

RECOMMENDATION FOR THE RELEASE OF SPIRIT GERMPLASM SWEETGRASS SELECTED CLASS

Introduction

Scientific Name: *Hierochloe odorata* (L.) Beauv.

Common Name: sweetgrass, holy grass, vanilla grass, buffalo grass, Seneca grass

Germplasm Name: Spirit

Other Identification Used: 9063351, 9025784

Origin: The vegetative propagules of Spirit Germplasm sweetgrass were originally collected from a single population located on the Irwin Brown Ranch in Toole County, Montana. The site latitude is N49°28', longitude W114°10', T37N R3E, Section 24. The physical characteristics of the site are a silty clay loam soil texture, a 5% slope on a west aspect, an elevation of 1,128 to 1,137 m (3,700 to 3,730 ft), and annual precipitation at 711-762 mm (28-30 in). It was collected in 1991 by Lynnel A. Hoffman, Soil Conservationist with the USDA, Soil Conservation Service (Natural Resources Conservation Service) at Shelby, Montana.

Description: *Hierochloe odorata* (L.) Beauv., sweetgrass, is a strongly rhizomatous, fragrant, native, cool-season, perennial grass. It grows in moist places such as wet meadows, sloughs, bogs, and along rivers, streams, and lakes (7). Sweetgrass is circumboreal and in North America it is geographically distributed from Alaska to Labrador, south to New Jersey, west across the Great Lakes region, and in the mountains of the western states south to Arizona, New Mexico, and northern California (14). The common name, holygrass, is derived from the Greek meaning of the genus name *Hierochloe*, which is *hieros* or sacred, and *chloe*, or grass (13). Sweetgrass leaves were used in Europe for "strewing before the doors of churches on festival days."

There are approximately 30 species and subspecies of *Hierochloe* in the temperate and cold regions of the world. The basic chromosome number is $x=7$ and ploidy varies from 2 to 11, with $2n$ ranging from 28 to 78 (34). Plant populations of the *Hierochloe odorata* complex in North America and Canada that appear morphologically uniform and have sterile pollen are most likely apomictic in their breeding system and are tetraploids, $2n=28$, or hexaploids, $2n=42$ (23). Apomictic grasses tend to have incomplete male meiosis that leads to unreliable flowering and seed set (36). Ohio and Michigan have evolved a separate race of octaploids, $2n=56$, that also has a 25% occurrence of polyembryony, or embryo twinning (23).

Sweetgrass plants are semi-erect, with hollow culms 25 to 60 cm (10 to 24 in) tall. The leaf sheaths are open, with ligules 3 to 5 mm (.12 to .2 in) long and membranous (24). The smooth, flat, blades are mostly 2 to 5 mm (.08 to .2 in) wide, oftentimes reddish at the base, glaucous above, and scabrous below (10). The herbage is fragrant and vanilla-scented due to the presence of coumarin (20). The inflorescence is a pyramidal, compacted to loose, 2- to 12-cm (.8- to 4.7-in) long panicle with bisexual florets (1). Small spikelets are 3 to 5 mm (.12 to .2 in) long, broad, shiny bronze to brownish in color and three-flowered, with only one floret perfect and seed-bearing (19). Glumes are more or less equal in length, boat-shaped, thin and papery, and acute. Sterile floret lemmas are awnless or nearly so, indurate and hairy, and nearly the same length as the glumes. The sterile floret palea is hyaline, two-nerved, and rounded on the back (9). The fertile floret lemma is somewhat hardened and hairy at the apex, and the fertile floret palea is three-nerved (5). The fruit is a very small, dark brown, caryopsis (25).

Method of Development: Spirit Germplasm was selected from among five collections of sweetgrass seed and vegetative propagules in Montana, and has been compared to vegetative populations in Colorado,

Kansas, Michigan, North Dakota, and South Dakota. Direct increase of G₀ vegetative propagules constitutes the germplasm.

Uses: Spirit Germplasm was selected for sweet vanilla fragrance and primarily for use as a culturally significant plant in Native American spiritual and religious ceremonies. Other ethnobotanical uses include as a body rinse, cold relief, perfume, tea, and to treat women's ailments (12). The dense, below-ground biomass may act as a soil stabilizer in the restoration of riparian and wetland ecosystems (32).

Area of Adaptation: Sweetgrass is widely distributed in the temperate and arctic regions of Eurasia and North America. It is considered a facultative wetland species in the lower 48 States, a facultative upland species in Alaska, and is listed as an endangered species in Maryland, North Carolina, and Pennsylvania (29). Sweetgrass is a very early flowering, mid-seral species that grows in mixed plant communities of wet meadows and in the transition zones of low, moist communities along streams and rivers (33). It survives under a fairly wide range of environmental conditions and prefers medium to coarse-textured soils, a pH range of 4.3 to 7.9, 20 to 30% soil moisture content, a 14 to 28 cm (6 to 11 in) depth to water table, mostly full light, and limited competition from other species (8). In Montana, it has been found at elevations as low as 1,100 m (3,600 ft) and reported at 3,500 m (11,500 ft) in Colorado and Utah (33).

Insect or Disease Problems: Thrips are known to frequent sweetgrass plants and seedheads, but do not impose a serious threat at any time. Powdery mildew may become temporarily present at times of elevated humidity, but usually does not have a long-term negative impact on the plants. There may be periodic occurrence of *Puccinea* rust, and Tilletiaceae and Ustilaginaceae smuts (34).

Increase and Distribution: G₀ vegetative propagules are available through the Foundation Seed Program at Montana State University-Bozeman or the University of Wyoming, and the USDA-Natural Resources Conservation Service (NRCS) Plant Materials Center (PMC) in Bridger, Montana. Vegetative stock will be available in 2004.

Performance of Spirit Germplasm Sweetgrass

Testing: Spirit Germplasm was tested as 9063351.

Initial Establishment. Plants were received in 1991 as plugs of native sod. They were transplanted several times into pots and the PMC greenhouse propagation bed to rogue out other contaminants such as bluegrass (*Poa* species), fescues (*Festuca* species), and sedges (*Carex* species). When purity was achieved, vegetative increase proceeded in the greenhouse and hoop house until out-planting in July 1994. The increase block was maintained until 2000, at which time tillers of the original plants were harvested and potted for relocation and transplanting in 2001. Material that had been received prior to 1995 from other Montana locations was determined to be less vigorous and faintly scented as compared to 9063351. These were eliminated from further examination.

Initial Evaluation Planting (IEP). Spirit Germplasm was included in an IEP established at the Bridger PMC in 2002 and will be evaluated for 3 to 4 years. A total of six accessions from regional sources were spaced-planted in a small, irrigated trial. The South Dakota State University cultivar, 'Radora' (4), was included as a standard of comparison. In 2002, individual plants were evaluated for establishment survival, vigor, establishment, spread rate, tiller number, leaf length, and overall performance (table 1). Spirit Germplasm rated the highest in all factors, with the exception of survival, in which all entries were the same. Radora rated lowest in four out of the seven factors. Preliminary results from the Plant Materials Centers in Colorado, Michigan, and North Dakota were variable, with the performance of Spirit Germplasm comparable to the other five entries. Kansas reported low overall survival due to drought conditions (30).

Table 1. Initial Evaluation Planting. The 2002 performance of six regional sources of sweetgrass *Hierochloa odorata*

in Field 3 at the Bridger PMC; planted June 18 and 28, 2002.

Accession	Survival %	Vigor [†]	Establishment [†]	Spread Rate [†]	Tillers No./0.08m ²	Leaf Length in	Overall [†]
Montana-9063351	100	1	1	1	25	16	1
Michigan-9070225	100	3	1	3	12	14	2
Colorado-9070988	100	3	1	5	11	12	3
Kansas-9050243	100	5	3	5	10	9	4
ND-9063128	100	5	3	5	9	10	5
SD-Radora	100	7	5	7	11	10	6
Average	100	4	2.3	4.3	13	11.8	3.5

[†] Ratings: 1-excellent, 3-good, 5-fair, 7-poor.

Table 2. Initial Evaluation Planting. The 2003 performance of six regional sources of sweetgrass *Hierochloe odorata* in Field 3 at the Bridger Plant Materials Center; planted June 18 and 28, 2002.

Accession	Survival %	Vigor [†]	Spread Rate [†]	Tillers no./0.86 ft ²	Seed Culm no./0.86 ft ²	Seed Culm Ht. in	Flowering [‡]	Overall
MT-9063351	100	1	1	40	11	18	begin flower	1
MI-9070225	100	2	3	21	7	17	no flower	2
KS-90501243	100	3	2	24	5	16	begin flower	3
CO-9070988	100	4	4	39	4	11	begin flower	4
ND-9063128	100	5	5	33	4	16	1/2 flower	5
SD-Radora	100	6	6	17	7	14	no flower	6

[†] Ratings 1-6 with 1 best.

[‡] Evaluated 5/12/03.

In 2003, each entry had spread considerably in their respective blocks and were evaluated for the above-mentioned factors, and for number and height of seed culms, flowering date, leaf width, above-ground biomass production, and leaf regrowth length (tables 2 and 3). Again, Spirit Germplasm rated higher than the other entries in nine of the 13 factors. Percentage survival was the same for all of the entries, and the Michigan source (9070225) scored slightly higher in leaf length and width, and regrowth in inches.

Table 3. Initial Evaluation Planting. The 2003 vegetative performance of six regional sources of sweetgrass *Hierochloe odorata* in Field 3 at the Bridger Plant Materials Center; planted June 18 and 28, 2002.

Accession	Leaf Length <i>in</i>	Leaf Width <i>in</i>	Biomass <i>oz./0.86 ft²</i>	Biomass <i>lb/ac</i>	Regrowth [†] <i>in</i>	Regrowth [‡] <i>in</i>
MT-9063351	24.5	0.22	1.27	4,014	6.4	7.0
MI-9070225	24.8	0.36	0.78	2,453	6.1	12.4
KS-90501243	22.3	0.37	0.49	1,561	4.4	8.1
CO-9070988	14.5	0.31	0.88	2,787	4.3	5.3
ND-9063128	20.5	0.38	0.74	2,341	6.4	7.1
SD-Radora	21.5	0.34	0.60	1,895	4.6	8.8

[†] Post-harvest 7 days.

[‡] Post-harvest 17 days.

On September 17, 2003, the NRCS Rose Lake Plant Materials Center in East Lansing, Michigan, conducted an evaluation of seven regional sources of sweetgrass (31). The accessions from Montana and Michigan were the most vigorous, as demonstrated by survival, spread, and leaf height (table 4). The cultivar, Radora, and the accession from Minnesota were the least vigorous under the conditions of the trial.

Table 4. Initial Evaluation Planting. The 2003 vegetative performance of seven regional sources of sweetgrass *Hierochloe odorata* at the Rose Lake Plant Materials Center. Planted September 10, 2002.

Accession	Leaf Length <i>in</i>	Tillers <i>no./30 ft²</i>	Rate of Spread [†]	Overall [†]	Replanting 9/18/03 <i>no./30 ft²</i>
MT-9063351	15	>50	1	1	0
MI-9070225	18	>50	1	1	0
ND-9063128	11	19	3	3	2
MN-9084205	5	2	7	7	6
CO-9070988	9	5	7	5	5
KS-90501243	11	6	7	5	4
SD-Radora	12	8	8	7	5

[†] Ratings: 1-excellent, 3-good, 5-fair, 7-poor, 9-none.

Off-Center Plantings. Potted or rhizome material of Spirit Germplasm has been distributed over the past 8 years to 10 states in the United States and to the Province of Saskatchewan in Canada. These numbers exceed 1,000 and averaged 130 per year. Tribal and non-tribal sources report that, when planted in the proper environment, Spirit Germplasm survival is high and overall performance is good (3, 6, 15, 16, 18, 21, and 35).

Vegetative Increase. In 2001, a 0.03-acre vegetative increase block was established in Field 4 at the Bridger PMC.

Environmental Considerations: Sweetgrass is a culturally significant plant that is primarily utilized by Native Americans for protective properties and spiritual purification (2). The long leaves are harvested, woven into braids, dried, and burned as a smudge so that evil will not come about. The plant possesses many important healing qualities for use as ceremonial incense, therapeutic tonic, perfume, personal adornment, and decoration (27). Wildlife, such as rodents and small mammals reportedly browse on

sweetgrass (28). Domestic livestock seem to avoid grazing the grass due to the disagreeable flavoring of coumarin (22).

Sweetgrass is listed as an endangered species in three states in the eastern region of the United States and has restricted distribution in areas of the western the United States. The natural limitations of its range, increased wetland disturbance from human activities, increased use by non-Indians, and a decline in traditional Indian knowledge has resulted in the need to develop a conservation strategy for the management of sweetgrass (37).

Wetlands are comprised of highly diverse plant communities and are especially dynamic in structure and function (11). The successful revegetation of wetlands is partially dependent on the availability and performance of adapted plant material (26). Sweetgrass has the ability to spread quickly and stabilize a disturbance in a wet meadow or subirrigated environment (17).

The release of this native grass, Spirit Germplasm, is justified due to a demonstrated superior performance over the commercial cultivar, Radora. There is a shortage of culturally significant plant material for use by American Indians to bolster and rejuvenate their cultural heritage. The majority of available material is of questionable identity and from sources outside the United States.

Submitted by: This recommendation for the release of Spirit Germplasm sweetgrass was prepared and submitted by Susan R. Winslow and Mark E. Majerus, USDA-NRCS for joint release by the USDA-NRCS and the Montana and Wyoming Agricultural Experiment Stations, December 2003.

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