to increase in proportion to the total number of stolons produced, even though stolon elongation was relatively slow.

Entries that averaged 300 or more square inches during this period of growth were Florida 50, Florida 8, Kansas 23–54, Kansas 24–54, Ohio, Texas 8, and Everglades 1, as shown in table 4. Entries that

TABLE 4.—*Ground cover in 1958 and average early-spring growth in April 1960 and 1961 of bermudagrasses with two nitrogen levels, Beltsville, Md.*[1]

Varieties, introductions, and selections	Ground cover		Early-spring growth with indicated amount of nitrogen per 1,000 square feet			
	Amount	Rank	10 pounds	20 pounds	Total	Rank
	Square inches		*Rating*	*Rating*	*Rating*	
Bayshore	288	8	1. 5	0. 9	2. 4	19
Everglades 1	300	5	1. 7	1. 1	2. 8	16
Ormond	268	13	. 2	0	. 2	26
Royal Cape	147	25	1. 7	1. 0	2. 7	17
Sunturf	276	11	1. 5	. 7	2. 2	20
Texturf 1F	190	23	2. 6	1. 7	4. 3	5
Tifgreen	279	10	2. 1	1. 5	3. 6	10
U–3	284	9	1. 6	1. 4	3. 0	14
Uganda	240	16	1. 6	1. 1	2. 7	17
P.I. 210979	207	21	2. 2	1. 7	3. 9	8
P.I. 213386	56	30	2. 5	2. 1	4. 6	3
P.I. 213388	72	29	1. 0	. 9	1. 9	22
P.I. 213390	261	14	1. 7	1. 2	2. 9	15
P.I. 213391	95	28	2. 4	2. 2	4. 6	3
P.I. 213457	229	18	1. 0	. 2	1. 2	24
P.I. 218006	142	26	2. 0	1. 4	3. 4	12
P.I. 224139	112	27	2. 0	1. 7	3. 7	9
P.I. 224140	272	12	2. 9	2. 6	5. 5	2
P.I. 224141	148	24	2. 9	2. 6	5. 5	2
P.I. 224143	198	22	. 5	. 2	. 7	25
P.I. 224145	256	15	1. 7	1. 4	3. 1	13
P.I. 224146	234	17	2. 0	1. 5	3. 5	11
P.I. 224151	216	20	2. 2	1. 9	4. 1	6
P.I. 225809	228	19	2. 2	1. 2	3. 4	12
C. bradleyi	293	7	. 9	. 5	1. 4	23
Florida 8	312	3	1. 6	. 9	2. 5	18
Florida 50	324	1	1. 2	. 7	1. 9	22
Kansas 1–51	299	6	2. 7	1. 7	4. 4	4
Kansas 23–54	313	2	1. 0	. 2	1. 2	24
Kansas 24–54	305	4	2. 6	1. 7	4. 3	5
Ohio	305	4	1. 5	. 6	2. 1	21
Texas 8	305	4	3. 4	2. 9	6. 3	**1**
Texas 22	284	9	2. 4	1. 6	4. 0	**7**

[1] Rating of 10=most growth.

covered less than 100 square inches were P.I. 213391, P.I. 213388, and P.I. 213386.

Early-spring growth ratings assigned in April shortly after the first few green leaves of bermudagrass appear may not be as reliable an indication of winter injury as spring-recovery ratings taken a month or 6 weeks later. The data in table 4 show, however, that some entries began to break dormancy and became green sooner than others. The ratings for early-spring growth for the lower level of nitrogen ranged from 0.2 for Ormond to 3.4 for Texas 8 and for the higher level from 0 to 2.9 for the same entries. All entries maintained at the 20-pound level of nitrogen were slower to break dormancy than those at the 10-pound level. Delayed dormancy at the higher rate may result from lower carbohydrate reserves induced by overstimulation during the previous growing season.

Spring Recovery

Winter hardiness is of major concern in determining the adaptation of bermudagrasses in the transition zone. Recovery rated after growth starts in the spring is an excellent measure of winter hardiness, as recovery is inversely proportional to winter damage. Average spring recovery for 33 bermudagrass entries maintained under two levels of nitrogen in 1961 and 1962 appear in table 5. A comparison of the average ratings for the 2 years for entries maintained under 10 and 20 pounds of nitrogen per 1,000 square feet shows a decided decrease in spring recovery for the heavier rate. This decrease ranged from 37.5 percent for Kansas 1–51 to 6.1 percent for P.I. 224141.

For easier comparison, average ratings for each of the 2 years have been ranked in descending order from 1 to 18 for 10 pounds and from 1 to 24 for 20 pounds of nitrogen. Statistically there was no significant difference for those rated 1 through 10 for the lower level and 1 through 11 for the higher level of nitrogen.

Except for Everglades 1, Royal Cape, Florida 8, Kansas 1–51, and Kansas 24–54, entries that ranked among the first 10 for spring recovery at the lower level of nitrogen also ranked among the first 11 at the higher level. P.I. 224140 ranked 1 for both nitrogen levels, and of the named varieties, Texturf 1F, Uganda, and Tifgreen rated highest at both nitrogen levels. The percentage decrease in spring recovery for the first 11 at the higher nitrogen level ranged from 6.1 percent for P.I. 224141 to 22.7 percent for *C. bradleyi*.

Ormond was the least winter hardy in this experiment followed by P.I. 213457 and Kansas 23–54. Observations have been obtained on the relative winter hardiness of additional varieties and selections; however, these data are not included in full, as the entries were evaluated in different plantings and years. Some of the extreme winterkilling percentages assigned in these various tests were as follows: P.I. 213383 – 35, P.I. 213385 – 100, P.I. 224131 – 100, P.I. 224149 – 95, P.I. 224691 – 70, P.I. 224694 – 50, P.I. 225126 – 100, P.I. 225595 – 95, Tiffine – 75, and Tiflawn – 95.

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TABLE 5.—*Average spring recovery of bermudagrasses with two nitrogen levels in 1961 and 1962 and decrease in recovery expressed as percentage of 10-pound level, Beltsville, Md.*[1]

Varieties, introductions, and selections	10 pounds of nitrogen per 1,000 square feet				20 pounds of nitrogen per 1,000 square feet				Decrease in recovery
	1961	1962	Average	Rank	1961	1962	Average	Rank	
	Rating	*Rating*	*Rating*		*Rating*	*Rating*	*Rating*		*Percent*
Bayshore	5.5	4.8	5.1	11	4.0	3.3	3.6	16	29.4
Everglades 1	6.2	5.3	5.7	8	4.2	5.0	4.6	12	19.3
Ormond	1.2	1.0	1.1	18	1.0	1.0	1.0	24	9.0
Royal Cape	5.7	5.8	5.7	8	4.0	4.5	4.2	13	26.3
Sunturf	5.2	4.5	4.8	13	3.0	3.8	3.4	18	29.2
Texturf 1F	6.2	6.5	6.3	5	6.0	5.3	5.6	4	11.1
Tifgreen	6.2	5.8	6.0	7	4.5	5.5	5.0	9	16.6
U–3	5.5	3.8	4.6	14	4.2	3.5	3.8	15	17.4
Uganda	5.5	6.5	6.0	7	5.2	5.5	5.3	6	11.6
P.I. 210979	6.2	6.5	6.3	5	6.2	5.3	5.7	3	9.5
P.I. 213386	5.0	5.8	5.4	10	5.0	4.8	4.9	10	9.2
P.I. 213388	6.2	5.0	5.6	9	6.2	4.3	5.2	7	7.1
P.I. 213390	5.2	4.8	5.0	12	3.2	3.5	3.3	19	34.0
P.I. 213391	6.2	5.0	5.6	9	5.5	4.0	4.7	11	16.1
P.I. 213457	3.7	3.3	3.5	17	2.0	3.3	2.6	23	25.7
P.I. 218006	5.7	6.3	6.0	7	5.2	4.8	5.0	9	16.6
P.I. 224139	5.5	6.5	6.0	7	5.5	5.5	5.5	5	8.3
P.I. 224140	7.0	7.3	7.1	1	6.5	6.3	6.4	1	9.8
P.I. 224141	6.0	7.0	6.5	3	6.2	6.0	6.1	2	6.1
P.I. 224143	5.0	4.3	4.6	14	3.0	3.5	3.2	20	30.4
P.I. 224145	6.2	5.8	6.0	7	6.0	4.3	5.1	8	15.0
P.I. 224146	6.0	6.8	6.4	4	6.5	5.3	5.9	2	7.8
P.I. 224151	5.7	6.3	6.0	7	5.5	5.0	5.2	7	13.3
P.I. 225809	6.2	7.0	6.6	2	5.7	5.5	5.6	4	15.2
C. bradleyi	6.0	7.3	6.6	2	4.2	6.0	5.1	8	22.7
Florida 8	6.0	5.5	5.7	8	4.0	4.0	4.0	14	29.8
Florida 50	3.7	5.0	4.3	15	2.5	4.5	3.5	17	18.6

Kansas 1–51	5.2	6.0	5.6	9	3.0	4.0	3.5	17	37.5
Kansas 23–54	4.2	4.0	4.1	16	2.0	3.5	2.7	22	34.1
Kansas 24–54	5.2	6.3	5.7	8	3.2	5.3	4.2	13	26.3
Ohio	5.7	3.5	4.6	14	2.5	3.3	2.9	21	36.9
Texas 8	6.2	6.0	6.1	6	5.0	6.0	5.5	5	9.8
Texas 22	5.5	5.3	5.4	10	5.0	4.5	4.7	11	12.9
L.S.D. at 5-percent level			1.7				1.7		

[1] Rating of 10=best spring recovery or most winter hardy.

Disease Resistance

Leaf spot diseases (*Helminthosporium* spp.) damage stands and reduce turf quality in many areas of the bermudagrass zone of adaptation, particularly in humid sections.

Thus far, leaf spot has not been considered a serious disease in the transition zone. Leaf spot infestation appears rather late in the growing season at Beltsville, and before serious injury occurs bermudagrasses become dormant. Little or no information is available as to whether a late attack of leaf spot reduces winter hardiness or otherwise has a detrimental effect. Rust (*Puccinia* spp.) was observed in this experiment. However, this fungus disease was not rated, as the degree of infestation was relatively light. Leaf spot infestation was most serious in 1960. Data for this year appear in table 6.

TABLE 6.—*Resistance to leaf spot of bermudagrasses with two nitrogen levels in October 1960, Beltsville, Md.*[1]

Varieties, introductions, and selections	10 pounds of nitrogen per 1,000 square feet		20 pounds of nitrogen per 1,000 square feet		Total	Rank
	Average	Rank	Average	Rank		
	Rating		*Rating*		*Rating*	
Bayshore	2. 3	6	4. 5	13	6. 8	13
Everglades 1	2. 8	8	4. 0	11	6. 8	13
Ormond	1. 3	2	1. 5	3	2. 8	3
Royal Cape	1. 0	1	1. 3	1	2. 3	1
Sunturf	2. 8	8	4. 8	14	7. 6	15
Texturf 1F	3. 3	9	5. 8	16	9. 1	19
Tifgreen	1. 0	1	1. 5	2	2. 5	2
U–3	3. 8	11	4. 3	12	8. 1	17
Uganda	2. 8	8	4. 0	11	6. 8	13
P.I. 210979	1. 8	4	2. 5	7	4. 3	8
P.I. 213386	1. 8	4	1. 8	4	3. 6	5
P.I. 213388	1. 8	4	2. 3	6	4. 1	7
P.I. 213390	1. 8	4	4. 5	13	6. 3	12
P.I. 213391	1. 3	2	2. 0	5	3. 3	4
P.I. 213457	6. 0	15	7. 3	18	13. 3	24
P.I. 218006	2. 0	5	3. 3	9	5. 3	10
P.I. 224139	1. 8	4	2. 0	5	3. 8	6
P.I. 224140	2. 0	5	3. 3	9	5. 3	10
P.I. 224141	2. 5	7	3. 3	9	5. 8	11
P.I. 224143	2. 3	6	2. 5	7	4. 8	9
P.I. 224145	2. 0	5	2. 8	8	4. 8	9
P.I. 224146	1. 5	3	1. 8	4	3. 3	4
P.I. 224151	3. 5	10	4. 8	14	8. 3	18
P.I. 225809	2. 5	7	4. 8	14	7. 3	14
C. bradleyi	2. 5	7	3. 8	10	6. 3	12
Florida 8	2. 8	8	4. 8	14	7. 6	15
Florida 50	4. 5	12	6. 3	16	10. 8	21
Kansas 1–51	4. 8	13	6. 5	17	11. 3	22
Kansas 23–54	5. 3	14	7. 5	19	12. 8	23
Kansas 24–54	4. 8	13	6. 5	17	11. 3	22
Ohio	3. 5	10	5. 3	15	8. 8	19
Texas 8	3. 0	8	6. 3	16	9. 3	20
Texas 22	3. 5	10	4. 5	13	8. 0	16

[1] Rating of 10=least disease resistant.

The entries that were most resistant to leaf spot at both levels of nitrogen were Royal Cape, Tifgreen, and Ormond. The least resistant entries for the two levels were P.I. 213457, the Kansas selections 1–51, 23–54, 24–54, Florida 50, Texas 8, Texturf 1F, and Ohio. The greatest increase in the incidence of leaf spot from the lower to the higher level of nitrogen was found for Texas 8 – 3.3, P.I. 213390 – 2.7, Texturf 1F – 2.5, and P.I. 225809 – 2.3. Texas 8 and Texturf 1F were also among the least resistant to leaf spot.

Seed-Head Formation

Seed heads are undesirable because they make unsightly turf. Also stemminess is associated with excessive seed-head production. Bermudagrasses vary with respect to this characteristic in the quantity of seed heads, when they appear, and how long they persist. Some

TABLE 7.—*Average seed-head formation of bermudagrasses with two nitrogen levels in 1959 and 1960, Beltsville, Md.*[1]

Varieties, introductions, and selections	10 pounds of nitrogen per 1,000 square feet				20 pounds of nitrogen per 1,000 square feet			
	1959	1960	Average	Rank	1959	1960	Average	Rank
	Rating	*Rating*	*Rating*		*Rating*	*Rating*	*Rating*	
Bayshore	2.7	4.0	3.4	16	1.7	4.2	3.0	16
Everglades 1	1.4	2.5	1.9	7	1.0	2.0	1.5	6
Ormond	0	0	0	1	0	0	0	1
Royal Cape	4.0	3.0	3.5	16	3.5	4.5	4.0	19
Sunturf	1.9	1.2	1.6	5	1.0	2.2	1.6	7
Texturf 1F	1.9	2.2	2.1	9	1.0	1.2	1.1	4
Tifgreen	2.0	4.5	3.3	15	1.0	3.7	2.4	13
U–3	3.5	4.0	3.8	17	2.0	4.0	3.0	16
Uganda	3.0	2.2	2.6	13	2.5	3.2	2.9	15
P.I. 210979	3.0	1.5	2.3	11	2.2	2.2	2.2	11
P.I. 213386	3.2	3.2	3.2	14	3.0	3.7	3.4	18
P.I. 213388	2.5	1.0	1.8	6	1.7	1.0	1.4	5
P.I. 213390	1.7	1.0	1.4	4	1.5	2.7	2.1	10
P.I. 213391	2.7	1.7	2.2	10	2.5	2.2	2.4	13
P.I. 213457	3.0	1.5	2.3	11	2.5	1.7	2.1	10
P.I. 218006	3.0	1.7	2.4	12	2.5	2.5	2.5	14
P.I. 224139	2.2	2.2	2.2	10	2.2	2.7	2.5	14
P.I. 224140	2.7	2.0	2.4	12	2.2	2.5	2.4	13
P.I. 224141	2.7	2.5	2.6	13	2.5	2.5	2.5	14
P.I. 224143	5.0	4.0	4.5	18	4.5	4.0	4.3	20
P.I. 224145	2.5	1.5	2.0	8	1.7	1.2	1.5	6
P.I. 224146	1.2	.5	.9	2	1.0	.7	.9	2
P.I. 224151	2.5	1.2	1.9	7	2.0	1.7	1.9	9
P.I. 225809	3.0	1.7	2.4	12	2.5	3.5	3.0	16
C. bradleyi	1.5	1.0	1.3	3	.7	1.2	1.0	3
Florida 8	3.0	3.5	3.3	15	2.0	4.7	3.3	17
Florida 50	1.4	2.2	1.8	6	.7	2.5	1.6	7
Kansas 1–51	1.7	2.7	2.2	10	1.0	3.0	2.0	9
Kansas 23–54	3.0	1.7	2.4	12	2.0	2.5	2.3	12
Kansas 24–54	1.7	2.5	2.1	9	1.0	2.5	1.8	8
Ohio	1.7	2.0	2.2	10	1.0	2.7	1.8	8
Texas 8	1.1	1.7	1.4	4	1.0	1.2	1.1	4
Texas 22	1.4	2.2	1.8	6	.7	2.7	1.8	8

[1] Rating of 5=most seed heads.

accessions have seed heads from early in the growing season throughout much of the summer, whereas with others seed heads may persist for a relatively short time. Evaluation of seed-head production necessitates rating at frequent intervals throughout the growing season.

A reduction in seed-head formation for the higher level of nitrogen occurred for most entries in this study except Royal Cape, Uganda, P.I. 213386, P.I. 213390, P.I. 213391, P.I. 218006, P.I. 224139, and P.I. 225809, as shown in table 7. Entries with the fewest seed heads for both levels of nitrogen were Ormond, P.I. 224146, and *C. bradleyi*. In fact, Ormond did not form any seed heads under the conditions of management and day length at Beltsville. Genetic factors and day length affect seed-head formation. Tifgreen, which is rated low in the production of seed heads in some of the Southern States, was rated relatively high in this study.

Response to Nitrogen Fertilization

Ten or twenty pounds of nitrogen per 1,000 square feet may be considered excessive for bermudagrasses maintained for general-turf purposes; yet each entry exhibited some improvement in turf quality. The variety × nitrogen interactions appear in figure 5. Among the entries that gave the greatest response to the higher level of nitrogen were Tifgreen, Texas 22, Everglades 1, U–3, and *C. bradleyi*. P.I. 213386, P.I. 213388, and P.I. 224139 gave the least response to the 10-pound level of nitrogen. Increase in turf quality at the 20-pound level for most of the entries, especially Tifgreen and U–3, may largely be attributed to a reduction of seed heads; however, most of the entries were also darker green.

A high level of nitrogen may not always be desirable. Even though turf quality improves, detrimental effects such as a decrease in winter hardiness and greater susceptibility to disease may become problems.

Turf Quality

Turf-quality ratings in this study represent a composite evaluation, based on such characteristics as density, weed infestation, injury from disease, stemminess, and general appearance. Quality ratings were assigned two or three times a year for each level of fertility. It should be emphasized that quality ratings for general-purpose turf, such as lawns and fairways, will differ appreciably from those for high-maintenance putting greens. In addition, turf quality is not very meaningful without reference to other agronomic factors. For example, Ormond produces high-quality turf at Beltsville, but it is very susceptible to winter damage. Quality ratings for 1960 and 1961 and rank by nitrogen levels appear in table 8.

The average turf-quality rating for each entry increased from the lower to the higher level of nitrogen fertility, even though the lower level might be considered excessive for bermudagrasses under some conditions. No significant difference was obtained for entries ranked 1 through 4 for either nitrogen level. Ormond, Tifgreen, Everglades 1, and P.I. 224143 appeared in this group. The following entries were rated at the bottom for both levels of nitrogen: P.I. 213386, P.I. 213388, P.I. 224139, P.I. 224145, and P.I. 224146. These

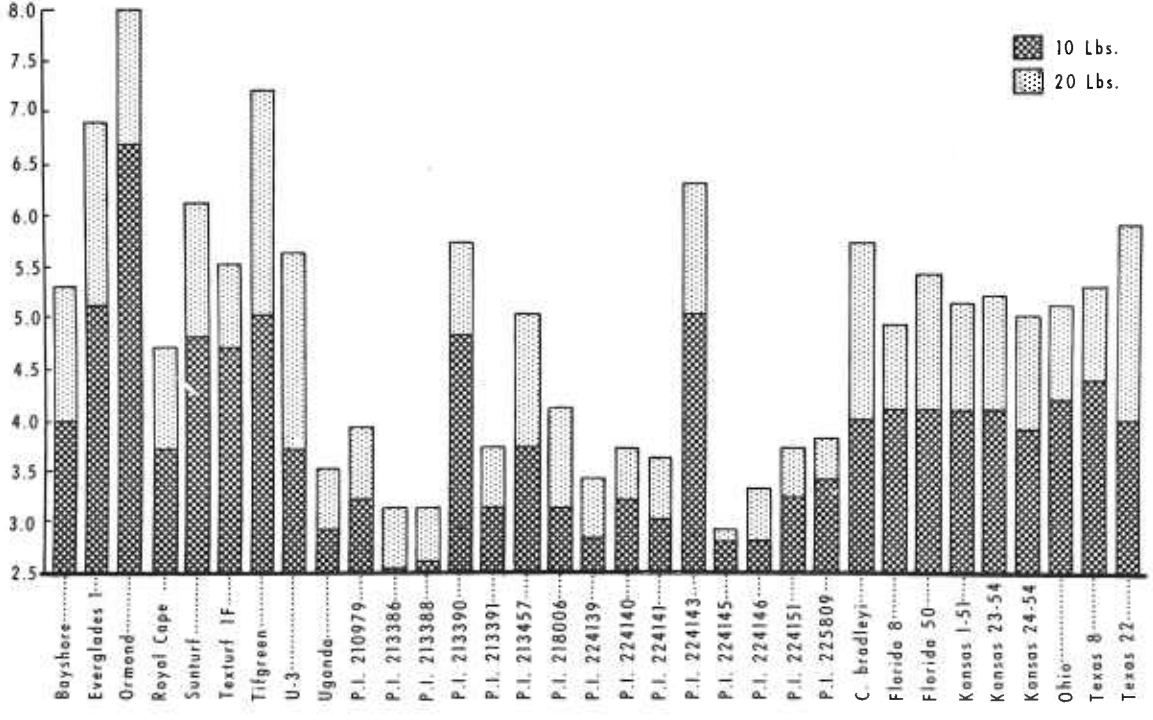

FIGURE 5.—Variety × fertilizer interaction: Average ratings for turf quality with 10- and 20-pound nitrogen levels per 1,000 square feet in August and September 1960 and October 1961, Beltsville, Md.

TABLE 8.—*Average turf quality of bermudagrasses with two nitrogen levels in 1960 and 1961, Beltsville, Md.*[1]

Varieties, introductions, and selections	10 pounds of nitrogen per 1,000 square feet					20 pounds of nitrogen per 1,000 square feet				
	Aug. 1960	Sept. 1960	Sept. 1961	Average	Rank	Aug. 1960	Sept. 1960	Sept. 1961	Average	Rank
	Rating	*Rating*	*Rating*	*Rating*		*Rating*	*Rating*	*Rating*	*Rating*	
Bayshore	4.5	4.4	3.2	4.0	9	6.0	4.4	5.2	5.3	11
Everglades 1	5.7	5.6	4.0	5.1	2	7.0	6.6	7.2	6.9	3
Ormond	8.2	7.0	5.0	6.7	1	9.2	7.7	7.0	8.0	1
Royal Cape	3.2	4.7	3.2	3.7	11	4.5	4.2	5.5	4.7	16
Sunturf	4.7	6.6	3.2	4.8	4	6.7	7.0	4.7	6.1	5
Texturf 1F	5.0	5.4	3.7	4.7	5	6.0	5.4	5.2	5.5	9
Tifgreen	4.2	6.4	4.5	5.0	3	6.2	8.1	7.2	7.2	2
U-3	3.7	4.4	3.2	3.8	10	6.0	5.6	5.2	5.6	8
Uganda	2.7	3.4	2.7	2.9	16	3.2	3.4	4.0	3.5	22
P.I. 210979	3.7	3.6	2.7	3.2	13	4.0	3.6	4.0	3.9	18
P.I. 213386	3.2	2.2	2.0	2.5	19	3.7	2.6	3.0	3.1	25
P.I. 213388	2.7	2.5	2.5	2.6	18	3.2	2.5	3.5	3.1	25
P.I. 213390	5.2	5.7	3.5	4.8	4	6.0	6.2	5.0	5.7	7
P.I. 213391	3.5	3.0	2.7	3.1	14	4.0	3.1	4.0	3.7	20
P.I. 213457	5.0	4.0	2.2	3.7	11	6.2	4.2	4.7	5.0	14
P.I. 218006	3.0	3.2	3.2	3.1	14	4.0	3.6	4.7	4.1	17
P.I. 224139	3.0	2.0	3.5	2.8	17	3.2	2.0	5.0	3.4	23
P.I. 224140	3.0	3.6	3.0	3.2	13	3.5	3.6	4.0	3.7	20
P.I. 224141	3.5	3.0	2.5	3.0	15	3.7	3.0	4.0	3.6	21
P.I. 224143	4.7	6.4	4.0	5.0	3	6.0	6.8	6.2	6.3	4
P.I. 224145	2.7	3.0	2.7	2.8	17	3.0	2.6	3.2	2.9	26
P.I. 224146	3.2	2.6	2.5	2.8	17	3.7	2.6	3.5	3.3	24
P.I. 224151	3.0	3.6	3.0	3.2	13	4.0	3.4	3.7	3.7	20
P.I. 225809	3.2	3.4	3.5	3.4	12	3.5	3.0	5.0	3.8	19
C. bradleyi	4.7	4.2	3.0	4.0	9	6.2	5.0	6.0	5.7	7
Florida 8	4.2	4.5	3.5	4.1	8	5.5	4.0	5.2	4.9	15
Florida 50	4.2	4.1	4.0	4.1	8	5.5	4.6	6.2	5.4	10
Kansas 1–51	5.0	4.2	3.0	4.1	8	6.2	4.4	4.7	5.1	13
Kansas 23–54	5.0	4.7	2.7	4.1	8	5.7	4.7	5.2	5.2	12
Kansas 24–54	4.2	4.6	3.0	3.9	10	5.7	4.7	4.7	5.0	14
Ohio	5.2	4.5	3.0	4.2	7	6.0	4.4	5.0	5.1	13
Texas 8	5.2	4.8	3.2	4.4	6	5.7	5.1	5.2	5.3	11
Texas 22	5.2	4.8	2.0	4.0	9	7.0	6.2	4.5	5.9	6

[1] Rating of 10=best turf quality.

introductions are fine textured and require higher maintenance, more frequent mowing, lower mowing height, vertical mowing (to thin turf), and top dressing with soil. These fine-textured introductions were also subject to scalping or loss of leaves, which resulted in stemmy turf.

Summary of Performance Ratings

Spring-recovery ratings represent the single most important criterion in establishing the value of varieties in the transition zone. When selections have demonstrated acceptable winter hardiness, then, and only then, will they be compared and selected for planting in terms of turf quality, seed-head formation, rate of growth, disease resistance, and use.

Several introductions exhibited satisfactory levels of winter hardiness, surpassing U–3 and Tifgreen in spring recovery. On the other hand, turf quality was lower than that recorded for the better named varieties. It would appear, therefore, that most introductions and selections included in this study would be of value for breeding purposes rather than for direct increase and use in the transition zone. In addition, it does not seem unreasonable to expect that the upper level of winter hardiness recorded in this experiment could be surpassed in further plant-collection and hybridization studies.

Although this study did not lead to the release of a new variety for the transition zone, it did serve to catalog vegetative introductions, many of which have been in the United States for several years. Information on the characteristics and performance of named and numbered varieties is essential in planning and evaluating plant-exploration studies and in accumulating germ plasm for hybridization and selection work.

It should be noted that although U–3 has been widely accepted in the transition zone, this variety is not necessarily the most desirable from the standpoint of winter hardiness, absence of seed heads, and general turf quality. Tifgreen and Sunturf are gaining in popularity; however, they produce turf that lacks the versatility of use found in U–3.

Performance of Additional Bermudagrass Selections

In another study 20 additional bermudagrass entries were sprigged into 4- by 4-foot plots in two replications in June 1960. One entry, Burning Tree, was included a year later. This experimental area was located adjacent to the previous study on soil with similar characteristics. After establishment, nitrogen as urea was applied at 1 pound per 1,000 square feet of elemental nitrogen every 2 to 3 weeks for the remainder of the growing season. For each of 2 years approximately 8 pounds of nitrogen per 1,000 square feet was broadcast annually in the form of urea except for one application each spring, which consisted of 10 pounds of 10–10–10 per 1,000 square feet. Rate-of-growth ratings were not obtained owing to the differential quantity of vegetative material planted for each entry. Even though equal amounts of stolons were not available to establish the selections, plots were fully covered by fall. Entries were rated for early-spring

growth, spring recovery, ground cover, turf quality, leaf spot, and fall color, as shown in table 9.

TABLE 9.—*Average ratings of bermudagrasses in 1961 and 1962, Beltsville, Md.*[1]

Varieties, introduction, and selections	Early-spring growth (Apr. 1961)	Spring recovery (May 1961)	Ground cover (June 1961)	Turf quality (Oct. 1961)	Leaf spot (Oct. 1961)	Fall color	Spring recovery (May 1962)
Tifway	0	2.0	7.0	6.3	7.7	4.0	3.0
Tufcote	2.0	7.0	9.5	5.0	5.5	4.5	7.5
P.I. 258846	2.0	7.0	9.5	5.0	6.5	3.0	6.5
Brunswick	.5	3.5	8.5	4.5	6.0	2.5	4.5
Burning Tree				5.0	9.0	4.0	7.0
Kansas B–1	5.5	6.0	10.0	4.5	5.0	2.5	7.0
Kansas C–7	5.0	7.0	10.0	4.5	8.0	2.5	3.5
Kansas E–1	4.5	7.0	9.5	3.5	6.0	4.0	7.5
Kansas E–5	7.0	7.0	10.0	3.5	5.5	2.5	8.0
Kansas F–7	5.5	9.0	10.0	4.5	8.0	2.0	6.0
Kansas G–11	3.0	8.0	10.0	3.5	6.0	2.0	5.0
Kansas H–8	3.5	7.5	10.0	7.0	7.5	3.5	6.5
Kansas J–5	1.5	5.5	9.5	3.0	6.5	2.0	4.0
Kansas K–9	4.5	7.0	9.5	4.5	3.5	2.0	6.0
Kansas O–8	1.0	5.0	10.0	3.5	7.0	4.5	4.5
Kansas P–16	5.5	7.5	10.0	3.0	7.5	1.0	6.0
Kansas Q–2	3.5	5.5	9.5	4.5	6.0	2.0	6.0
Kansas Q–17	1.5	7.0	10.0	5.0	7.5	3.0	6.5
Kansas R–8	4.5	7.0	9.5	4.5	7.0	3.5	7.5
Kansas S–16	5.5	8.0	10.0	4.5	6.5	2.5	8.0
Kansas T–4	4.5	5.5	8.5	3.5	7.0	2.5	7.0

[1] Rating of 10=most growth, best spring recovery, most ground cover, best turf quality, least leaf spot, and best fall color.

Spring-recovery notes taken in May 1961 indicate that this group of bermudagrasses is relatively winter hardy except for Tifway and Brunswick. Of the 16 Kansas selections, B–1 through T–4, only 5 entries were rated below 7 for spring recovery. Spring-recovery ratings for 1962 follow a similar pattern when compared with those for the previous year, except for a sharp decline for three Kansas selections—C–7 from 7 to 3.5, F–7 from 9 to 6, and G–11 from 8 to 5. Spring-recovery ratings of 5 and above for this and the previous study indicate an acceptable degree of winter hardiness.

Ground-cover notes were taken in June 1961. Fully covered plots had a rating of 10. Even though Tifway and Brunswick were not satisfactory from the standpoint of winter hardiness for the transition zone, both of these grasses recovered rapidly, as indicated by ground-cover ratings of 7 and 8.5, respectively.

Of the 21 entries, only 6 rated 5 or above for turf quality—Kansas H–8, Tifway, Tufcote, P.I. 258846, Burning Tree, and Kansas Q–17. Kansas H–8 and Tifway rated highest. Quality ratings below 5 ranged from 3 to 4.5 and probably were not significantly different. The bermudagrasses were rated for turf quality late in the growing season when differences in quality were most apparent.

Leaf-spot incidence ranged from 3.5 to 9, with 10 as the least infestation. Ratings above 5 may represent a satisfactory level of

tolerance in the transition zone, because the bermudagrasses become dormant soon after leaf spot appears. The high rating for Burning Tree (9.0) may not represent a reliable index of disease resistance, as this selection was planted in the spring of 1961.

Fall-color notes were taken after light frosts, when the bermudagrasses differed in color. Tufcote, Kansas O–8, Tifway, Burning Tree, and Kansas E–1 rated 4 and above. Cold tolerance, or resistance to early browning, is often evident among selections during periods of light frost and cool nights. However, these differences largely disappear with heavy frost, which may occur either early or late in the fall. Fall color may be a more important characteristic farther south where light frosts are more likely to occur over a longer period of time.

DISCUSSION

Variation within bermudagrass species in texture, leafiness, number of rhizomes, winter hardiness, and rate of spread is indicative of the possibility of developing new and superior varieties and of extending the area in which bermudagrasses are planted for turf purposes. The potential for such varieties exists in the wide base of germ plasm provided by natural selection, plant introduction, and the promise of recombining valuable characteristics in hybrid varieties. Examples of varieties obtained through natural selection are U–3 and Texturf 1F; through direct increase of introductions, Sunturf and Tufcote; and through hybridization, Tifgreen and Tifway.

Research on bermudagrass breeding has been reviewed by Burton (*2*). Practically all bermudagrass breeding for turf has been done in the South. Since winter hardiness in the Deep South is usually less important, most of the emphasis in breeding has been on improvement of turf quality, as illustrated by such outstanding examples as Tifway, Tiflawn, and Tifgreen. Tifway is well adapted for fairway turf in the South, but it lacks winter hardiness in the transition zone. Tiflawn also falls in the same category with respect to winter hardiness. Tifgreen is comparable to U–3 in winter hardiness, but it is better adapted for putting greens, for which it is one of the finest varieties. Tifgreen is widely used to establish new greens throughout the South and to sprig into renovated greens. U–3, a single plant selection from common bermudagrass, is adapted for tees, fairways, and general-purpose turf in the transition zone. This variety, with a relatively high degree of winter hardiness and other desirable turf characteristics, provided the impetus for the northward progress of bermudagrass. However, a need exists in the northern bermudagrass region for varieties that are superior in both winter hardiness and turf quality.

In the Deep South and in southern California, Ormond provides a dark-green lawn grass that is more frost resistant than other varieties and retains its color later in the fall. In the Southwest and in other areas of the South, Tiflawn, Texturf, and Sunturf are well adapted for lawns; however, many lawns in this region still consist of common bermudagrass. With continued education of the public through the Federal Extension Service and other means, many lawns and other turf areas gradually will be converted to improved bermudagrasses. Furthermore, the development and use of varieties that compete with

common bermudagrass will aid in converting lawns and other turf areas to improved varieties. Aggressive improved varieties could eliminate the need for soil fumigation prior to renovation and sprigging.

In the transition zone, aggressiveness is equally desirable, but it must be tempered with the possibility of growing combination turf. Thus on some bermudagrass lawns and fairways, fall nitrogen applications, overseeding, and mechanical renovation may be practiced in an attempt to maintain a reasonable percentage of the cool-season perennials for early-spring, late-fall, and winter color. A rather open, rapid-spreading variety would be preferred under these circumstances to a very dense, fine-leaved variety, in which it would be virtually impossible to maintain cool-season perennials such as Kentucky bluegrass.

The promotion of improved bermudagrasses would be facilitated in both the North and the South by the development of improved varieties that could be established from seed. Lack of uniformity is a major limitation to seed versus vegetative propagation, together with the fact that many outstanding hybrids are sterile and of limited value in selecting fertile varieties. Nevertheless, some consideration is being given to the possibility of developing fertile synthetic varieties, the seed from which would display a relatively high level of uniformity and other desirable turf characteristics. Studies on the development of seed-propagated varieties have not progressed far enough to determine their ultimate value.

Marked differences in the degree of winter hardiness exist among bermudagrass species and selections. Personnel of the Kansas State Experiment Station have made one of the first serious attempts through hybridization to develop winter-hardy varieties specifically for the transition zone. Winter-hardy clones collected in northern Kansas and southern Nebraska were planted in a polycross nursery, where a high degree of hybridization was obtained between common bermudagrass selections and African introductions. The polycross progenies were screened and over 600 seedlings evaluated for turf characteristics. Sixteen selections with a high degree of winter hardiness and other desirable turf qualities were distributed to several State experiment stations and to the Plant Industry Station for further testing. Data on the performance of these selections at Beltsville appear in table 9.

Through research in breeding and selection, better bermudagrasses will probably be available within the near future to fulfill the needs of the transition zone.

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APPENDIX

Performance of Bermudagrasses at Other Locations

Data in tables 10–31 were obtained on the performance of bermudagrasses in other regions of the United States.[3] The tables are self-explanatory, and no attempt has been made to compare these results with the performance data obtained at Beltsville. Different rating methods have been followed, and this fact must be considered in comparing locations. Information was not obtained from all research stations engaged in turf research and sometimes complete data were not available.

Results from other research stations are presented so that interested individuals can make their own interpretations. This information will provide a guide to the performance of many named varieties, introductions, and selections over a wider area of the United States.

[3] The following persons from agricultural experiment stations in the indicated States submitted data for the tables: D. G. Sturkie, Alabama; A. A. Baltensperger, Arizona; V. B. Youngner, California; G. W. Burton, Georgia; E. C. Roberts, Iowa; W. R. Thompson, Jr., Mississippi; H. D. Jones, New Mexico; E. C. Holt, Texas; and R. E. Schmidt and H. M. Camper, Virginia.

Alabama

TABLE 10.—*Average ratings of bermudagrasses managed as lawn turf, mowed at ¾-inch height in spring and gradually raised to 1½ inches by fall, Alabama Agricultural Experiment Station, Auburn, 1955–60* [1]

Varieties and selections	Color	Texture	Seed heads	Spring earliness	Drought resistance	Recovery after drought	Disease resistance	Height uncut	Damage from herbicides	Recovery after scalping	Turf quality
Everglades 1	4	7	3	2	4	7	7	2	6	10	6
Ormond	6	3	5	3	2	2	3	2	5	2	2
Sunturf	10	10	10	2	5	7	5	10	4	10	7
Texturf 1F	6	5	6	10	4	2	5	2	2	10	3
Tiffine	2	10	2	2	5	5	5	10	5	5	4
Tifgreen	10	10	4	10	10	10	7	10	2	5	10
Tiflawn	7	5	5	2	10	5	10	2	6	2	7
U–3	7	5	3	3	5	7	10	6	10	10	7
C. transvaalensis	3	10	2	10	4	4	2	10	2	2	4
Alabama Ensminger	7	4	6	7	4	4	5	10	6	5	5
Alabama Florence	7	2	5	7	4	2	3	1	6	2	4
Florida 3	5	5	2	2	2	2	5	6	2	5	3
Florida 8	7	4	5	2	10	4	10	2	6	2	4
Florida 50	4	3	6	3	2	2	3	10	2	2	2
Puerto Rico	3	6	2	4	4	7	3	2	2	10	5
Sea Island	6	4	7	2	2	4	7	10	2	2	4
Tifton 3	6	5	2	3	6	3	3	2	6	10	4
Tifton 12	5	2	3	2	10	3	5	2	5	2	4
Common	5	3	5	3	4	4	5	2	10	2	4
Number of ratings	3	3	3	3	4	3	3	3	2	1	3

[1] Rating of 10=darkest green, finest texture, fewest seed heads, earliest in spring, most drought resistant, most rapid recovery after drought, most disease resistant, lowest uncut height, least herbicide damage, most rapid recovery after scalping, and best turf quality.

TABLE 11.—*Average ratings of bermudagrasses managed as lawns and as golf greens, Alabama Agricultural Experiment Station, Auburn, 1959–61* [1]

Varieties, introductions, and selections	Rate of spread	Color	Texture	Density	Seed heads		Spring earliness	Recovery after drought	Disease resistance	Height uncut	Turf quality
					Early	Late					
										Inches	
Everglades 1	10	5	6	5	4	6	10	6	5	6	6
NK–37	10	4	1	4	10	2	2	2	2	16	2
Royal Cape	5	6	2	6	6	5	5	2	5	6	5
Sunturf	4	8	6	8	10	6	10	10	6	5	7
Texturf 10	4	5	3	4	5	4	10	5	4	6	5
Tiffine	5	5	6	6	2	3	2	10	6	6	5
Tifgreen	6	10	7	8	10	6	10	10	7	2	8
Tiflawn	5	6	3	5	2	2	2	10	7	9	5
U–3	5	9	5	6	5	2	2	6	6	5	6
Uganda	6	3	10	5	2	10	10	2	3	4	4
P.I. 213385	10	6	3	6	2	4	10	10	6	12	6
P.I. 224145	4	3	10	3	5	10	5	4	2	2	4
P.I. 224146	5	4	10	6	2	10	10	10	4	4	6
P.I. 224151	5	3	10	2	2	10	10	2	2	7	4
P.I. 224159	5	2	10	3	2	10	10	2	2	5	4
P.I. 225809	6	4	10	4	2	10	10	2	2	5	5
Florida 8	4	6	4	4	2	4	2	6	6	8	5
Georgia 420	10	6	3	5	2	4	2	2	6	10	6
New Zealand	10	6	3	6	4	3	2	4	6	9	6
Texas 22	4	5	4	3	5	5	10	5	4	7	5
Number of ratings	1	3	3	3	1	3	2	1	4	1	7

[1] Rating of 10=most rapid spread, darkest green, finest texture, most dense, fewest seed heads, earliest in spring, most rapid recovery after drought, most disease resistant, and best turf quality.

Alabama—Continued

TABLE 12.—*Average ratings of bermudagrasses managed as lawns and as golf greens, Alabama Agricultural Experiment Station, Auburn, 1962* [1]

Varieties, introductions, and selections	Rate of spread	Color	Texture	Density	Seed heads	Disease resistance	Recovery after scalping	Discoloration by frost
Everglades 1	8	6	7	9	8	9	1	5
Ormond	10	8	7					8
Sunturf	7	8	8	9	9	9	5	4
Tifgreen	9	8	8	9	8	10	5	1
Tiflawn	7	7	5	8	9	10	7	5
Tifway	9	8	8	9	9	10	6	10
U–3	4	8	5	8	5	10	8	6
Uganda	10	2	10	7	10	3	1	3
P.I. 213385	9	7	5	8	9	10	3	7
P.I. 213388	3	10	8	9	9	10	10	4
P.I. 213391	3	6	10	7	10	6	9	9
P.I. 224140	3	3	9	4	10	3	6	2
P.I. 224146	7	3	10	8	10	8	3	6
Auburn 1	10	8	6	8	9	10	3	7
Auburn 2	7	8	3	4	8	10	3	5
Florida 8	6	8	4	7	9	10	7	6
Georgia 420	6	8	5	8	9	10	7	5
Norrie	1	10	1	3	1	10	8	7
Tifturf [2]	5	7	7					4
Number of ratings	3	4	4	2	1	1	1	1

[1] Rating of 10=most rapid spread, darkest green, finest texture, most dense, fewest seed heads, most disease resistant, most rapid recovery after scalping, and least discoloration by frost.

[2] Southern Turf Nurseries, Tifton, Ga.

Arizona

TABLE 13.—*Average ratings of bermudagrasses managed as general-purpose turf, Arizona Agricultural Experiment Station, Tucson, 1960 and 1961* [1]

Varieties, introductions, and selections	Rate of spread (Aug. 2, 1960)	Color		Texture (Sept. 19, 1960)	Density (Sept. 19, 1960)	Seed heads (summer)	Disease		Eriophyid mite (May 2, 1961)	Vigor (Sept. 19, 1960)	General quality (Sept. 21, 1961)
		Spring	Fall				Rust (Nov. 8, 1960)	Summer blight (Aug. 21, 1961)			
Bayshore	7	4	6	4	8	7	3	5	4	8	4
Everglades 1	9	4	6	3	7	6	5	5	3	8	6
Ormond	9	3	6	4	7	3	1	4	9	7	1
Royal Cape	5	5	8	1	8	4	1	6	2	6	7
Sunturf	6	3	6	3	8	5	4	3	4	7	2
Texturf 1F	8	3	4	5	7	5	4	3	6	9	3
Texturf 10	8	4	8	5	7	4	1	7	3	8	3
Tiffine	5	4	5	3	7	6	1	7	4	7	4
Tifgreen	7	5	6	3	9	3	6	3	4	7	3
Tiflawn	5	4	4	5	7	8	1	4	5	6	2
Tifway	4	5	7	3	7	3	3	2	2	5	2
U-3	6	3	7	3	7	6	3	2	2	5	3
Uganda	3	4	4	1	9	7	5	4	2	5	6
P.I. 210979	2	3	6	1	8	7	6	3	1	6	5
P.I. 213383	2	4	5	1	8	3	4	4	1	2	5
P.I. 213385	2	5	6	1	7	4	7	4	1	4	4
P.I. 213386	4	4	5	1	8	4	5	5	1	4	7
P.I. 213388	2	3	6	1	7	6	4	5	1	4	7
P.I. 213389	5	3	7	3	7	5	3	4	1	5	3
P.I. 213391	3	3	5	1	8	3	4	5	3	4	7
P.I. 213457	7	3	4	3	7	5	1	4	9	7	7
P.I. 224131	8	3	7	4	7	3	1	1	8	8	1
P.I. 224139	4	3	5	1	7	7	4	5	1	6	7
P.I. 224140	2	3	6	2	8	7	5	5	1	5	7
P.I. 224141	1	3	8	1	6	4	2	4	1	3	7

See footnote at end of table.

Arizona—Continued

TABLE 13.—*Average ratings of bermudagrasses managed as general-purpose turf, Arizona Agricultural Experiment Station, Tucson, 1960 and 1961* [1]—Continued

Varieties, introductions, and selections	Rate of spread (Aug. 2, 1960)	Color		Texture (Sept. 19, 1960)	Density (Sept. 19, 1960)	Seed heads (summer)	Disease		Eriophyid mite (May 2, 1961)	Vigor (Sept. 19, 1960)	General quality (Sept. 21, 1961)
		Spring	Fall				Rust (Nov. 8, 1960)	Summer blight (Aug. 21, 1961)			
P.I. 224143	4	3	6	5	5	7	3	8	5	5	9
P.I. 224145	3	4	7	2	7	5	5	5	2	5	5
P.I. 224146	2	3	7	1	9	5	4	5	1	3	5
P.I. 224149	1	3	6	5	8	8	2	2	6	2	4
P.I. 224151	2	5	6	1	8	4	6	5	1	5	7
P.I. 224691	6	4	3	7	6	9	3	5	9	7	6
P.I. 224694	4	2	6	6	7	7	2	2	4	6	1
P.I. 225126	4	3	6	6	4	7	4	7	2	3	7
P.I. 225595	6	4	8	6	6	8	1	2	2	7	2
P.I. 225809	2	4	6	1	7	8	6	4	2	7	5
P.I. 258846	2	4	4	1	5	3	5	9	1	2	7
C. bradleyi	5	3	5	4	8	6	5	9	1	4	7
C. incompletus	2	4	5	5	5	7	3	2	1	3	4
Brunswick	8	2	5	5	8	6	9	5	9	7	4
Florida 8	8	3	2	3	7	7	1	6	4	7	5
Florida 50	6	3	4	5	7	6	5	5	8	7	5
Kansas 1–51	8	3	6	5	6	6	5	5	5	9	5
Kansas 23–54	8	3	4	4	8	5	2	5	9	7	7
Kansas 24–54	7	4	3	5	8	6	1	5	3	9	4
Kansas B–1	6	4	7	4	8	5	1	5	1	7	5
Kansas C–7	6	5	6	4	7	1	1	5	2	7	4
Kansas E–1	4	5	6	4	6	3	3	1	2	6	1
Kansas E–5	5	5	6	4	5	2	7	2	1	4	3
Kansas F–7	6	4	6	3	8	1	5	6	1	7	5
Kansas G–11	8	3	2	3	7	3	1	9	5	7	9
Kansas H–8	7	4	8	4	7	4	1	5	5	7	5

Kansas J–5	8	2	6	4	9	4	1	4	3	9	4
Kansas K–9	7	3	5	4	7	4	3	5	2	8	7
Kansas M–6	5	3	4	9	6	3	9	3	1	3	6
Kansas N–5	6	4	4	3	5	5	1	5	2	4	5
Kansas O–8	4	3	6	3	7	6	7	4	2	5	1
Kansas P–16	7	4	6	6	7	5	3	5	1	9	2
Kansas Q–2	8	3	6	4	7	1	1	8	2	7	7
Kansas Q–17	5	3	5	3	7	5	4	7	1	6	5
Kansas R–8	5	5	6	7	6	2	9	9	1	6	9
Kansas S–16	7	4	6	5	8	4	3	4	2	7	3
Kansas T–4	6	6	6	5	5	1	3	6	1	5	7
Kansas T–8	7	4	6	5	7	5	5	7	4	7	4
Kansas T–11	7	3	5	5	7	6	1	5	8	8	4
Ohio	8	3	6	6	7	5	3	2	2	9	4
Texas 8	8	2	4	4	8	5	2	5	8	8	4
Texas 22	8	3	5	7	7	5	3	5	2	8	3

[1] Average of two replications for texture, density, rust, vigor, and general quality; average of three replications for rate of spread, seed heads, summer blight, and eriophyid mite; average of two or more ratings with three replications for color. Rating of 9=most rapid spread, most green, coarsest texture, most dense, most seed heads, most damage from diseases and insect, most vigorous, and poorest general quality.

California

TABLE 14.—*Average ratings of bermudagrasses, California Agricultural Experiment Station, South Coast Field Station, Santa Ana, 1960–62* [1]

Varieties, introductions, and selections	Rate of spread	Color		Texture	Seed heads	General quality	Remarks
		Summer	Winter				
Royal Cape	4.0	1.5	2.5	Fine	3.5	2.0	Puffy and scalps.
Tifgreen	3.5	3.5	1.5	do	2.5	4.0	Often shows red tips on leaf blades.
P.I. 224143	4.0	1.0	2.5	Very fine	4.0	2.5	Invaded by other bermudagrasses.
P.I. 224149	4.0	5.0	4.0	Coarse	3.5	3.5	Tends to be bumpy.
R.C. 55 [2]	4.0	4.5	3.5	Medium	2.0	4.0	Heavy thatch.
R.C. 102	4.0	4.0	3.5	do	3.0	3.5	
R.C. 134	3.5	4.0	3.5	Coarse	1.5	3.5	
R.C. 140	2.0	5.0	4.5	Medium	1.5	4.5	Stiff leaf blades, prostrate.
R.C. 141	4.0	3.5	3.0	do	2.5	3.0	
R.C. 145	4.5	4.5	4.5	Medium fine.	2.0	4.5	Vigorous.
I–54–68–19 [3]	4.0	4.0	3.0	Medium	3.0	3.0	Heavy thatch.
I–54–68–44 [3]	4.5	4.0	4.0	do	2.5	4.5	Soft leaves.
I–54–72–38 [4]	4.0	3.0	3.0	Coarse	3.0	3.0	

[1] Rating of 5=most rapid spread, most green, most seed heads, and best general quality.
[2] Strains designated R.C. are seedlings of P.I. 213387.
[3] Seedlings of P.I. 213385 × P.I. 213389.
[4] Seedlings of P.I. 213389 × P.I. 213385.

TABLE 15.—*Average ratings of bermudagrasses, California Agricultural Experiment Station, Los Angeles, 1957–60* [1]

Varieties and introductions	Rate of spread	Color		Texture	Seed heads	Wear resistance	General quality	Remarks
		Summer	Winter					
Ormond	4.5	5.0	5.0	Medium	1.5	4.0	4.5	Heavy thatch.
Texturf 1F	4.5	3.5	2.0	Medium fine.	3.0	2.0	3.5	
U–3	3.5	4.0	1.5	Medium	3.0	4.5	3.5	
Uganda	4.0	2.5	1.5	Very fine	4.0	1.0	2.5	Puffy, turns red in cool weather.
P.I. 210837	4.0	3.0	2.0	do	4.0	1.5	3.0	Similar to Uganda.
P.I. 213390 [2]	4.0	4.0	3.5	Fine	4.0	5.0	4.0	Periods of heavy seedhead production.

[1] Rating of 5=most rapid spread, most green, most seed heads, best wear resistance, and best general quality.
[2] Another source of Sunturf.

California—Continued

TABLE 16.—*Average ratings of bermudagrasses, Los Angeles State and County Arboretum, Arcadia, Calif., 1961–62* [1]

Varieties, introductions, and selections	Rate of spread	Color		Texture	Seed heads	General quality	Remarks
		Summer	Winter				
Royal Cape	3. 5	2. 5	3. 0	Fine	4. 0	3. 0	Puffy.
Tifgreen	4. 5	3. 0	1. 5	do	3. 5	3. 5	Red to tips of blade may be partly caused by smog.
Tifway	3. 0	4. 0	4. 0	do	3. 5	4. 0	Swirling growth, red tips on leaf blades.
P.I. 224143	3. 5	2. 0	1. 5	Very fine	4. 5	2. 0	Puffy.
P.I. 224149	2. 5	4. 0	3. 0	Coarse	3. 5	2. 5	Swirling growth.
R.C. 55 [2]	2. 5	4. 0	3. 5	Medium	4. 0	1. 5	Invaded by weeds.
R C. 134	2. 5	4. 0	3. 5	Coarse	3. 0	3. 5	
R.C. 140	2. 0	4. 5	4. 5	Medium	2. 0	4. 5	Slow to cover.
R.C. 141	4. 0	3. 5	3. 0	do	3. 0	3. 0	
R.C. 145	5. 0	4. 5	5. 0	Medium fine.	4. 0	5. 0	Rated best.
I–54–68–44 [3]	4. 0	4. 0	4. 0	Medium	3. 0	4. 0	

[1] Rating of 5=most rapid spread, most green, most seed heads, and best general quality.
[2] Strains designated R.C. are seedlings of P.I. 213387.
[3] Seedlings of P.I. 213385 × P.I. 213389.

TABLE 17.—*Average ratings of bermudagrasses, Bakersfield, Kern County, Calif., 1962* [1]

Varieties and selections	Color November	Seed heads	General quality	Recovery after renovation	Remarks
Ormond	5	1	5. 0	2	Consistently top quality.
Royal Cape		2	3. 5	7	
Sunturf	3	3	3. 5	3	
Tiffine	2	5	2. 0	5	Seed heads most of time.
Tifgreen	3	4	3. 5	1	
Tifway	4	2	4. 0	6	Tends to thatch and swirl.
R.C. 140 [2]	3	1	3. 0		Gray-green cast.
R.C. 145 [2]	5	1	5. 0		Top quality; needs further testing.
Common	3	4	3. 5	1	

[1] Rating of 5=most green, most seed heads, and best in general quality; rating of 7=slowest recovery.
[2] Strains designated R.C. are seedlings of P.I. 213387.

California—Continued

TABLE 18.—*Average ratings of bermudagrasses, El Centro, Imperial County, Calif., 1961*[1]

Varieties, introduction, and selections	Ground cover	Color		Density		Remarks
	July–November	November	January	November	March	
Ormond	5	5	2	3	4	
Royal Cape	4	4	3	5	5	
Sunturf	5	4	1	3	4	
Tiffine	4	3	1	3	3	
Tifgreen	5	4	1	4	5	Lighter green than Sunturf or Ormond.
P.I. 224143	3	4	4	4	5	
R.C. 102 [2]	3	3	3	3	4	
R.C. 134	4	3	2	3	2	
R.C. 140	3	3	5	2	2	Very few seed heads.
R.C. 295		4	2	1	1	
I–54–68–44 [3]	5	4	2	3	3	
I–54–72–19 [4]	1	4	2	3	4	

[1] Rating of 5=fullest ground cover, most green, and most dense.
[2] Strains designated R.C. are seedlings of P.I. 213387.
[3] Seedlings of P.I. 213385 × P.I. 213389.
[4] Seedlings of P.I. 213389 × P.I. 213385.

Georgia

TABLE 19.—*Average ratings of bermudagrasses, Georgia Coastal Plain Experiment Station, Tifton, 1957–59*[1]

Varieties, introductions, and selections	Ground cover		Total greenness for season (1959)	Total density (sod) for season (1959)	Seed heads (Sept. 22, 1958)	Leafhopper resistance (May 28, 1957)
	Size of spread (diameter) (Apr. 12, 1957)	Amount of plot covered (May 28, 1957)				
	Inches	*Percent*				
Bayshore	38. 0	82. 5	38	33	6	2
Everglades 1	21. 0	75. 0	48	49	7	2
Ormond	22. 5	82. 5	27	29	2	2
Sunturf	19. 0	62. 5	26	31	9	3
Texturf 1F	35. 5	86. 5	34	37	4	3
U–3	20. 5	62. 5	39	56	7	2
Uganda	16. 5	60. 0	54	52	2	6
P.I. 213382	30. 5	82. 5	52	54	2	2
P.I. 213383	14. 5	40. 0	50	59	2	6
P.I. 213385	25. 0	92. 5	35	40	5	2
P.I. 213386	22. 0	85. 0	57	58	2	5
P.I. 213387	23. 0	67. 5	48	48	10	2
P.I. 213389	17. 0	67. 5	26	27	2	2
P.I. 213391	15. 5	60. 0	51	56	2	5
P.I. 224139	14. 0	50. 0	53	58	2	5
P.I. 224140	21. 5	72. 5	53	59	2	4
P.I. 224141	13. 0	65. 0	57	64	2	6
P.I. 224143	31. 5	87. 5	38	41	4	2
P.I. 224145	16. 5	67. 5	52	58	2	4
P.I. 224146	16. 0	52. 5	52	57	2	4
P.I. 224147	14. 5	42. 5	41	41	2	6
P.I. 224148	22. 5	75. 0	41	44	2	2
P.I. 224149	12. 5	45. 0	38	42	10	2
P.I. 224151	19. 5	67. 5	51	60	2	4
P.I. 224694	26. 5	77. 5	41	48	7	2
P.I. 225084	23. 5	70. 0	44	53	5	4
P.I. 225595	23. 5	82. 5	43	37	10	2
P.I. 225809	17. 5	67. 5	53	55	3	6
Arizona 3	14. 5	60. 0	55	59	2	4
Florida FB–81	34. 0	90. 0	44	49	2	2
Kansas 2–51	17. 0	65. 0	61	66	2	5
Pinehurst	20. 0	80. 0	50	56	2	2
Common	28. 0	82. 5	53	61	5	2
57 – seedling from Tifton 57	20. 0	77. 5	37	35	5	2
127 – Tifton 57 X *C. transvaalensis*	26. 0	70. 0	29	36	8	2
328 – Charlottee C.C. X *C. transvaalensis*	18. 0	75. 0	22	25	2	2
411 – No. 2 seeded (S. Africa)	23. 0	55. 0	44	45	6	2
412 – *C. transvaalensis*	18. 0	40. 0	49	53	2	5
419 – seedling from 411	34. 0	70. 0	19	23	2	2

[1] The smaller the rating, the better the color, the more density, the fewer seed heads, and the greater leafhopper resistance.

Georgia—Continued

TABLE 20.—*Response of Tifway bermudagrass in comparison with three checks, Georgia Coastal Plain Experiment Station, Tifton, 1957* [1]

Varieties	Plant diameter (Apr. 12)	Amount of plot covered (May 28)	Average greenness for season	Average density (sod) for season	Leafhopper resistance (May 28)	Height uncut	
						May 28	June 26
	Inches	*Percent*	*Rating*	*Rating*	*Rating*	*Inches*	*Inches*
Tifway	34. 0	70. 0	2. 4	2. 3	2	3. 0	7. 0
Tifgreen	18. 0	75. 0	3. 4	2. 3	2	1. 0	3. 8
Tiflawn	20. 0	77. 5	4. 5	4. 2	2	5. 0	6. 8
Common	28. 0	82. 5	4. 2	6. 5	2	5. 0	9. 0
L.S.D. at 5-percent level	2. 0	9. 6	1. 1	1. 1	N.S.	. 6	. 9

[1] Rating of 1=darkest green, most dense, and most leafhopper resistance.

TABLE 21.—*Response of Tifway bermudagrass in comparison with three checks, Georgia Coastal Plain Experiment Station, Tifton, 1958 and 1959* [1]

Varieties	Average greenness for season (1958)	Average density (sod) for season (1958)	Average seed heads for two dates (1958)	Greenness of turf (Mar. 28, 1959)	Density of ryegrass overseeded on plots (Mar. 21, 1959)	Recovery from ryegrass (Apr. 22, 1959)
Tifway	2. 2	2. 5	2. 0	4. 0	6. 0	3. 0
Tifgreen	2. 8	2. 0	2. 0	4. 0	5. 0	2. 0
Tiflawn	4. 3	3. 0	4. 5	7. 0	7. 0	5. 0
Common	7. 3	9. 0	5. 0	7. 0	6. 0	10. 0

[1] Rating of 1=darkest green, most dense, fewest seed heads, and most rapid recovery.

TABLE 22.—*Response of Tifway bermudagrass in comparison with three checks, Georgia Coastal Plain Experiment Station, Tifton, 1959* [1]

Varieties	Greenness	Average greenness for season	Average density (sod) for season	Softness of turf	Resistance to spurge invasion (Aug. 8, 1959)	Frost resistance
Tifway	Very dark	1. 7	2. 0	3	1. 0	1
Tifgreen	Dark	1. 9	2. 3	1	2. 0	3
Tiflawn	do	2. 7	2. 6	4	1. 0	2
Common	Medium	3. 8	4. 0	4	4. 0	2

[1] Rating of 1=darkest green, most dense, most soft, and greatest resistance to spurge and frost.

Iowa

TABLE 23.—*Response of bermudagrasses in fall and spring, Iowa Agricultural Experiment Station, Ames, 1961–62*

Varieties and selections	Dormant (mid-October)	Recovery (early May)	Recovery (early June)
	Percent	*Percent*	*Percent*
Everglades 1	80	20	75
Royal Cape	80	60	95
Sunturf	30	20	95
Tifgreen	80	5	60
Tifway	20	5	5
U–3	20	0	2
Uganda	90	50	95
Burning Tree	60	80	99
Kansas B–1	70	5	15
Kansas C–7	80	5	40
Kansas E–1	30	50	95
Kansas E–5	70	80	98
Kansas F–4	10	80	99
Kansas F–7	90	5	25
Kansas G–11	80	20	90
Kansas H–8	40	70	99
Kansas J–5	40	30	95
Kansas K–9	50	80	98
Kansas O–8	60	40	95
Kansas P–16	50	80	98
Kansas Q–2	20	85	99
Kansas Q–17	80	20	60
Kansas R–8	20	85	99
Kansas S–16	40	85	99

Mississippi

TABLE 24.—*Average seed-head ratings of bermudagrasses, Mississippi Agricultural Experiment Station, State College, 1960* [1]

Varieties, introductions, and selections	Rating	Varieties, introductions, and selections	Rating
Bayshore	2. 0	P.I. 224140	1. 4
Everglades 1	2. 4	P.I. 224141	1. 4
Ormond	4. 0	P.I. 224143	2. 0
Sunturf	2. 7	P.I. 224145	1. 6
Texturf 1F	2. 9	P.I. 224146	2. 6
Texturf 10	3. 0	P.I. 224147	2. 0
Tiffine	1. 7	P.I. 224151	1. 4
Tifgreen	1. 7	P.I. 224694	1. 2
Tiflawn	2. 2	P.I. 225809	1. 0
U–3	1. 8	*C. bradleyi*	3. 6
U–3 (from seed)	1. 5	Florida 8	1. 0
Uganda	1. 2	Florida 50	3. 4
P.I. 210979	1. 2	Kansas 1–51	2. 0
P.I. 213383	1. 2	Kansas 2–51	2. 4
P.I. 213386	1. 4	Kansas 23–54	2. 2
P.I. 213388	1. 0	Kansas 24–54	1. 5
P.I. 213390	1. 4	Texas 8	2. 8
P.I. 213391	1. 1	Texas 11	2. 2
P.I. 213457	3. 0	Texas 22	2. 6
P.I. 218006	1. 5	Common	1. 5
P.I. 224139	1. 2		

[1] Rating of 4=none.

New Mexico

TABLE 25.—*Average ratings of bermudagrasses selected for possible increase, Middle Rio Grande Substation, Los Lunas, N. Mex., 1958–61* [1]

Varieties and selections	Rate of spread	Color	Texture	Density	Seed heads	Winter hardiness
Sunturf	7	8	5	8	1. 6	9
Tifway	7	8	4	7	2. 0	8
African (check)	6	5	3	8	3. 1	8
New Mexico 1	7	6	6	7	5. 9	8
Texas 47	8	7	8	6	1. 0	8
Texas 94	9	8	5	7	1. 1	8

[1] Rating of 10=most rapid spread, darkest green, coarsest texture, most dense, most seed heads, and most winter hardy.

New Mexico—Continued

TABLE 26.—*Average ratings of bermudagrasses maintained at 1-inch cutting height, Middle Rio Grande Substation, Los Lunas, N. Mex., 1958–61* [1]

Varieties, introductions, and selections	Color	Texture	Density	Seed heads
Ormond	8	7	8	1. 7
Sunturf	8	5	8	1. 6
Texturf 1F	2	7	2	4. 7
Tiffine	2	4	3	3. 0
Tifgreen	2	1	3	2. 5
Tiflawn	8	8	3	6. 1
Tifway	8	4	7	2. 0
P.I. 213383	8	3	8	3. 7
P.I. 213388	8	2	5	3. 2
P.I. 213457	6	7	7	7. 4
P.I. 218006	8	2	8	4. 0
P.I. 218879	5	3	4	3. 5
P.I. 224139	5	2	8	3. 2
P.I. 224140	8	5	9	4. 5
P.I. 224141	2	5	8	2. 4
P.I. 224143	5	4	3	3. 1
P.I. 224145	2	2	8	3. 3
P.I. 224146	2	1	8	2. 1
P.I. 224147	5	4	4	4. 6
P.I. 224149	6	7	3	5. 5
P.I. 224151	8	2	8	4. 7
P.I. 224691	3	9	4	6. 4
P.I. 225595	2	8	8	3. 6
P.I. 225809	8	2	6	3. 2
African	6	3	8	3. 1
Barberspan	8	8	4	2. 8
Florida 8	2	6	5	6. 0
Florida 50	5	7	7	4. 4
Kansas 1–51	3	9	3	6. 1
Kansas 2–51	2	2	9	4. 5
Kansas 23–54	8	5	3	5. 8
Kansas 24–54	2	8	9	6. 6
Murray	2	3	8	4. 0
New Mexico 1	8	7	5	5. 9
New Mexico 2	8	8	3	5. 7
Texas 8	5	7	6	5. 1
Texas 22	8	8	3	5. 1
Texas 47	8	9	7	1. 0
Texas 94	8	3	6	1. 1
Tifton 322	2	7	2	3. 8
Tifton 401	8	2	3	3. 3
Tifton 414	2	7	8	1. 7
Tifton 415	8	3	2	6. 3
Tifton 416	8	4	6	1. 6
Tifton 417	2	3	2	4. 7
Tifton 421	6	3	8	4. 1

[1] 20 pounds of nitrogen applied per 1,000 square feet. Rating of 10=darkest green, finest texture, most dense, and most seed heads.

Texas

TABLE 27.—*Average ratings of bermudagrasses maintained at 1-inch cutting height, Texas Agricultural Experiment Station, College Station, 1961 and 1962* [1]

Introductions and selections	Ground cover (1961)	Spring recovery (1962)	Density (1962)	Thatch (1962)
	Percent			
P.I. 206427	55	1	5.0	3.5
P.I. 220558	33	1	4.0	3.5
P.I. 224141	35	2	3.0	5.0
P.I. 224145	47	3	4.0	4.4
P.I. 224146	35	2	3.7	4.2
P.I. 224151	15	2	4.0	3.5
P.I. 225809	73	2	3.5	5.0
P.I. 235440	33	2	5.0	4.0
P.I. 251109	30	1	4.0	3.5
P.I. 251809	15	1	4.5	3.0
P.I. 255440	20	3	4.0	2.5
Kansas C–7	35	4	3.0	4.5
Kansas E–1	15	3	3.0	2.0
Kansas F–7	15	3	4.0	4.0
Kansas G–11	55	5	3.0	5.0
Kansas H–8	25	3	3.0	4.0
Kansas J–5	20	3	3.5	5.0
Kansas K–9	20	2	4.0	3.0
Kansas O–8	35	2	4.0	3.0
Kansas P–16	20	4	4.0	3.0
Kansas Q–2	55	5	5.0	3.5
Kansas Q–17	65	3	5.0	3.5
Kansas R–8	20	5	4.5	2.5
Kansas S–16	35	5	4.0	5.0
Kansas T–155	15	1	2.0	2.5

[1] Notes taken 6 weeks after sprigging. Rating of 5=best spring recovery, most dense, and most thatch.

TABLE 28.—*Average ratings of bermudagrasses maintained at 1-inch cutting height, Texas Agricultural Experiment Station, College Station, 1961 and 1962* [1]

Variety, introductions, and selections	Ground cover (1961)	Texture (1961)	Density		Seed heads (1962)	Frost resistance (1961)	Thatch (1962)
			1961	1962			
	Percent						
Texturf 10	85	3	3.5	4.8	3.3	4.0	4.0
P.I. 220558	55	5	2.0	4.4	3.2	4.2	4.2
P.I. 251109	66	3	3.5	3.6	4.4	5.0	3.1
Kansas J–5	48	1	5.0	4.8	1.0	4.5	4.9
Kansas P–16	86	3	4.0	4.0	1.8	2.5	4.4
Kansas Q–2	58	3	3.0	5.0	1.0	1.0	5.0
Kansas S–16	58	3	5.0	4.5	1.8	4.0	5.0

[1] Rating of 5=coarsest texture, most dense, most seed heads, most frost resistance, and most thatch.

Texas—Continued

TABLE 29.—*Average ratings of bermudagrasses maintained at ⅜-inch cutting height, Texas Agricultural Experiment Station, College Station, 1961 and 1962* [1]

Variety, introductions, and selection	Color (1962)	Density (1962)	Seed heads (1961)	Frost resistance (1961)	Aggressiveness (1962)
Tifgreen	3. 8	5. 0	2. 8	2. 5	4. 0
P.I. 213388	5. 0	5. 0	4. 5	4. 0	4. 5
P.I. 213390	4. 6	4. 6	3. 8	3. 5	3. 8
P.I. 224141	2. 0	1. 8	1. 2	4. 0	1. 0
P.I. 224146	2. 8	3. 1	1. 8	4. 5	2. 8
P.I. 225809	2. 6	3. 9	1. 0	4. 0	3. 0
Kansas G–11	3. 6	2. 8	1. 0	4. 8	3. 0

[1] Rating of 5=darkest green, most dense, most seed heads, most frost resistance, and most aggressiveness.

Virginia

TABLE 30.—*Average ratings of bermudagrasses, Norfolk, Va., 1959 and 1960* [1]

Varieties and selections	Ground cover		Color		Texture		Seed heads		Disease	
	1959	1960	1959	1960	1959	1960	1959	1960	1959	1960
Ormond	9. 5	10. 0	5. 0	5. 0	3. 0	3. 0	1. 0	2. 0	1. 0	1. 0
Sunturf	8. 0	10. 0	4. 0	4. 0	2. 0	2. 0	1. 0	1. 0	1. 0	1. 0
Tifgreen	9. 5	10. 0	5. 0	5. 0	1. 0	1. 0	1. 0	1. 0	1. 0	1. 0
U–3	9. 0	9. 0	5. 0	5. 0	2. 0	2. 0	1. 0	1. 0	1. 0	1. 0
Uganda	10. 0	10. 0	5. 0	5. 0	1. 0	1. 0	1. 0	1. 0	1. 0	1. 0
Florida 8	9. 0	10. 0	4. 0	4. 0	2. 0	2. 0	1. 0	1. 0	1. 0	1. 0
Texas 8	9. 0	10. 0	5. 0	5. 0	2. 0	2. 0	1. 0	1. 0	1. 0	1. 0
Texas 22	9. 5	10. 0	3. 0	3. 0	3. 0	3. 0	1. 0	1. 0	1. 0	1. 0
Native	2. 0	9. 0	4. 0	4. 0	3. 0	3. 0	1. 0	2. 0	1. 0	1. 0

[1] 13 pounds of nitrogen applied per 1,000 square feet annually. Rating of 10=best ground cover; rating of 5=darkest green, coarsest texture, most seed heads, and most disease.

Virginia—Continued

TABLE 31.—*Average ratings of bermudagrasses, Warsaw, Va., 1956–61* [1]

Varieties, introductions, and selections	Established ground cover (July 3, 1957)	Ground cover (Apr. 22, 1959)	Color (Oct. 28, 1959)	Established seed heads (June 15, 1959)	Recovery	
					Apr. 20, 1960	April 1961
Series A						
	Percent			*Percent*		
Ormond	76	8.0	1.0	0	4.0	8.0
Sunturf	65	5.0	5.0	99	2.2	4.0
Tiffine	75	7.0	2.0	98	2.2	6.0
Tifgreen	96	2.0	6.0	96	1.0	6.2
U–3	71	4.0	3.0	98	3.3	2.8
Uganda	76	3.0	8.0	100	2.2	1.5
Florida 8	92	6.0	4.0	100	3.3	4.0
Texas 22	95	1.0	7.0	91	1.0	1.0
Series B						
Gene Tift	94	4.0	4.0	99	------	7.0
Texturf 1F	92	2.0	3.0	91	------	1.7
Tifgreen	96	7.0	6.0	99	------	7.0
P.I. 213386	84	5.0	1.0	86	------	1.7
P.I. 218006	89	3.0	4.0	100	------	2.0
Florida 50	99	5.0	7.0	100	------	5.0
Texas 8	95	1.0	5.0	90	------	3.5

[1] Rating of 10=best ground cover, darkest green, and best recovery.

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