REGISTRATIONS OF CULTIVARS

Registration of 'Tamcot Pyramid' Cotton

'Tamcot Pyramid' cotton (*Gossypium hirsutum* L.) (Reg. no. CV–120, PI 617042) was developed by the Texas Multi-Adversity Resistance (MAR) Genetic Improvement Program, Department of Soil and Crop Sciences, Texas Agricultural Experiment Station (TAES) and released in 2000. The TAES-MAR cotton genetic improvement program utilizes techniques and selection procedures for the simultaneous genetic improvement of resistance to abiotic and biotic stresses in addition to yield, earliness, fiber, and seed quality (Bird, 1982; El-Zik and Thaxton, 1989).

Tamcot Pyramid combines high yield potential, earliness, and excellent fiber properties with wide adaptation over the diverse growing and environmental conditions in Texas. Tamcot Pyramid was derived by crossing 'Tamcot Sphinx' (El-Zik and Thaxton, 1996) and CD3HGCBU8S-1-91, an unreleased MAR strain. CD3HGCBU8S-1-91 was the result of cross between CD3HCAHUGH-2-88 (El-Zik and Thaxton, 1998) and CABUCAG8US-1-88, an unreleased MAR strain. On the basis of visual selection for yield potential, bolls from individual plants were bulked within an F_2 row for advance to the F_3 generation. By means of the MAR procedures (Bird, 1982; El-Zik and Thaxton, 1989), a single F_3 plant was selected on the basis of boll set in the greenhouse for subsequent field evaluation. The resulting $F_{3:4}$ progeny row was selected in the field on the basis of apparent yield potential, overall plant conformation, and fiber quality in comparison with commercial checks in 1995, was hand harvested and given the strain designation MAR-SPNXCDUG8H-1-95.

Tamcot Pyramid is early maturing, has pubescent stems and leaves, is glanded, possesses normal leaves and bracts, is nectaried, and has dark green leaves. It has a cylindrical shaped growth habit, flowers with cream-colored pollen, and storm resistant bolls. On the basis of measurements from yield trials conducted at College Station and Chillicothe, TX, in 1999, plants of Tamcot Pyramid are of medium height, averaging 4 cm taller than Tamcot Sphinx and 2.5 cm shorter than 'Paymaster 330' (Calhoun et al., 1997).

Tamcot Pyramid is highly resistant to bacterial blight [caused by *Xanthomonas campestris* pv. *malvacearum* (Smith) Dye]. Tamcot Pyramid has similar levels of resistance to aphids (*Aphis gossypii* Glover), thrips (*Thrips* and *Frankliniella* spp.), fleahopper [*Pseudatomoscelis seriatus* (Reuter)], boll weevil (*Anthonomus grandis* Boheman), tobacco budworm [*Heliothis virescens* (F.)], bollworm [*Helicoverpa zea* (Boddie)], and sweetpotato whitefly (*Bemesia argentifolii* Bellows & Perring), plus pathogens causing seed-seedling diseases (*Pythium ultimum* Trow and *Rhizoctonia solani* Kühn), Verticillium wilt (*Verticillium dahliae* Kleb.), Fusarium wilt-root-knot nematode complex [*F. oxysporum* sp. *vasinfectum* and *Meloidogyne incognita* (Kofoid & White) Chitwood], Phymatotrichum root rot (*Phymatotrichum omnivorum* Duggar), and leaf spots (*Alternaria*, *Aschochyta*, and *Phomopsis* spp. and other genera) affecting cotton as Tamcot Sphinx.

In irrigated trials conducted at College Station for 2 yr, Tamcot Pyramid reached 55% open bolls 136 d from planting, while Tamcot Sphinx required 142 d and Paymaster 330 required 149 d. Averaged across 17 yield trials in Texas from 1997 to 1999, Tamcot Pyramid averaged 10% higher lint yield and 11% larger bolls than Tamcot Sphinx and Paymaster 330. Lint fraction was similar to Tamcot Sphinx and Paymaster 330. On the basis of 17 yield trails in Texas during 1997 through 1999, upper half mean (UHM) length, fiber bundle strength, and uniformity index of Tamcot Pyramid were similar to those of Paymaster 330. The UHM length of Tamcot Pyramid was 3% shorter and strength was 7% lower than Tamcot Sphinx. Micronaire reading of Tamcot Pyramid averaged 4.1 compared with 4.4 for Tamcot Sphinx and Paymaster 330.

The Foundation Seed Service of the Texas Agricultural Experiment Station produces, maintains and sells Foundation seed to producers of Registered and Certified classes. Tamcot Pyramid has U.S. Plant Variety Protection (PVP 200100114) requiring that it be sold by variety name only as a class of Certified seed.

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Registration of 'Tyto' Barley

'Tyto' barley (*Hordeum vulgare* L.) (Reg. no. CV-310, PI 632403) was released in 2002. Tyto was developed at the Field Crop Development Centre (FCDC) of Alberta Agriculture, Food and Rural Development (AAFRD), and was granted full registration (Reg. no. 5496) in 2002 by the Canadian Food Inspection Agency, Ottawa, ON, Canada. The name Tyto is adopted from the genus of birds commonly known as barn owls. Tyto is a hulless, six-rowed, smooth-awned, semi-dwarf, spring-habit, feed barley.

Tyto was derived from the cross of 'Falcon'/'Samson' that was made in 1989. Falcon (PI 59612) (Helm et al., 1996) was released in 1993 and is a hulless, six-rowed, semi-dwarf, smooth-awned barley cultivar developed by the FCDC, Lacombe. Falcon was derived from the cross 11012.2/'Tern'/'Tulelake'. Samson (PI 494767) (Helm et al., 1986) is a semi-dwarf, six-rowed, hulled, rough-awned, barley cultivar also developed at the FCDC, Lacombe and originated from the

cross 'Olli'/M64-69//R72-181. Olli (CIho 6251) is a six-rowed early-maturing cultivar from Finland that was widely grown in the northern barley regions of Alberta and Alaska. The line M64-69, from Minnesota, is derived from the cross of 'Jotun'/'Kindred'//'Vantage'/3/'Trophy'/4/'Dickson'/5/M59-38 (Lambert, 1958; Johnston, 1965; Peterson, 1964; Peterson et al., 1968).

Tyto was developed by means of a modified bulk pedigree breeding method. Progeny from this cross were advanced in bulk in diseases (e.g., scald, smuts, net blotch) and yield screening nurseries in Alberta, Canada, and in California, USA, through the F_6 generation. Spike selections, based on disease resistant and robust plants, were made from the F_6 bulk and selection of an F_7 head row was made to establish a line designated as 'T89047103NX'. Yield trials of T89047103NX were conducted from 1995 to 2001 in the FCDC Barley Yield Trials. In 2000, T89047103NX was designated as 'HB513' and entered in the Western Cooperative Hulless Barley Test of the Canada Prairie Registration Recommending Committee for Grain. Breeder seed was developed from bulking 195 heads at the F_{13} generation.

Juvenile plants of Tyto show semi-prostrate growth habit with short, green-colored coleoptiles, and glabrous pubescence on sheaths of the lower leaf blades. Tyto has a medium-long and wide flag leaf with an intermediate attitude. It has white auricles and slightly waxy sheaths. Tyto has medium stem thickness and slight stem exertion (0–3 cm). The plant height of Tyto averages 83 cm on the basis of data derived from 52 station years of the FCDC Barley Yield Trials. Tyto has strong straw and good resistance to lodging. It has semi-compact and nodding, medium long, medium density and tapering spikes that show kernel overlaps at the tips. Tyto has medium long rachillas and long rachilla hairs. It has medium-long glumes with medium length hairs that are confined to a band, and long smooth awns. Tyto has medium-long and medium-wide kernels that have clasping lodicules with an incomplete horseshoe-shaped lemma base.

Data generated from over 30 station years, including the 1995 to 2001 FCDC Barley Yield Trials and the Western Co-op Hulless Barley Tests, show that Tyto has good grain yield, kernel weight, test weight and biomass production. It takes an average of 99 d from seeding to physiological maturity. Tyto has good kernel size measured by 1000-kernel weight (37.0 g), an average test weight of 72.0 kg hL^{-1}, and 79% plump seed. Tyto has silage potential of 12.9 Mg ha^{-1} DM. Tyto yielded over 8000 kg ha^{-1} of grain in areas with deep soils high in organic matter and relatively high summer rainfall, based on average yield derived from seven station years of the FCDC Barley Yield Trials.

Tyto has field resistance to scald [caused by *Rhynchosporium secalis* (Oud em.) J.J. Davis.]. It is moderately resistant to net-form of net blotch [caused by *Pyrenophora teres* f. *teres* Drechs.], and resistant to spot-form of net blotch [caused by *P. teres* f. *maculata* Smedeg.]. Tyto has good resistance to covered smut [caused by *Ustilago hordei* (Pers.) Lagerh.] and false loose smut {caused by *U. nigra* Tapke [syn. *U. avenae* (Pers.) Rostr.]}. It is moderately susceptible to loose smut [caused by *U. nuda* (Jens.) Rostr.], and susceptible to common root rot [caused by *Cochliobolus sativus* (Ito & Kurib) Drechster Ex Dastur.]. It is moderately resistant to stem rust [caused by *Puccinia graminis* f. sp. *tritici* Eriks & E. Henn.]. Tyto is resistant to spot blotch [caused by *C. sativus* (Ito & Kurib) Drechster ex Dastur.] and resistant to Septoria speckled leaf blotch (caused by *Septoria paserinii* Sacc).

The Field Crop Development Centre, Lacombe, Alberta, Canada, will maintain the Breeder seed of Tyto. Seed distribution rights were granted to Progressive Seeds Ltd. 4819C-48 Avenue, Red Deer, AB, T4N 3T2. Tel: (403) 347-4929, Fax: (403) 886-2098, Email: info@progressiveseeds.ca, Website: http://www.progressiveseeds.ca. Application (Application No. 02-3061) has been made for Plant Breeder's Rights.

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Registration of 'Shiwasuaoba' Annual Ryegrass

'Shiwasuaoba' annual ryegrass (*Lolium multiflorum* Lam.) (Reg. no. CV-228, PI 632337) was released 18 Mar. 1999 by Yamaguchi Prefecture, Japan, and tested and registered under the designation No. 9661. The first certified seed was produced in 1998 by the National Livestock Breeding Center, Japan.

Shiwasuaoba was developed from a recurrent selection breeding program to generate an early maturing annual ryegrass that could be used in crop rotations with rice (*Oryza sativa* L.), sorghum [*Sorghum bicolor* (L.) Moench], maize (*Zea mays* L.), and other summer crops in Japan. Selections for early flowering were made in space-planted nurseries at the Yamaguchi Agricultural Experiment Station, Yamaguchi City, Yamaguchi Prefecture, Japan, from 1985 to 1990. During the fall of 1985, 72 single-plant selections were made for early flowering and plant vigor from 900 plants of the annual ryegrass population Yamaiku No. 78. The 72 selected individuals were intermated in an isolated field at the Yamaguchi Agricultural Experiment Station, Japan. Yamaiku No. 78 is a subselection of the cultivar Minamiwase (Kinoshita et al., 1978). During the fall of 1986 to the spring of 1989, 1140 to 3168 plants were generated for five cycles of recurrent phenotypic selection that were practiced for early flowering, plant vigor, and crown rust resistance (caused by *Puccinia coronata* Corda var. *coronata*). After five cycles of recurrent phenotypic selection, 44 individuals possessing desirable qualities were identified and allowed to cross-pollinate. In 1990, 185 individuals representing 11 of the original 44 maternal lines were selected for days-to-flower and plant vigor from a population of 3340 plants. Selection intensity for early flowering and other characters varied from 1.4 to 8.8% among selection cycles. The 185 selected individuals were intermated and an equal quantity of seed from each half-sib progeny was bulked and assigned

the name Yamakei No. 26 in 1990. In 1991, seed was increased and the harvested seed was designated Breeder seed of Yamakei No. 26 was produced in 1991.

Shiwasuaoba has medium resistance to crown rust. In 1996, the germplasm was evaluated for crown rust resistance by artificial inoculations performed at the Yamaguchi Agricultural Experiment Station, Japan. Disease tolerance was scored with a numerical ranking from 1 (susceptible) to 9 (tolerant). Crown rust scores were Shiwasuaoba, 5.9; 'Miniamioba', 5.2; and 'Sakurawase', 2.8.

Shiwasuaoba is a leafy, annual Italian ryegrass forage cultivar that produces reliable early spring yields. In Japan, Shiwasuaoba was evaluated for regional adaptability and performance from central Japan to Okinawa. In the USA, it was evaluated for adaptability and performance at El Reno, Lane, and Enid, OK. Total yearly biomass production of Shiwasuaoba was approximately 60% of 'Marshall' annual ryegrass (Arnold et al., 1981) and 'Linn' perennial ryegrass (*Lolium perenne* L.) (Alderson and Sharp, 1994). In 2001 and 2002, single spring clippings for biomass production indicated its potential as an early maturing cultivar that would be suitable for early hay production in central and southern Oklahoma. Near infra-red reflectance spectroscopy values obtained 2 wk before flowering provided crude protein, acid digestible fiber and neutral digestible fiber estimates of 13.66, 23.95, and 47.14% for Shiwasuaoba; 13.95, 21.36, and 41.05% for Marshall; and 18.05, 22.77 and 46.21% for Linn, respectively.

The distinctive features of Shiwasuaoba are its extremely early maturity and early spring forage production potential. When sown in September, heading usually occurs in late March to late April. Shiwasuaoba flowers 2 to 3 wk earlier than Marshall and Linn. Early heading date makes Shiwasuaoba a useful cultivar for growers interested in a cool-season grass forage that has vigorous spring production and is nutritious and palatable to livestock. Because of its early maturity, Shiwasuaoba may be useful for livestock grazing or haying followed by the sowing of no-till summer crops such as vegetables and melons (*Citrullus* spp.). Shiwasuaoba is recommended for areas in the USA where the mean temperature is above 16°C in October. It is also suggested for use in blends with later maturing annual ryegrass cultivars to enhance early forage production potential.

An unusual feature of Shiwasuaoba is its possession of several B-chromosomes (Jones, 1991). As a consequence, the chromosome number of Shiwasuaoba exceeds $2n = 2x = 14$ and is not stable for the B-chromosome complement. There are no records or data indicating the source of the B-chromosomes found in this material, and the B chromosomes have no apparent effect on agronomic performance of Shiwasuaoba.

Certified seed of Shiwasuaoba is licensed through the Japanese Grassland Farming Forage Seed Association, Tokyo, Japan, and has Ministry of Agriculture, Forestry, and Fisheries protection in Japan (Registration no. 9661) (Anonymous, 2002). Propagation of Shiwasuaoba past Breeder seed is limited to one generation each of Foundation and Certified seed. Foundation and Certified seed are maintained in Japan by National Livestock Breeding Center. Limited samples of Certified seed for research purposes are available in the USA on request from the corresponding author. U.S. Plant Variety Protection of Shiwasuaoba has been applied for (PVP Application no. 200300058).

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Registration of 'Citation Fore' Perennial Ryegrass

'Citation Fore' perennial ryegrass (*Lolium perenne* L.) (Reg. no. CV-229, PI 631484) was released by Pure Seed Testing, Inc. (PST), Hubbard, OR, in 2001. Pure Seed Testing, Inc. developed Citation Fore in cooperation with the New Jersey Agricultural Experiment Station (NJAES). The first Certified seed was harvested in 2001. Citation Fore was tested under the experimental designation PST-2BR.

The germplasm collection, evaluation, and breeding program that led to the development of Citation Fore was initiated by the NJAES of Rutgers University in 1962. Persistent, attractive, lower-growing, turf-type perennial ryegrass plants were found in old lawn-type turfs in parks, sports fields, campus lawns and golf courses. The most useful were selected in Maryland, New Jersey, New York, and Pennsylvania. Promising plants collected from old turfs were evaluated as mowed turfs, in spaced-plant nurseries, in greenhouse disease screening tests, and in single-plant progeny tests in closely mowed turf trials. After undergoing severe interplant competition and environmental stresses, promising plants were selected and intercrossed to initiate subsequent cycles of recurrent phenotypic and genotypic selection. Seed yield trials were conducted in cooperation with PST. A cooperative breeding program between the NJAES and PST led to the development and release of 'Citation' perennial ryegrass (Bailey et al., 1978) and its continued genetic improvement.

This cooperative breeding program involved population backcrossing of genes for stem rust (caused by *Puccinia graminis* Pers:Pers.) resistance into advanced breeding populations and the expansion of phenotypic and genotypic recurrent selection. This cooperative program provided for concurrent selection for improvement of seed production characteristics and turf performance. Fungal endophytes (*Neotyphodium lolii* Latch, Christensen & Samuels) were also selected and incorporated into advanced breeding populations. This cooperative

breeding program led to the release of 'Citation II' (Meyer et al., 1987) and 'Citation III' (Rose-Fricker et al., 2002).

Plants selected from Citation II, Citation III, and breeding populations used in their development were intercrossed and subjected to additional cycles of population improvement in both Oregon and New Jersey. Citation Fore contains germplasm from progenies of 30 plants chosen from a spaced-plant nursery established at the Rutgers Plant Biology and Pathology Research and Extension Farm at Adelphia, NJ, during the summer of 1996. The 30 progenies trace their maternal origin to the following sources: 15 trace to plants collected from a lawn of the Waksman Institute of Microbiology and adjacent areas of the Rutgers University Golf Course, Piscataway, NJ, in 1991; four to a plant collected from 4 Delaware Drive in East Brunswick, NJ; three to plant PR92-210; three to plants that survived severe flood damage and associated Pythium blight (caused by *Pythium* spp.) at Adelphia during 1989, designated A89-SPL; two to plot H87-666, established at North Brunswick, NJ, in the late summer of 1987; one to a plant that survived severe flood damage and associated Pythium blight at Adelphia during 1989, designated A89-ROR; one to plant DKR90-6; and one to a plant selected from Georgian Court College, Lakewood, NJ, in 1992. The plants collected from near the Rutgers University Golf Course appeared quite distinct from plants in the NJAES breeding population and contained a *Neotyphodium* endophyte.

These 30 single-plant progenies were designated A96 and were developed through a population backcrossing program using the selected plants described above as recurrent parents and as sources for genes, cytoplasm, and endophyte. Various populations from the NJAES breeding program served as donor pollen sources. Over 90 percent of the parental germplasm of the populations used as pollen sources in the development of these progenies came from selections selected from old turfs of New York, New Jersey, Maryland, and Pennsylvania, and included germplasm used to develop Citation II and Citation III. Population A96 also was used in development of 'Manhattan 4' (Fraser et al., 2004, this issue) and 'Brightstar SLT' (Rose-Fricker et al., 2003).

Seed from each of the 30 A96 progenies was sent to PST, near Hubbard, during the late summer of 1996. This seed was used to establish an isolated 3200-plant nursery, designated A96, during the fall of 1996. During the spring of 1997, plants were removed from this nursery prior to anthesis, leaving 669 plants that displayed freedom from crown rust (caused by *P. coronata* Corda) and stem rust symptoms, low growth habit, dark-green color, and a high percentage of reproductive tillers. These remaining plants interpollinated, and seed was subsequently harvested during the summer of 1997.

Seed harvested from the A96 nursery was used to establish an isolated 5050-plant nursery near Hubbard during the fall of 1997. During the summer of 1998, 89 attractive plants were selected from this nursery after anthesis when stem rust disease pressure was high. These plants were dark-green, had low growth habits, and exhibited no visible symptoms of stem rust. Seed was harvested from these plants during the summer of 1998. Seed harvested from the 80 plants with the highest seed yield were bulked to create a composite designated Syn 2BR OP. These 80 plants were also vegetatively divided into 20 propagules each. Seed from Syn 2BR OP was planted in alternating rows with each of the 80 2BR clones to establish an isolated 4120-plant nursery, designated PST-2BR, near Hubbard during the fall of 1998. Plants were removed from this nursery, prior to anthesis, to increase population uniformity. Selection criteria for remaining plants were low growth habit, dark-green color, freedom from crown and stem rust symptoms, and a high percentage of reproductive tillers. Remaining plants interpollinated, and seed was harvested from 1455 plants as Breeder seed of Citation Fore during the summer of 1999.

Citation Fore is a dark-green, low-growing, turf-type perennial ryegrass. It has shown good turf quality in trials throughout the USA; good resistance to stem rust, leaf spot [caused by *Drechslera siccans* (Drechs.) Shoemaker], red thread [caused by *Laetisaria fuciformis* (McAlpine) Burdsall] and crown rust; and moderate resistance to dollar spot (caused by *Sclerotinia homoeocarpa* F.T. Bennett) and brown patch (caused by *Rhizoctonia solani* Kühn) (Morris, 2001 and 2002). Citation Fore has a lower growth habit, darker green color, improved crown rust and gray leaf spot [caused by *Pyricularia grisea* (Cooke) Sacc.] resistance, and better turf quality compared with Citation III.

Citation Fore was developed for turf uses and is recommended for lawns and sports turfs in temperate regions. Citation Fore should perform well as a monostand, in blends with other turf-type perennial ryegrasses, or in mixtures with Kentucky bluegrass (*Poa pratensis* L.) or fine-leaved fescues (*Festuca* L. spp.). Citation Fore is also recommended for winter overseeding of bermudagrass (*Cynodon* L. Rich spp.).

Seed propagation of Citation Fore is limited to three generations of increase from Breeder seed: one each of Foundation, Registered and Certified. Pure Seed Testing, Inc. maintains Breeder seed in Oregon and has applied for U.S. Plant Variety Protection (PVP application no. 200200243).

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W.A. Meyer, and C.R. Funk

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Registration of 'Manhattan 4' Perennial Ryegrass

'Manhattan 4' perennial ryegrass (*Lolium perenne* L.) (Reg. no. CV-230, PI 632377) was released by Pure Seed Testing, Inc. (PST), Hubbard, OR in 2001. Manhattan 4 was developed as part of a cooperative breeding program between PST, the New Jersey Agricultural Experiment Station (NJAES), and the Manhattan Ryegrass Growers Association to continue the improvement of 'Manhattan' perennial ryegrass (Funk et al.,

1969). The first Certified seed was produced in 2002. Manhattan 4 was tested under the experimental designation PST-2CRL.

The parental germplasm of Manhattan 4 included plants from the PST breeding program selected for crown rust (caused by *Puccinia coronata* Corda) resistance, summer turf performance, or salt tolerance; selections from 'Manhattan 3' (Rose-Fricker et al., 2002); and germplasm from NJAES, designated A96. During the late spring of 1998, 110 plants with low growth profile, dark green color, high number of reproductive tillers, and late maturity were selected from three perennial ryegrass nurseries at PST near Hubbard. These three nurseries were 2CL, which was comprised of plants that had been selected for crown rust resistance; 2SB, which was comprised of plants that had been selected for salt tolerance at 6 g L^{-1} NaCl; and A96. These 110 plants were transplanted into an isolated polycross, designated 2CRL, near Hubbard and allowed to interpollinate. Seed was harvested from each plant during the summer of 1998.

Seed from 83 plants in the 2CRL polycross with high seed yield and good stem rust (caused by *P. graminis* Pers:Pers.) resistance, along with seed harvested in 1998 from the 2CL nursery, was used to establish an isolated 4000-plant nursery, designated PST-2CRL, during the fall of 1998. Before anthesis, plants were removed from this nursery, leaving 836 plants that displayed low growth habit, dark-green color, high number of reproductive tillers, late maturity, and freedom from stem rust and crown rust. These remaining plants interpollinated, and seed was subsequently harvested to produce the first Breeder seed of Manhattan 4 during the summer of 1999.

These harvested plants trace their maternal origins to the following sources: 48% trace their origin to Manhattan 3 (23%), 'Manhattan II' (18%) (Funk et al., 1984), and Manhattan (7%); 16% trace their origin to plants collected by PST in Missouri (11%), Virginia (4%) and Illinois (1%); and 36% trace their origin to A96. A96 traces its origin to 30 single-plant progenies established in a turf trial near Adelphia, NJ, during the late summer of 1996. The 30 progenies trace their maternal origins to the following sources: 15 to plants collected from the lawn of the Waksman Institute of Microbiology and adjacent areas of the Rutgers University Golf Course, Piscataway, NJ in 1991; four to a plant collected from 4 Delaware Drive in East Brunswick, NJ; three to plant PR92-210; three to a plant that survived severe flood damage and associated Pythium blight (caused by *Pythium* spp.) at Adelphia during 1989, designated A89-SPL; two to plot H87-666, established at North Brunswick, NJ, during the late summer of 1987; one to plants that survived severe flood damage at Adelphia during 1989, designated A89-ROR; one to plant DKR90-6; and one to a plant selected from Georgian Court College, Lakewood, NJ, in 1992. Over 90% of the parental germplasm of all populations used in the development of these 30 progenies came from selections found in old turfs of the USA. These selections were evaluated in frequently mowed clonal trials, spaced-plant nurseries, disease screening tests and, subsequently, in single-plant progeny turf trials. Intercrosses of the best-performing plants were subjected to varying cycles of population improvement, which included both phenotypic and genotypic selection, combined with occasional population backcrossing. Population A96 also was used in development of 'Brightstar SLT' (Rose-Fricker et al., 2003), and 'Citation Fore' (Fraser et al., 2004).

Manhattan 4 has shown good turf quality in trials in the USA (Morris, 2001 and 2002). It has exhibited good resistance to stem rust, crown rust, dollar spot (caused by *Sclerotinia homoeocarpa* F.T. Bennett), red thread [caused by *Laetisaria fuciformis* (McAlpine) Burdsall], and moderate leaf spot [caused by *Drechslera siccans* (Drechs.) Shoemaker] resistance. Manhattan 4 maintained good turf quality under traffic stress (Morris, 2001 and 2002) and is recommended for sports turfs and lawns in temperate climates. Manhattan 4 has shown good turf quality in winter overseeding turf trials and is recommended for the winter overseeding of bermudagrass (*Cynodon* L. Rich spp.). Manhattan 4 has a lower growth habit, darker color, improved red thread and crown rust resistance, and better turf quality compared to Manhattan 3.

Seed propagation of Manhattan 4 is limited to three generations of increase from Breeder seed: one each of Foundation, Registered and Certified. Pure Seed Testing, Inc. maintains Breeder seed of Manhattan 4 in Oregon and has applied for U.S. Plant Variety Protection (PVP application no. 200300047).

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Registration of 'Endure' Tall Fescue

'Endure' tall fescue (*Festuca arundinacea* Schreb.) (Reg. no. CV-91, PI 628335) was released by Pure Seed Testing, Inc., Hubbard, OR in 2001. Endure was developed as part of a breeding program to develop tall fescue cultivars with improved resistance to brown patch (caused by *Rhizoctonia solani* Kühn). The first Certified seed was produced in 2002. Endure was tested under the experimental designations PST-R5AU and R5AU.

The 30 parental clones of Endure were selected from spaced-plant tall fescue nurseries at Pure Seed Testing, Inc. near Rolesville, NC, during the spring of 1995. These nurseries were comprised of plants that had been selected from, or that traced their maternal origins to plants that had been selected from, turf plots that had exhibited good turf quality and brown patch resistance near Rolesville. The selection criteria for these 30 plants were attractive appearance, dark-green color, low growth profile, freedom from disease, and upright leaves and panicles. The selected plants were moved before anthesis

to an isolated crossing block, designated PST-R5AU, near Rolesville and allowed to interpollinate.

The 30 parental clones of Endure traced their origins to 13 maternal sources. Five plants traced their origin to PST-5MX, which traced its origin to 'Murietta' and 'Silverado' (Rose-Fricker and Meyer, 1993). Five plants traced their origin to population PST-R5AE, which was developed into 'Bandana' (Fraser et al., 1999a). Four plants traced their origin to PST-5NX, which traced its origin to Murietta and Silverado. Three plants traced their origin to 'Coronado' (Rose-Fricker et al., 1999). Two plants traced their maternal origin to a plant collected at the Holly Springs Golf Course, Holly Springs, MS, during the early spring of 1976. Two plants were from population 5F8, which traced its origin to 'Apache' (Meyer et al., 1991), 'Eldorado' (Rose-Fricker and Meyer, 1994), 'Safari' (Rose-Fricker and Meyer, 1995), and Silverado. One plant traced its origin to Apache. One plant was from population PST-R5TK, which was developed into 'Wolfpack' (Fraser et al., 1999b). Two plants traced their maternal origin to Silverado. Three plants traced their origin to population MW from the New Jersey Agricultural Experiment Station (NJAES). One plant traced its origin to population NJFD-87 from NJAES. One plant traced its origin to population DFL from NJAES. The MW, NJFD-87 and DFL populations from NJAES traced their parental germplasm to plants selected from or related to 'Rebel' (Funk et al., 1981) and to plants selected from old turfs in Georgia, Virginia, Mississippi, Kansas, Kentucky, Alabama, North Carolina, Ohio, Texas, New Jersey, Pennsylvania, Idaho, and Australia as part of a tall fescue germplasm collection, evaluation, and improvement program initiated in 1962 by NJAES.

Seed was harvested from the plants in the PST-R5AU crossing block during the summer of 1995 and subsequently used to establish a 1150-plant nursery near Rolesville during the fall of 1995. During the spring of 1996, approximately 25% of the population was removed before anthesis to increase uniformity of plant-type and maturity. The remaining plants were allowed to interpollinate, and seed was harvested during the summer of 1996. Seed from this harvest was used to establish a 2900-plant nursery near Hubbard during the fall of 1996. Plants were removed from this nursery before anthesis to eliminate plants with high susceptibility to stem rust (caused by *Puccinia graminis* Pers.:Pers.) and increase uniformity of plant type and maturity. Seed was harvested from 549 plants during the summer of 1997 to produce the first Breeder seed of Endure.

Endure is a medium-dark green, upright tall fescue that has shown good turf quality in trials in the USA (Morris, 2001). It maintains good summer density, has shown resistance to brown patch (Morris, 2001), and has exhibited moderate stem rust resistance. Endure is recommended for lawns, golf course roughs and sports turfs in climates where tall fescue is adapted. Endure should perform well as a monostand, in blends with other turf-type tall fescues, or in mixtures with up to 5% Kentucky bluegrass (*Poa pratensis* L.).

Seed production of Endure is limited to three generations of increase from Breeder seed: one each of Foundation, Registered, and Certified. Pure Seed Testing maintains Breeder seed of Endure in Oregon and has applied for U.S. Plant Variety Protection (PVP application no. 200100288).

M.L. Fraser* and C.A. Rose-Fricker

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Registration of 'Transcontinental' Bermudagrass

'Transcontinental' bermudagrass [*Cynodon dactylon* (L.) Pers.] (Reg. no. CV-44, PI 614789) was released by Pure Seed Testing, Inc., Hubbard, OR, in 2000. Pure Seed Testing developed Transcontinental near Rolesville, NC, with the goal of producing a seeded bermudagrass cultivar with good potential for winter survival. The first Certified seed was produced in 2002. Transcontinental was tested under the experimental designation PST-R69C.

Transcontinental traces its origin to 13 parents. Five of these plants trace their origin to a six-clone polycross, designated B51, made near Rolesville during 1993. Four of the plants in the B51 cross were from a collection of bermudagrasses that were selected in the southwestern USA. One of the plants in the B51 cross was collected in Norlina, NC, and one traces its maternal origin to a plant collected in Jackson, TN. Two of the parents of Transcontinental trace their maternal origins to a plant, designated P91-77, which was from the southwestern USA collection. Three of the parents trace their maternal origins to a plant that resulted from a cross among plants collected in Atoka, OK, Jackson, TN, and Charlotte, NC. One of the parents of Transcontinental traces its maternal origin to a plant that resulted from a cross among plants collected from Dandridge, GA, Walla Walla, WA, and northern Tennessee. The other two parents of Transcontinental trace their maternal origins to plants collected on golf courses in northern Tennessee and Charlotte, NC.

During the spring of 1996, the 13 parents of Transcontinental were planted into an isolated crossing block near Rolesville. Eighteen 10-cm plugs of each parent were planted, randomly, on 15-cm spacings. The plants were allowed to grow together and interpollinate during the summer of 1996. Seed was subsequently harvested from the entire block and bulked.

During the spring of 1997, 2000 seedlings from the 1996 harvest were used to establish an isolated spaced-plant nursery near Rolesville. Each plant in this population was planted into a 26-cm (dia) by 25-cm (ht) pot. The 2000 pots were arranged in rows with 7-cm spacing between pots. Less than 10% of this population was removed before anthesis to increase population uniformity of plant-type and maturity. Remaining plants were allowed to interpollinate. The first Breeder seed of Transcontinental was harvested in bulk from this nursery during August 1997.

Transcontinental bermudagrass was developed for turf uses and forms a low-growing turf with medium-fine texture and

medium-high density. Transcontinental has shown good performance in U.S. turf trials at mowing heights from 1.3 to 3.8 cm and good winter survival compared to other seeded bermudagrasses (Morris, 2002). Transcontinental is recommended for lawns, sports fields, and golf course fairways and roughs.

Pure Seed Testing, Inc. maintains Breeder seed of Transcontinental in North Carolina. Multiplication of Transcontinental is limited to three generations of increase from Breeder seed: one each of Foundation, Registered, and Certified. Pure Seed Testing, Inc. has applied for U.S. Plant Variety Protection of Transcontinental (PVP application no. 200000333).

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Registration of 'Showcase' Kentucky Bluegrass

'Showcase' Kentucky bluegrass (*Poa pratensis* L.) (Reg. no. CV-74, PI 615532) was released by Pure Seed Testing, Inc., Hubbard, OR in 1998. Showcase originated as a single highly apomictic plant selected from 'Unique' (Rose-Fricker et al., 1999). The first Certified seed was produced in 2000. Showcase was tested under the experimental designation PST-BO-141.

During the fall of 1989, a 480-plant nursery of Unique Kentucky bluegrass was established near Hubbard. During the spring of 1990, 10 off-type plants were selected from this nursery, including one that was designated PST-BO-141. Seed was harvested from PST-BO-141 during the summer of 1990 and used to establish single-plant progeny turf plots in Oregon and New Jersey. During 1990 to 1994, PST-BO-141 was evaluated for seed yield and turf performance. 'Apollo', 'Bedazzled', 'Boutique', 'Brilliant', and 'Langara' Kentucky bluegrasses were also principally derived from Unique.

A Breeder seed nursery of PST-BO-141 was established during the fall of 1994 near Hubbard. Aberrant and off-type plants were removed from this nursery during the spring of 1995. During the summer of 1995, seed was harvested from 261 plants to produce the first Breeder seed of Showcase. Showcase is a facultative apomict with approximately 95% of its progeny appearing genetically identical to the maternal parent.

Showcase has shown good turf quality in trials maintained at mowing heights ranging from 1.3 cm to 5 cm (Morris, 2001). It has good billbug (*Sphenophorus* spp.) resistance and has shown good resistance to dollar spot (caused by *Sclerotinia homoeocarpa* F.T. Bennett), stripe smut [caused by *Ustilago striiformis* (Westend.) Niessl], powdery mildew (caused by *Erysiphe graminis* DC), summer patch (caused by *Magnaporthe poae* Landschoot & Jackson), and necrotic ring spot (caused by *Leptosphaeria korrae* J.C. Walker and A.M. Sm.) (Morris, 2001) and moderate resistance to leaf spot [caused by *Drechslera poae* (Baudys) Shoemaker] and Rhizoctonia sheath spot (caused by *Rhizoctonia zeae* Voorhees). Showcase has shown good turf quality in trials in the transition zone of the USA (Morris, 2001) and has good summer turf performance, exhibiting good heat tolerance, summer density, and drought tolerance. In North Carolina turf trials, Showcase has shown excellent summer turf performance under heat and drought stress at mowing heights from 1.3 cm (Fraser et al., 2002) to 2.6 cm.

Showcase Kentucky bluegrass was developed for turf uses. It has a medium-green color, medium leaf texture, and a lower growth habit, compared to Unique. It is recommended for golf course fairways and roughs, lawns, and sports turfs. Showcase may be planted as a monostand, in blends with other turf-type Kentucky bluegrasses, or in mixtures with turf-type perennial ryegrass (*Lolium perenne* L.) or tall fescue (*Festuca arundinacea* Schreb.).

Seed propagation of Showcase is limited to three generations of increase from Breeder seed: one each of Foundation, Registered, and Certified. Fewer than 5% off-types or variants have been observed in the reproduction or multiplication of Showcase. Pure Seed Testing, Inc. maintains Breeder seed of Showcase in Oregon and has applied for U.S. Plant Variety Protection (PVP application no. 200100055).

C.A. Rose-Fricker and M.L. Fraser*

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Registration of 'Greenwich' Velvet Bentgrass

'Greenwich' velvet bentgrass (*Agrostis canina* L.) (Reg. no. CV-9, PI 630925) was released by Pure Seed Testing, Inc., Hubbard, OR in 2000. Pure Seed Testing, Inc. developed Greenwich using germplasm obtained from the New Jersey Agricultural Experiment Station of Rutgers University. The first Certified seed was produced in 2001. Greenwich was tested under the experimental designation PST-EVM.

Greenwich traces its origin to maternal progenies of 35 velvet bentgrass plants. Twenty-two of these plants trace their origin to plants selected from old turfs at Lake Success Country Club, Long Island, NY. One parent traces its origin to a plant collected from Pine Hollow Country Club, Long Island. The other 12 maternal parents trace to selections from 'Emanuel Francis' velvet bentgrass in a turf trial seeded in October 1985 at North Brunswick, NJ, that was maintained at a 6-mm mowing height. The trial contained Emanuel Francis velvet bentgrass and several creeping bentgrasses (*Agrostis palustris* Huds.). After 5 yr, plots of Emanuel Francis velvet bentgrass had mostly disappeared. Mowing height was then lowered to 4 mm and velvet bentgrass subsequently began to dominate the original plots. An extremely small percentage of the original seedlings were able to thrive under the conditions of this trial and produced patches averaging 15 cm in diameter. The most attractive of these velvet bentgrasses were selected during the summer of 1996 and transferred to a spaced-plant nursery at the Rutgers Plant Science Research Farm at Adelphia, NJ, along with selections from Lake Success Country

Club and National Golf Links Country Club, Bridgehampton, NY.

In June 1997, 27 attractive, low-growing and disease-free velvet bentgrass plants were moved before anthesis to an isolated polycross, designated EVB, at Adelphia. Twenty-three of these plants were from Lake Success Country Club, two were from National Golf Links Country Club, and two were from Emanuel Francis. These plants were allowed to interpollinate during the summer of 1997, and seed was subsequently harvested from each plant. Seed harvested from the EVB polycross, along with new selections from Pine Hollow Country Club and the Emanuel Francis plots, were used to establish an isolated 2400-plant nursery at Adelphia during the fall of 1997.

In June 1998, the most attractive medium-maturing, medium-dark green, low-growing, fine-textured plants were moved to an isolated polycross, designated EVM, at Adelphia. Ninety-nine plants were allowed to interpollinate during the summer of 1998, and seed was subsequently harvested from 35 plants. The origins of the plants in the EVM polycross were as follows: 29 traced maternally to Emanuel Francis, of which 12 were harvested; 61 traced maternally to Lake Success Country Club, of which 22 were harvested; 8 traced maternally to Pine Hollow Country Club, of which one was harvested; and one traced maternally to National Golf Links Country Club, but was not harvested.

Seed harvested from the 35 EVM parents was sent to Pure Seed Testing, Inc., near Hubbard, during the summer of 1998. Seedlings were transplanted to an isolated 4450-plant nursery, near Hubbard, during the fall of 1998. Plants with wide leaves, light-green color, prostrate growth habits, disease symptoms, or a low number of reproductive tillers were removed from the population during the spring of 1999 before anthesis. Remaining plants interpollinated, and seed was subsequently harvested from 1185 plants as the first Breeder seed of Greenwich during the summer of 1999.

Greenwich is a fine-textured, low-growing, medium-green cultivar developed for turf uses. It has shown good quality in turf trials maintained at mowing heights from 3 to 13 mm in New Jersey, North Carolina, and Oregon (Murphy et al., 2000; Plumley et al., 2001; Bonos et al., 2002; Pure Seed Testing, Inc., 2002). Greenwich has shown good resistance to dollar spot (caused by *Sclerotinia homoeocarpa* F.T. Bennett) and brown patch (caused by *Rhizoctonia solani* Kühn). Greenwich has good heat tolerance and is recommended for golf course greens, tees, and fairways in temperate climates.

Seed production of Greenwich is limited to three generations of increase from Breeder seed: one each of Foundation, Registered, and Certified. Pure Seed Testing, Inc. maintains Breeder seed in Oregon and has applied for U.S. Plant Variety Protection (PVP application no. 200200094).

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Registration of 'Applaud' Perennial Ryegrass

'Applaud' perennial ryegrass (*Lolium perenne* L.) (Reg. no. CV-231, PI 632258) is a turf-type perennial ryegrass developed with the participation of Advanta Seeds Pacific, Albany, OR, and released by Pennington Seed Co., Madison, GA, in 2001. Germplasm obtained from the New Jersey Agricultural Experiment Station was used in its development. Applaud was tested as Pennington-11301. The first certified seed was produced in 2001.

Applaud is an advanced-generation synthetic cultivar selected from the half-sib progenies of 285 plants, which trace maternally to plants selected from 20 different sources of germplasm. Approximately 6% of the maternal germplasm traces to a population related to 'Premier' (Funk et al., 1983). Twenty-one percent of the germplasm traces to plants selected from the grounds of the Waksman Institute of Microbiology and adjacent areas of the Rutgers University Golf Course in Piscataway, NJ, in 1991. Fifty percent traces to plants selected for survival in a flooded field, which suffered severe Pythium blight disease (caused by *Pythium* spp.) damage in 1989. This genotype and the other 23% traces primarily to plants selected from old turfs in the mid-Atlantic region of the USA starting in 1962. Three additional pollen sources not harvested included progeny from two plants collected from Poland in 1996 and a plant selected for dark-green color and low growth habit from 4 Delaware Drive, East Brunswick, NJ (identified as Delaware Dwarf). Progenies of each of these plants were subjected to many cycles of phenotypic and genotypic recurrent selection in greenhouse disease screening tests, spaced-plant nurseries, and single-plant progeny turf trials located in central New Jersey for up to three decades before the final development of Applaud.

Seven hundred fifty single-plant progenies were established in a turf trial at the Rutgers Plant Biology and Pathology Research and Extension Farm at Adelphia, NJ, in 1997. This turf trial included many standard cultivars and experimental synthetics. The trial was evaluated at frequent intervals for turf performance including speed of establishment, overall appearance, growth characteristics, color, density, texture, uniformity, disease reaction, and stress tolerance. During the fall of 1998, approximately 96 plants were selected from each of the 23 best performing single-plant progeny turf plots based on vigor, density, dark-green color, overall disease resistance, and summer stress tolerance. These plants were screened for shoot density, low growth habit, and freedom from disease. Twenty-four plants of each progeny line (540 plants) were transplanted to a spaced-plant nursery in the fall of 1998. During the spring of 1999, approximately 22% of the 540 plants were rogued for poor quality, disease susceptibility, poor seed yield potential, and/or lack of crown density to improve uniformity. Approximately 33% of the remaining plants were not harvested because of crown rust (caused by *Puccinia coronata* Corda var. *coronata*) development after anthesis and/or poor floret fertility. Breeder seed was harvested in the summer of 1999 from 285 plants selected from

20 of the 23 maternal clones and sent to Advanta Seeds Pacific, Inc. Approximately 95% of this seed contained a *Neotyphodium* spp. endophyte. This seed was used to establish an experimental Foundation seed increase field during the fall of 1999 and was also entered in the 1999 National Turfgrass Evaluation Program (NTEP) perennial ryegrass test (Morris, 2000).

Applaud is a medium-late maturing, low-growing, turf-type perennial ryegrass, with an attractive dark-green color, fine leaf texture, and medium-high shoot density (Morris, 2000; Morris, 2001). It showed excellent overall turf performance in NTEP trials under various maintenance regimes. Applaud also exhibited good resistance to crown rust disease and good resistance to leaf spot (caused by *Drechslera siccans* Drechs.), stem rust (caused by *P. graminis* Pers.:Pers.), red thread [caused by *Laetisaria fuciformis* (McAlpine)], and dollar spot [caused by *Sclerotinia homoeocarpa* (F.T. Bennet)] in NTEP trials (Morris, 2000; Morris, 2001). Applaud shows promise for excellent turf performance on home lawns, athletic fields, and golf course fairways throughout regions where perennial ryegrass is well adapted.

Seed production of Applaud is limited to one generation of Foundation and two generations of Certified seed. U.S. Plant Variety Protection for Applaud has been applied for (PVP Application no. 200200259). Breeder seed is maintained by Pennington Seed Co.

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Registration of 'Merlot' Small Red Bean

'Merlot' small red dry bean (*Phaseolus vulgaris* L.) (Reg. no. CV-211, PI 633423) was developed and released cooperatively by the USDA-ARS and the Michigan Agricultural Experiment Station in 2002 as an upright, short vine (Type IIA), full-season maturity, disease resistant cultivar. Merlot's unique features are that it is the first small red commercial cultivar with resistance to bean rust disease [caused by *Uromyces appendiculatus* (Pers.:Pers.) Unger], with a robust upright vegetative growth appearance, and consistent and desirable canning quality.

Merlot, tested as breeding line no. ARS-R98026, was derived from a cross made in 1994 between breeding lines ARS-R94037 and ARS-R94161. Both parents had the upright indeterminate Type IIA growth habit (Singh, 1982) and were full-season breeding lines. ARS-R94037 had a seed weight of 40 g 100 seeds^{-1}, yielded 3476 kg ha^{-1} in the 1994 yield trial, and displayed acceptable canning quality. ARS-R94161 showed field resistance to bean rust. The F_1 plants were advanced in the greenhouse and space-planted in an F_2 nursery at the Saginaw Valley Bean and Sugar Beet Research Farm near Saginaw, MI. In 1996, a single plant was selected from an F_4 row on the basis of desired agronomic performance and small red seed traits and advanced as a single row in a nursery in Puerto Rico. The $F_{4:6}$ (Michigan) and $F_{4:7}$ (Puerto Rico) progenies were handled as bulk populations. In 1998, the $F_{4:8}$ breeding line coded ARS-R98026 was entered into replicated yield trials.

Merlot was tested at 18 locations in the mid-Michigan bean production area over five seasons (1998–2002) and at Othello, WA (2002) and compared with the following small red cultivars: 'Brooks', 'Rufus', 'UI239', 'NW63', and 'Garnet'. Over the 19 locations Merlot averaged 2773 kg ha^{-1}. Merlot's yield advantage was 3% over the Type IIA cultivar, Brooks, and 6, 7, 10, and 23% over the prostrate, Type III cultivars: Rufus, UI239, NW63, and Garnet, respectively.

Plants of Merlot averaged 47 cm tall and exhibited a narrow profile architecture (Adams, 1982). These features combined with the Type IIA growth habit gave the cultivar superior lodging resistance compared to the Type III checks. Merlot has white flowers and blooms 45 d after planting. Merlot matures 93 d after planting and ranges from 87 to 100 d depending on the season, thus, making it a mid- to full-season maturing bean. Merlot matures and dries-down uniformly and has an appealing straw-yellow appearance at harvest maturity.

Dry seed of Merlot has the garnet color and noticeable hilum ring typical for small red beans. However, Merlot has a greater intensity of color than check cultivars giving the dry seed a highly appealing appearance. Intensity of color was determined by the hue angle criterion (Hosfield et al., 1995). The intensity of Merlot's dry seed color carries over to the canned product. The hue angle for Merlot was 34.5 compared to 36.0, 36.8, 37.7, and 39.4 for Garnet, Brooks, UI239, and NW63, respectively (the closer to 0°, the more intense red). Individual seed are oval, approximately 1.2 by 0.8 cm in length and width, plump at the surface tangential to the hilum and gently rounded at the apices, giving Merlot a more attractive shape than the rhomboid-like seeds of the checks. At the eight locations in which seed mass data were taken, Merlot averaged 39.2 g 100^{-1} seed and ranged from 37.5 g to 39.8 g 100^{-1} seed. Merlot's seed mass was significantly greater than the commercial check cultivars at those locations where comparisons were made.

Merlot was tested for its aggregate canning quality, which reflects consumer and processor preferences, in the Michigan State University Pilot Processing Laboratory (Dep. of Food Science and Human Nutrition). A team of panelists subjectively rated Merlot as having desirable canning quality. Merlot scored 5.0 for visual appeal (Walters et al., 1997) on a seven-point hedonic scale (where seven is most desirable, one least desirable, and four, neither desirable nor undesirable). This evaluation is based on whole bean integrity (the perception of clumping and splitting in the can), uniformity of size of individual grains (uniform water uptake), and clarity and viscosity of the canning medium (a measure of starch exudation into the brine). Compared with Merlot, the visual appeal scores for Brooks, NW63, UI239, Garnet, and Rufus were 2.8,

3.2, 3.8, 4.4, and 5.9, respectively. The human eye can detect a one point difference in visual appeal (Hosfield, unpublished). After it is processed, Merlot is similar to the checks for hydration and washed drained weight ratios (Wassimi et al., 1990).

Merlot's cooked bean kinesthetic properties (texture and mouth feel) is desirable for the small red market class. Kinesthetic properties of cooked beans were measured with an Allo-Kramer Shear Press and indicated that Merlot was significantly firmer than NW63 and UI239, which were judged soft and marginally satisfactory. The kinesthetic properties of Merlot are equivalent to Brooks, Rufus, and Garnet.

Merlot carries the *bc-1²* gene for resistance to bean common mosaic virus and the *Ur-3* gene for resistance to Race 53 and all indigenous races of *U. appendiculatus* prevalent in Michigan. The recessive *bc-1²* resistance gene protects plants against systemic infection caused by *Beancommon mosaic virus* (BCMV) from pathogroups I, II, III, and IV of the virus. The *bc-1²* gene is thought to condition tolerance to the NL-3 strain of bean *Common mosaic necrosis virus* (BCMNV) (Strausbaugh et al., 1999). Merlot is susceptible to bean anthracnose [caused by *Colletotrichum lindemuthianum* (Sacc. & Magnus) Lams.-Scrib.].

Variety protection for Merlot has been applied for under the U.S. Plant Variety Protection Act with the option that the cultivar may be sold for seed by name only as a class of Certified seed. Breeder and Foundation seed will be maintained by the Michigan Crop Improvement Association, East Lansing, Michigan. A royalty will be collected on each unit of Foundation seed sold.

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Registration of 'Cariblanco N' Lima Bean

'Cariblanco N' (*Phaseolus lunatus* L.) (Reg. no. CV-212, PI 632361) was developed by the University of California, Davis (UCD) and Riverside (UCR) and released by the California Agricultural Experiment Station in 2001. Cariblanco N is an indeterminate, vine type, small seeded or "baby" Lima bean that has resistance to root-knot nematodes [*Meloidogyne incognita* (Kofoid and White) Chitwood and *M. javanica* (Treub) Chitwood]. Cariblanco N was evaluated in performance trials in California from 1994 through 1998 under the designation V-8.

Cariblanco N was developed from a single plant selection (9399-6) made in 1993 from progeny derived from a cross between UCD Selection-144 and UCD Accession L-136 made in 1989. L-136 originated in Puerto Rico (Allard, 1954) and carries an introduced source of root-knot nematode resistance for baby Limas (Allard, 1954; McGuire et al., 1961). L-136 has an indeterminate growth habit, bright red seed, and very late maturity. Selection-144 is root-knot nematode susceptible, has a determinate (bush) growth habit, matures in about 110 d and during the growing season, it is similar in appearance to commercial cultivars Henderson Bush (PI 549466) and UC-Luna. Selection-144 was derived from a cross between commercial cultivars Bridgeton (PI 549508) and Mezcla (PI 549505), selected at F_2 and F_3 for white seed coat, white cotyledon, determinate bush type, and maturity. Selection-144 was one of several F_4 families bulked from a total of 215 F_3 progeny rows. Selection-144 has small flat white seeds similar in appearance to those of commercial bush cultivars Henderson Bush and UC-Luna.

The F_1 from the Selection-144 × Accession L-136 cross produced 411 F_2 seeds from which individual plants were field selected for vine and bush type and white seed. The F_3 seed from these single plants were planted in progeny rows at field sites infested with the root-knot nematodes to select lines with dual resistance. In 1993 and 1994, agronomic traits were selected by means of F_3 reserve seed from nematode resistant families. Individual seeds were planted in the greenhouse and the plants were evaluated for morphological traits, seed coat and cotyledon color, and seed quality (shape, size, and eye pattern). F_4 seed was harvested from individual F_3 plants. The F_4 seed was then split between a controlled greenhouse pot test used to assess resistance to both *M. incognita* and *M. javanica*, and a seed increase planted in the 1994 Davis field nursery. On the basis of nematode resistance data, F_5 seed was bulk-harvested from F_4 families. For F_4 families that continued to segregate for nematode resistance, F_5 seed from single plants was harvested to reselect homozygous resistance to *M. incognita* and *M. javanica*. The F_5 vine families that demonstrated consistent resistance reactions to both nematode species were advanced to multilocation yield tests in commercial fields during 1995, and thereafter increased and retested through 2000 to confirm fixed nematode resistance. V-8 was the best-performing nematode resistant family.

No current California cultivars of baby Lima beans carry resistance to the common root-knot nematodes *M. incognita* and *M. javanica,* or to other root-knot species. The large-seeded Lima bean cultivars Maria, UC 92, and White Ventura N carry resistance to *M. incognita* but not to *M. javanica* (Anonymous, 1979; Temple and Helms, 1992; Tucker, 1969). Cariblanco N carries resistance genes from the L-136 parent that suppress both reproduction and root-galling by *M. incognita* and root-galling but not reproduction by *M. javanica*. Genetic analysis and segregation of the resistance at various generations during breeding of Cariblanco N suggested that three nonallelic genes confer the three resistance traits (resistance to *M. incognita* reproduction, to *M. incognita* galling, and to *M. javanica* galling) independently (Roberts and Matthews, unpublished data). Reproduction of *M. incognita* on Cariblanco N measured by eggs per gram of root and per root system in controlled, replicated greenhouse pot tests averaged about 10% of that produced on susceptible Henderson Bush

Lima bean (6198 eggs g^{-1} root compared to 60721 eggs g^{-1} root). In both greenhouse and field tests, root-galling caused by *M. incognita* and *M. javanica* is suppressed almost completely on Cariblanco N compared with the typical galling reaction on the primary root and fibrous roots of susceptible baby Lima bean cultivars such as Mezcla and Henderson Bush.

Cariblanco N has similar botanical and phenological characteristics as Mezcla (Sanchez, 1966). It has similar white flowers, leaf size and shape, and green foliage and stem color with no anthocyanin pigmentation. With a May sowing date and typical growing conditions in the San Joaquin Valley, Cariblanco N begins flowering about 45 d after sowing and matures its flush of pods about 120 d from sowing. Maturity varies from 110 to 130 d depending on planting date, growing season temperature, soil type and environmental conditions of the growing location. Cariblanco N has a spreading indeterminate vine growth habit similar to Mezcla, and completely fills spaces between beds when grown on 0.75 m to 1.0 m-spaced beds. Growth and yield observations showed that Cariblanco N is well adapted to the climate and soils of traditional baby lima growing areas along the west side of the upper San Joaquin Valley and in the western Sacramento Valley. Cariblanco N is not recommended for most northern California regions of Sutter, Yuba, Glenn, Butte, and Colusa Counties or other subirrigated areas, including the Sacramento–Stockton Delta, which appear more suited to Mezcla and 'Wilbur', the most widely grown cultivars of vine baby Lima beans under those conditions.

Cariblanco N and the dominant California baby Lima cultivar Mezcla had similar average grain yields (4355 and 4493 kg ha^{-1}, respectively) over six replicated yield trials that were conducted at several sites (Davis, Mendota, Meridian, Farmington, Tracy) in the San Joaquin and Sacramento Valleys of California from 1995 through 1998. All of those trials were conducted in fields free from root-knot nematodes. In addition, five replicated yield trials at three locations in the San Joaquin Valley (Denair, Mendota, and Parlier) and at one location in southern California (Tustin) were conducted from 1995 to 2000 in fields infested with the root-knot nematodes *M. incognita* (four trials) and *M. javanica* (one trial). On these nematode infested sites, Cariblanco N and Mezcla had average grain yields of 2824 and 1895 kg ha^{-1}, respectively, indicating a significant ($P \leq 0.05$) suppression of yield of susceptible Mezcla compared with resistant Cariblanco N. In the most representative commercial production trial (at Mendota in 2000) in a field heavily infested with *M. incognita*, Cariblanco N and Mezcla grain yields were 5058 and 2811 kg ha^{-1}, respectively. Compared with the susceptible Mezcla, resistant Cariblanco N had 80% higher yield ($P \leq 0.05$). The severe nematode attack also resulted in a smaller and more variable seed size of susceptible Mezcla, compared with normal and stable seed size of resistant Cariblanco N. All field trials were conducted on raised beds with furrow irrigation, and with inter- and intrarow spacing and management systems typical of commercial fields in the San Joaquin Valley.

Cariblanco N has small flat white seeds similar in appearance to those of Mezcla, 'Pat', and Wilbur vine baby Limas. Individual average seed weight of Cariblanco N is 400 to 500 mg $seed^{-1}$ depending on the growing location. Comparisons of seed size range within Cariblanco N and Mezcla were made using round hole sieve screens, and indicated an equal or slightly larger size than Mezcla over four Central Valley growing locations–environments. Cariblanco N has very satisfactory canning quality (1 or 2 rating), acceptable and equal in quality and color when compared to Mezcla, Pat, and Wilbur. The replicated "blind" (coded) canning evaluations were based on seed size variation, seed color, seed splitting, and excretion of starch, with entries rated 1 for excellent (passing all categories), 2 for good (failing only one category), and 3 for reject (failing in two or more categories).

Breeder seed will be maintained by the University of California, Davis. Foundation seed will be maintained and distributed by the University of California Foundation Seed and Certification Service, Davis, CA 95616. Certification will be available under the supervision of the California Crop Improvement Association. Cultivar protection under the U.S. Plant Variety Protection Act and Title V of the Federal Seed Act is pending (Application No. 2002017).

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Registration of 'Bolivar' Rice

'Bolivar' rice (*Oryza sativa* L.) (Reg. no. CV-116, PI 628791), an early-maturing, long-grain cultivar with improved disease resistance and superior parboiling and canning quality, was developed at the Texas A&M Univ. System Agric. Res. & Ext. Ctr. at Beaumont, TX, by the USDA-ARS in cooperation with the Texas Agric. Exp. Stn., the Texas Rice Improvement Assoc., and the Texas Rice Res. Foundation. Bolivar was officially released in 2001 by the USDA-ARS in cooperation with the Agric. Exp. Stn. of Texas A&M Univ., the Univ. of Arkansas, Louisiana State Univ., and Mississippi State University.

Bolivar was developed from the cross 'Gulfmont'*2/'Te Qing' (cross no. B8911A9) produced at Beaumont in 1989. Gulfmont is an early maturing, semidwarf cultivar with excellent main crop yield and milling quality that was released in 1986 (Bollich et al., 1990a). Te Qing (PI 536047) is a high yielding medium grain cultivar from China that possesses high amylose content and firm cooking quality that is typical of indica long grains. When grown in the southern USA, Te Qing has been characterized as having high yield potential, medium height, relatively late maturity, and excellent resistance to rice blast disease (caused by *Pyricularia grisea* Sacc. = *P. oryzae* Cavara) and sheath blight disease (caused by *Rhizoctonia solani* Kühn). Bolivar was developed by the pedigree breeding method and was entered into the 1995 Uniform Regional Rice

Nurseries under the designation RU9503012 using a bulk of F_{10} breeding rows.

Bolivar has grain dimensions intermediate to the long grain cultivars Cypress and Dixiebelle (Table 1). Bolivar has a relatively wide kernel which will result in a bold grain appearance that is considered desirable in some products. The endosperm of Bolivar is nonglutinous, nonaromatic, and covered by a light brown pericarp. Bolivar has 2 to 3% higher apparent amylose content (240–250 g kg^{-1}) and a significantly higher amylographic viscosity (hot paste and cool paste) than conventional U.S. long-grain types. DNA marker analysis (Bergman et al., 2001) has confirmed that these cooking qualities are due to inheritance of the Te Qing allele of the granule bound starch synthase gene in Bolivar. These grain characteristics are indicative of the superior parboiling and canning quality that is found in Dixiebelle and 'Rexmont' (Bollich et al., 1990b; McClung et al., 1998). Bolivar has an intermediate gelatinization temperature (70–75°C), as indicated by alkali spreading values of 3 to 5 in a 17 g kg^{-1} KOH solution.

Another feature of Bolivar is its excellent resistance to rice blast disease. Greenhouse inoculation tests during 1996 to 2000 demonstrated that Bolivar has the same reaction as 'Saber' to various races of blast. On the basis of the phenotypic reactions and molecular marker analysis Bolivar appears to possess the *pi-d*, *Pi-k*^{h} and *Pi-b* blast resistance genes (Fjellstrom et al., 2002). This combination of genes appears to provide excellent resistance to all races of the blast pathogen that are known to occur in the USA, except for IB-49. Saber and Bolivar are the only two U.S. cultivars known to possess the *Pi-b* gene (Fjellstrom et al., 2002), which was inherited from Te Qing, a common parent of both cultivars. In nursery inoculation tests for leaf blast symptoms conducted during 1996 to 2000 on a scale of 1 = highly resistant and 9 = highly susceptible, Bolivar was rated the same as Saber and 'Kaybonnet' (2) and more resistant than Gulfmont (5) and Dixiebelle (6). In 5 yr of regional field tests for reaction to the sheath blight pathogen, using the same scale, Bolivar (6.3) was less susceptible than Gulfmont (7.0) and was similar to Dixiebelle (6.8). In a 5 yr study at Beaumont, yield losses due to sheath blight were observed to be similar for Bolivar (9.8%) and Dixiebelle (10.9%) but less than Cypress (20.8%) and 'Lemont' (20.7%). Bolivar is more resistant to narrow brown leaf spot [caused by *Cercospora janseana* (Racib.) O. Const.] than Gulfmont, Dixiebelle, or Cypress. Like Saber and 'Jefferson', Bolivar is rated more resistant than Dixebelle, Cypress, and Kaybonnet for the physiological disorder straighthead. Bolivar provides a unique combination of superior cooking and processing quality with improved resistance to blast disease, which should make it profitable for growers and benefit the parboiling, canning, and other rice processing industries.

Bolivar has a semidwarf plant type (95 cm mature plant height) that is similar to Cypress (94 cm) but taller than Dixiebelle (87 cm). At maturity, the spikelet and apiculus are tawny-colored and awnless. Plants have erect tillers, and the leaves, lemma, and palea are glabrous. Average number of days to 50% flowering (75) and days to harvest (109) are very similar to Jefferson. Seedling vigor is similar to Jefferson and is less vigorous than Cypress.

In 41 statewide and regional tests conducted during 1996 to 2000, average grain yield (120 g kg^{-1} moisture) of Bolivar was 7066 kg ha^{-1}, compared with 7626, 7661, 8044, and 7449 kg ha^{-1} for Jefferson, Gulfmont, Cypress, and Dixiebelle, respectively. Compared with other commercial cultivars in these trials, the milling yield (mg g^{-1} whole milled kernels: mg g^{-1} total milled rice) of Bolivar (533:701) was lower than Gulfmont (576:704) and Dixiebelle (590:691).

Taller variants (2–4 cm) were removed from the Breeder seed field; the total number of variants was <1 per 5000 plants. U.S. Plant Variety Protection of Bolivar has been applied for (PVP 200200095). Breeder seed of Bolivar will be maintained by the Texas A&M University System Agric. Res. & Ext. Ctr. at Beaumont. Foundation seed will be available from the Texas Rice Improvement Association, 1509 Aggie Dr., Beaumont, TX 77713-8530. Limited quantities of seed will be available on request from the corresponding author for at least 5 yr. Recipients of seed are asked to make appropriate recognition of source of Bolivar if it is used in the development of a new cultivar, germplasm, parental line, or genetic stock.

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Table 1. Rough, brown, and milled grain dimensions and weight of Bolivar, Cypress, and Dixiebelle long-grain rice cultivars grown at Beaumont, TX, in 2002.

Class	Length (L)	Width (W)	Thickness	L/W ratio	Weight
	mm				mg
Bolivar					
Rough	8.59	2.61	1.92	3.29	21.3
Brown	6.89	2.26	1.75	3.05	19.8
Milled	6.62	2.18	1.68	3.04	18.0
Cypress					
Rough	8.89	2.51	1.98	3.54	24.2
Brown	6.99	2.23	1.80	3.14	20.3
Milled	6.77	2.05	1.75	3.30	18.9
Dixiebelle					
Rough	8.59	2.51	1.83	3.42	19.1
Brown	6.84	2.15	1.63	3.21	17.4
Milled	6.79	2.12	1.56	3.21	15.8

versity, College Station, TX 77843. Registration by CSSA. Accepted 30 June 2003. *Corresponding author (amcclung@ag.tamu.edu).

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Registration of 'TAM 111' Wheat

'TAM 111' (Reg. no. CV-930, PI 631352) is a medium-maturing, awned, white chaffed, semidwarf hard red winter wheat (*Triticum aestivum* L. em Thell) developed by the Texas Agricultural Experiment Station (TAES) and released in April 2002. TAM 111 was evaluated as TX95A3091, and has the pedigree 'TAM 107'//TX78V3630/'Centurk 78'/3/TX87V1233 (Porter et al., 1987; Schmidt et al., 1981). TX78V3630 has the pedigree 'Sturdy' sib/'Kaw'//'Centurk' (Atkins et al., 1967; Heyne et al., 1963; Schmidt et al., 1973). TX87V1233 has the pedigree TX78V3630//'Jupeteco' (PI 591766)/'Bluejay' (PI 591773). The final cross that generated the population that was the source of the selection, TX95A3091, was made in the greenhouse at Vernon, TX, in 1990. Bulk populations were advanced in the field until 1993, when single, fully fertile heads were selected at random from an F_4 population at Bushland, TX, and planted in an F_5 head row nursery in 1994. From a single head row, selected for maturity and uniformity, 2 single rows were grown for increase in 1995. Following testing in Texas preliminary and advanced yield trials in 1996 through 1998 (a total of 15 site-years), TX95A3091 was entered into regional and statewide nurseries beginning in the fall of 1998.

TAM 111 spikes are awned, dense, tapering, and inclined. Glumes are white, glabrous, short, and midwide. Glume shoulders are oblique. Beaks are acuminate and short, 6 to 7 mm long. Kernels are ovate, with rounded cheeks and a shallow, narrow crease. The brush is midlong and collared.

An important distinguishing characteristic of TAM 111 is that it is relatively tall for a drought-adapted (in terms of rainfed yield in a semi-arid climate), semidwarf wheat, especially so for its maturity range. In rainfed yield nurseries in the Texas Panhandle (6 site-years, 30-yr mean growing season precipitation of 256 mm), TAM 111 averaged 74 cm, 6 cm taller than TAM 107, 12 cm taller than 'TAM 200' (Worrall et al., 1995), and 7 cm shorter than the standard-height cultivar 'Larned' (Livers, 1978). In the same nurseries, TAM 111 mean heading date (days after 1 January) was 124, 5 d later than TAM 107, 2 d later than TAM 200 and 2 d earlier than Larned. Response to postanthesis drought was measured in terms of flag leaf senescence, on a 0-to-5 scale (0 = no damage, 5 = complete leaf senescence), and TAM 111 was found to average 2.7, about 0.6 greater than 'TAM W-101' (Porter, 1974), about 0.3 greater than TAM 107, about equal to TAM 200, and about 0.3 less than '2137' (Sears et al., 1997a).

In grain yield, TAM 111 has placed consistently among the highest ranking entries in nurseries in the southwestern Great Plains. In 1999 and 2000, in the rainfed Western Plains Regional Performance Nursery (WPRPN, a total of 14 site-years), mean yield of TAM 111 was 3610 kg ha^{-1}, about 10% greater than that of 'Trego' (mean yield of 3239 kg ha^{-1}) (Martin et al., 2001), the highest ranking check cultivar. Mean yield rank of TAM 111 in that nursery was 1 for 1999, and 3 for 2000. In Texas Panhandle rainfed yield testing over 4 yr (24 site-years), TAM 111 mean yield was 3932 kg ha^{-1}, 413 kg ha^{-1} greater than that of TAM 200 and 658 kg ha^{-1} greater than that of TAM 107. In addition, yield rank has been consistently high in both high-productivity and low-productivity environments. For example, in low productivity environments, the yield rank of TAM 111 was 4 in the 2000 WPRPN at Scottsbluff, NE, (mean nursery yield 1471 kg ha^{-1}), and yield rank of TAM 111 was 2 at Akron, CO, in the same nursery and year (mean nursery yield 2110 kg ha^{-1}). In high productivity environments in the WPRPN, TAM 111 yield ranks were 1 at Bushland, TX, in 1999 (mean nursery yield 4132 kg ha^{-1}), 2 at Colby, Kansas in 1999 (mean nursery yield 4095 kg ha^{-1}), 4 at Dakota Lakes, SD, in 1999 (mean nursery yield 4717 kg ha^{-1}), and 5 at Dakota Lakes in 2000 (mean nursery yield 4609 kg ha^{-1}). Grain volume weight of TAM 111 in the Texas Panhandle nurseries averaged 789 g L^{-1}, 5 g L^{-1} less than that of TAM 200 and 27 g L^{-1} more than that of TAM 107.

TAM 111 exhibits a resistant reaction to *Puccinia striiformis* Westend, the causal agent of stripe rust, similar to that of 'Jagger' (Sears et al., 1997b), on the basis of field reactions at 6 site-years in 2000 and 2001. TAM 111 is also resistant (postulated to possess *Sr6* and *Sr24*, on the basis of seedling screening by D. McVey at the USDA-ARS Cereal Disease Laboratory, St. Paul, MN) to stem rust (caused by *Puccinia graminis* f. sp. *tritici* Eriks. & E. Henn.). Moderate resistance has been observed to *Barley yellow dwarf virus*, and an intermediate reaction to *Wheat streak mosaic virus* has been documented, similar to or better than the comparable reactions of TAM 107, on the basis of field observations at four sites in 2000, and two sites in 2001. TAM 111 is susceptible to current races of leaf rust (caused by *Puccinia triticina* Eriks.), on the basis of both field reactions and seedling screening at the USDA-ARS Cereal Disease Lab. TAM 111 has been observed to be susceptible to powdery mildew (caused by *Blumaria graminis* DC f. sp. *tritici* em. Marchal), glume blotch [caused by *Stagnospora nodorum* (Berk.) Castellani & E.G. Germano], and *Wheat soilborne mosaic virus*. TAM 111 is susceptible to both the greenbug (*Schizaphis graminum* Rondani) and Russian wheat aphid (*Diuraphis noxia* Mordvilko), on the basis of seedling screening conducted by D. Porter and C. Baker at the USDA-ARS Laboratory at Stillwater, OK.

Quality characteristics of TAM 111 have been evaluated in milling and baking tests over three crop years (1998–2000) by the U.S. Grain Marketing and Research Laboratory, Manhattan, KS, as well as by the Cereal Quality Laboratory of Texas A&M University, College Station, TX. In the 1999 and 2000 WPRPN, quality characteristics were found similar to those of 'Arapahoe' (Baenziger et al., 1989). In Texas nurseries from 1998 through 2001, quality characteristics were superior to those of 'TAM 110' (Lazar et al., 1997) and TAM 200. In the WPRPN, in 2000 (including 7 locations), 1000-kernel weight averaged 23.7 g, 1.0 g more than 'Prowers' (Quick et al., 2001), 1.1 g less than Trego, and 1.8 g more than Arapahoe. Hardness score (single kernel hardness tester) was 73, equivalent to Larned, less than Prowers (81) and Trego (80), and more than Arapahoe (69). Milling score was 85, more than Trego (82) and Arapahoe (82), but less than Larned (87) and Prowers (92). Flour protein content was 13.1%, more than Trego (12.8%), but less than Arapahoe (13.9%), Prowers (14.2%) and Larned (13.2%). Flour absorption was 64.5%, more than Trego (63.2%), but less than Arapahoe (65.0%) and Prowers (66.5%). Mixogram mix time was 3.38 min, equal to Larned, more than Trego (2.88 min), but less than Prowers (4.88 min) and Arapahoe (3.50 min). Mixing tolerance was rated 4, greater than Trego (2), Larned (3) and Arapahoe (3), but less than Prowers (5). Proof height was 7.2 cm, equal to Arapahoe, but less than Prowers (7.4 cm) or Trego (7.4 cm). Loaf volume was 875 mL, greater than Arapahoe (865 mL), but less than Prowers (940 mL) or Trego (900 mL). Crumb grain was rated 4.0, equal to Arapahoe, and greater than Larned (3.5), Prowers (3.8) and Trego (2.8).

Seed of TAM 111 may be sold by cultivar name only as a class of Certified seed. Bulk seed is maintained by the Texas Foundation Seed Service, Vernon, Texas. Small quantities of seed for research purposes may be obtained from the corre-

sponding author. Application for U.S. Plant Variety Protection (Title V) of TAM 111 has been made (PVP).

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REGISTRATIONS OF GERMPLASMS

Registration of LG92-1255, LG93-7054, LG93-7654, and LG93-7792 Soybean Germplasm

The soybean [*Glycine max* (L.) Merr.] germplasm lines LG92-1255 (Reg. no. GP-283, PI 615553), LG93-7054 (Reg. no. GP-284, PI 615554), LG93-7654 (Reg. no. GP-285, PI 615555), and LG93-7792 (Reg. no. GP-286, PI 615556) were cooperatively developed and released in 1998 by the USDA-ARS and the Illinois Agricultural Experiment Station for use as parental lines in yield improvement programs. These lines combine high yield with unique genetic diversity not currently present in the commercially used gene pool in the USA. They were challenged with and found to be susceptible to races 4 and 7 of *Phytophthora sojae* M.J. Kaufmann & J.W. Gerdemann. No other data are available on reaction to soybean pathogens for these lines. All four lines were developed through an early generation testing procedure. The progenitor populations were yield tested as F_2 families in the F_3 and F_4 generations. The released lines were derived from single-plant selections made in the F_5 generation and bulk harvested in the F_6.

LG92-1255 is an F_6 line from LG84-1291 × 'A3127'. A3127 is from 'Williams' × 'Essex' (Bernard and Lindahl, 1972; Smith and Camper, 1973) and was used with permission from the Asgrow Seed Company. LG84-1291 is an F_5 selection from PI 68522 × 'Hobbit' (Bernard et al., 1987a; Cooper et al., 1991). LG92-1255 has indeterminate stem termination and is classified as late group II maturity. It has purple flowers, tawny pubescence, tan pods, yellow seed coat, and black hilum. In tests at six locations in central Illinois, LG92-1255 was 6 d later in maturity and yielded 20% more than 'IA2021'. At 12 locations in the Uniform Preliminary Test IIB in 1997, it was also 6 d later than IA2021 but yielded 3% less (Wilcox, 1997). LG92-1255 was higher in protein (411 vs. 372 g kg^{-1}) and lower in oil (207 vs. 221 g kg^{-1}) than IA2021 but the two lines were similar in other agronomic traits measured (Wilcox, 1997).

LG93-7054 is an F_6 line from LG85-3343 × 'S42-30'. LG85-3343 is an F_5 selection from PI 361064 × PI 407710 (Bernard et al., 1987b). S42-30 is from Essex × 'AgriPro 35' and was used with permission from the Northrup King Company. AgriPro 35 is from L15 × 'Cutler' (Probst et al., 1969) and L15 is from 'Wayne'(5) × 'Clark 63' with selection for *Rps*1 (Bernard, 1966; Williams and Bernard, 1964). LG93-7054 has indeterminate stem termination and is classified as late group II maturity. It has purple flowers, gray pubescence, brown pods, yellow seed coat, and imperfect black hilum. In tests at six locations in central Illinois, LG93-7054 was 5 d later in maturity and yielded 6% more than IA2021. At 12 locations in the Uniform Preliminary Test IIB in 1997, it was also 5 d later than IA2021 but yielded 3% less (Wilcox, 1997). LG93-7054 was higher in protein (414 vs. 372 g kg^{-1}), lower in oil (200 vs. 221 g kg^{-1}), and had smaller seed size (15.3 vs. 17.4 cg $seed^{-1}$) than IA2021 but the two lines were similar in all other agronomic traits measured (Wilcox, 1997).

LG93-7654 is an F_6 line from LG86-2734 × 'A3205'. LG86-2734 is an F_5 selection from PI 424195B × PI 361066A (Bernard et al., 1987b). A3205 is from 'S1474' × A3127 and was used with permission from the Asgrow Seed Company. S1474 was developed by Northrup King Company from 'Hark' × Wayne (Weber, 1967). LG93-7654 has indeterminate stem termination and is classified as late group III maturity. It has purple flowers, tawny pubescence, brown pods, yellow seed coat, and brown hilum. In tests at six locations in central Illinois, LG93-7654 was 1 d earlier in maturity and yielded 3% less than 'Macon'. At 10 locations in the Uniform Preliminary Test IIIA in 1997, it was 2 d earlier than Macon and yielded 4% less (Wilcox, 1997). LG93-7654 was higher in protein (421 vs. 407 g kg^{-1}), and smaller in seed size (15.4 vs. 18.0 cg $seed^{-1}$) but similar in oil (193 vs. 194 g kg^{-1}) and in all other agronomic traits measured compared with Macon (Wilcox, 1997).

LG93-7792 is an F_6 line from LG86-6989 × A3205. LG86-

6989 is an F_9 selection from PI 253665D × PI 283331 (Bernard et al., 1987b). LG93-7792 has indeterminate stem termination and is classified as early group IV maturity. It has purple flowers, tawny pubescence, brown pods, yellow seed coat, and brown hilum. In tests at six locations in central Illinois, LG93-7654 was 6 d later in maturity and yielded 3% less than Macon. At eight locations in the Uniform Preliminary Test IVA in 1997, it was 2 d later than Macon and yielded 3% less (Wilcox, 1997). LG93-7654 was higher in protein (411 vs. 401 g kg^{-1}) lower in oil (193 vs. 205 g kg^{-1}) and had smaller seeds (16.2 vs. 18.1 cg $seed^{-1}$) than Macon but the two lines were similar in all other agronomic traits measured (Wilcox, 1997).

The seven exotic parental lines (PI 68522, PI 253665D, PI 283331, PI 361064, 361066A, PI 407710, and PI 424195B) are yellow-seeded, grain-type soybeans in MG I, II, or III. PI 68658 was imported in 1926 from northeast China (Bernard et al., 1987a). PI 253665D originated in China and was brought to the USA in 1958 (Bernard et al., 1987b). PI 283331 came from Morocco in 1958 (Bernard et al., 1987b). PIs 361064 and 361066A are experimental lines that were developed in Yugoslavia and brought to the USA in 1971 (Bernard et al., 1987b). PI 407710 is a primitive Chinese cultivar obtained from Heilongjiang province in 1976 (Bernard et al., 1987b). PI 424195B was developed in Hungary and imported to the USA in 1978 (Bernard et al., 1987b). These introductions do not occur in the pedigrees of any released cultivars or germplasm in the USA.

Five (PI 68522, PI 253665D, PI 283331, PI 361064, and PI 407710) of the seven exotic accessions used to develop these experimental lines have been characterized by RAPD fragments and compared with the major ancestral lines of current U.S. cultivars (Brown-Guedira et al., 2000). These five accessions were classified into four different genetic groups. PI 283331 and PI 68522 were in two genetic groups that contained no U.S. ancestral lines. PI 253665D and PI 407710 were in the same genetic group that included ancestral lines that contributed less than 1% of the genes in current U.S. cultivars (Brown-Guedira et al., 2000). PI 361064 was grouped with major U.S. ancestral lines including S-100 and Lincoln when the clustering was based on 109 RAPD fragments and three SSR loci (Brown-Guedira et al., 2000) but did not cluster with any U.S. ancestral lines or exotic accessions and was classified as an outlier when the clustering was based on 281 RAPD fragments (Thompson et al., 1998)

Seeds of LG92-1255, LG93-7054, LG93-7654, and LG93-7792 will be deposited in the USDA Soybean Germplasm Collection and may be requested from the corresponding author for research purposes, including development and commercialization of new cultivars. It is requested that appropriate recognition be made if this germplasm contributes to the development of a new breeding line or cultivar.

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Registration of Rhizomania Resistant, Monogerm Populations C869 and C869CMS Sugarbeet

Sugar beet (*Beta vulgaris* L.) population C869 (Reg. no. GP-226, PI 628754) and its cytoplasmic male-sterile (CMS) counterpart C869CMS (Reg. no. GP-227, PI 628755) were developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association. These lines were released in 2002.

C869 is a monogerm (*mm*), O-type, self-fertile (S^f), genetic-male-sterile (*A_:aa*) facilitated, random-mated population. It segregates for resistance to rhizomania (caused by *Beet necrotic yellow vein virus*) conditioned by the *Rz1* allele. It has mostly red (*R*) hypocotyls. It is moderately resistant to *Beet curly top virus* (BCTV). C869 has wide variability for reaction to bolting, Erwinia rot (caused by *Erwinia carotovora* subsp. *betavasculorum* Thomson et al.) and powdery mildew (caused by *Erysiphe polygoni* DC.). C869 is an N-type for sucrose concentration with average sugar yield combining ability.

C869CMS is the cytoplasmic male sterile counterpart of C869. It will facilitate rapid development of CMS equivalents of lines extracted or developed from C869. It also may be useful as a monogerm, CMS tester to evaluate multigerm lines for general combining ability.

C869 is a moderately diverse population with good monogerm seed and O-type traits. It produces vigorous plants and high seed yield. Before 1995, the germplasm base of C869 involved developing and recombining subpopulations and selected progeny lines from various sources. Collectively, C869 comprises about 44% of its germplasm from C790 (PI 515964) (Lewellen and Skoyen, 1988) through C890 (PI 593700) (Lewellen, 1998); 12.5% from C310 (C6) (PI 590873) (Lewellen and Skoyen, 1988); 12.5% from BCTV and Erwinia resistant monogerm inbred C1546 (PI 590649) (McFarlane and Skoyen, 1965); and about 31% from the original source of *Rz1* (Biancardi et al., 2002). C790 was a broad based monogerm, self-fertile population that had undergone five cycles of S_1 progeny recurrent selection for sugar yield and was the source of mono-

germ inbreds such as C790-15 (PI 564758) (Lewellen, 1994). C310 is a monogerm, self-fertile population that has proven valuable as a source of *Lettuce infectious yellows virus* resistant parental lines, e.g., C301 (PI 590717) (Lewellen and Skoyen, 1987). Since 1995 when populations 867 [(C310 × C546)aa × Rz source] and C890 were combined to form 5869, the progenitor of C869, four cycles of selection have been completed. These included individual and combined selections for monogerm, rhizomania resistance, O-type, resistance to Erwinia, powdery mildew, bolting, and for higher sucrose content. From these cycles of selection, subpopulations 7869NB, 7869, and 8869 were formed. Mother root selections from these subpopulations were recombined in 1999 to produce 9869. In 2000, high quality, monogerm plants of 9869 were selfed to produce selfed progeny families. These families were indexed for O-type and separately evaluated for resistance to rhizomania. About 600 plants from 24 selfed families (i.e., 24 S_o plants) that appeared to be O-type and had resistance to rhizomania were recombined through their genetic male sterile segregants to produce 1869. Seed of 1869 is being released as C869. In 1996, plants of 5869 were increased through their male sterile segregants to produce 6869. Population 6869 was not used directly to produce C869 but was made available for genetic research and tentatively called C6869 (McGrath et al., 1999).

C869 and C869CMS should be useful as sources of resistance to rhizomania, BCTV, and other diseases in a monogerm, O-type background. Sufficient genetic variability should remain to permit continued population improvement and development of potential parental lines. C869 may be useful also as a base population from which to develop additional populations and breeding lines and from which to develop selfed progeny for mapping molecular markers. U.S. Plant Variety Protection will not be sought for these lines. Breeder seed is maintained by the USDA-ARS and will be provided to sugarbeet researchers in quantities adequate for reproduction, on request to the author (rlewellen@pw.ars.usda.gov or rtlewellen@hotmail.com).

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Registration of Sugarbeet Germplasm Lines C67/2, C69/2, C78/3, and C80/2 with Resistance to Virus Yellows and Rhizomania

Sugarbeet (*Beta vulgaris* L.) germplasm lines C67/2 (Reg. no. GP-229, PI 628750), C69/2 (Reg. no. GP-230, PI 628751), C78/3 (Reg. no. GP-231, PI 628752), and C80/2 (Reg. no. GP-232, PI 628753) were developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association. These lines were released in 2002. These are self-sterile (S^sS^s), multigerm (*MM*) lines that segregate for resistance to rhizomania caused by *Beet necrotic yellow vein virus*. Resistance to rhizomania is conditioned by *Rz1*. These lines have predominantly red (*R*) hypocotyls. Earlier versions of these lines have been released. They encompass a broad cross-section of the "Salinas" multigerm, germplasm base. The origin and development of these breeding lines span 20 to 60 yr of breeding efforts for improvements in productivity and combined disease resistance. Sugar yields tend to be primarily of the N-type but full-sib and other types of progeny tests have shown wide genetic variability for components of productivity. Selection pressure has been exerted to improve resistance to virus yellows caused by the *Beet yellows virus* (BYV), *Beet western yellows virus* (BWYV), and *Beet chlorosis virus* complex; *Erwinia carotovora* subsp. *betavasculorum* Thomson et al.; *Erysiphe polygoni* DC., the cause of powdery mildew; rhizomania; *Peronospora farinosa* (Fr.:Fr.) Fr., the cause of downy mildew; and *Uromyces betae* J. Kickx fil., the cause of rust.

C67/2 was selected from C67 (PI 599340) released in 1998. Since that release, C67/2 has undergone two additional cycles of recurrent phenotypic selection. In both cycles, emphasis was placed on selecting mother roots for sucrose concentration, size, and conformation from plants grown in the field under rhizomania conditions, inoculated with virus yellows and sugarbeet *Erwinia*, and naturally infected with powdery mildew. Plants that bolted before harvest were eliminated. C67/2 is estimated to have about 10% of its germplasm from *B. vulgaris* subsp. *maritima* (*Bvm*). The *Bvm* germplasm was derived from R322Y3%, a component of C51 (PI 593694) (Lewellen, 2000b), that had been selected for combined resistance to rhizomania, virus yellows, and agronomic traits. The sugarbeet germplasm was largely from C37 (PI 590715) (Lewellen et al., 1985b), C78 (PI 593671) (Lewellen et al., 1985a), C80 (PI 593672) (Lewellen, 1997), and C82 (PI 593675) (Lewellen, 1997). Resistance to rhizomania is conditioned by both *Rz* and factor(s) from C51 (*Bvm*) that gives a high level of resistance under high temperature conditions. During its development C67/2 has been tested as Y967 and Y167.

C69/2 was selected from C69 (PI 599341) released in 1998 (Lewellen, 2000a). Since then, C69/2 has undergone two additional cycles of recurrent phenotypic selection. In both cycles, emphasis was on selecting mother roots for sucrose concentration, size, and conformation from field plants grown under rhizomania conditions, inoculated with virus yellows and sugarbeet *Erwinia*, and naturally infected with powdery mildew. C69/2 is predominantly the germplasm of C31/6 (PI 590799) (Lewellen et al., 1978) with smaller amounts from C37, C46/2 (PI 590800), C39 (PI 583373) (Lewellen, 1995), C64 (McFarlane and Skoyen, 1965), and other sources. C69/2 is moderately resistant to virus yellows, bolting, powdery mildew, and *Er-*

winia. It is moderately susceptible to curly top. During its development, C69/2 has been tested as breeding line numbers Y969 and Y169.

C78/3 was selected from C78/2 (PI 593695) released in 1996 and C78 (PI 593671) released in 1994 (Lewellen, 1997). Since being released as C78/2, C78/3 has undergone three additional cycles of recurrent phenotypic selection. In each cycle, emphasis was on selecting mother roots for sucrose concentration, size, and conformation from field plants grown under rhizomania conditions, inoculated with virus yellows and sugar beet *Erwinia*, and naturally infected with powdery mildew. C78/3 is predominantly the germplasm from curly top resistant breeding line C46/2 (PI 590800) (Lewellen et al., 1985a). C78/3 is moderately resistant to virus yellows, bolting, powdery mildew, *Erwinia*, and *Beet curly top virus*. During its development, C78/3 has been tested as breeding line numbers R578, R578/2, R578%, R778, R778%, R978, and R178. Although handled as if completely self-sterile ($S^s S^s$), recent use of C78/3 progenitors as a recurrent parent in backcrossing programs has shown that some plants expressed varied degrees of self-fertility.

C80/2 was selected from C80 (PI 593672) (Lewellen, 1997), C80NB (PI 593673), and C80-45 (PI 593674) released in 1994. These sublines were recombined to produce C80/2. C80/2 has undergone four additional cycles of recurrent phenotypic selection. The first of these four cycles was for resistance to rhizomania in 4-mo-old plants within C80, C80NB, and C80-45. Selected plants from these lines were recombined into one population. In each of the next three cycles, emphasis was placed on selecting mother roots for sucrose concentration, size, and conformation from field plants grown under rhizomania conditions, inoculated with virus yellows and sugarbeet *Erwinia*, and naturally infected with powdery mildew. C80/2 was developed from a broad base of breeding lines in the virus yellows and multiple disease resistance program at Salinas. During its development, C80/2 has been tested as breeding line numbers R580, R580-45, R580NB, R780/2, R780-45, R980, and R180.

Lines C67/2, C69/2, C78/3, and C80/2 may be useful for continued line improvement and as sources of multiple disease resistant germplasm. These four lines represent a broad germplasm base and encompass much of the germplasm developed in the long term breeding program at Salinas. They account for much of the germplasm from the virus yellows (BYV/BWYV) breeding program that has been ongoing since 1955. On the basis of previous successes and evidence from progeny family evaluations (both S_1 and full sib), these lines may continue to be useful as sources from which to extract parental lines. U.S. Plant Variety protection will not be sought for these lines.

Breeder seed is maintained at the USDA-ARS and will be provided to sugarbeet researchers in quantities adequate for reproduction, on request to the author (rlewellen@pw.ars.usda.gov or rtlewellen@hotmail.com).

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Registration of Sugarbeet Germplasm Lines C927-4, C929-62, C930-19, and C930-35 with Resistance to Rhizomania, Virus Yellows, and Bolting

Sugarbeet (*Beta vulgaris* L.) germplasm lines C927-4 (Reg. no. GP-233, PI 628756), C929-62 (Reg. no. GP-234, PI 628757), C930-19 (Reg. no. GP-235, PI 628758), and C930-35 (Reg. no. GP-236, PI 628759) were developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association. These lines were released in 2002. They are narrowly based, each having been increased from one S_1 progeny (one selfed S_o plant). They are multigerm (*MM*), self-fertile (S^f) diploids that segregate for genetic male sterility (*aa*) and resistance to rhizomania conditioned by *Rz1*. They have shown good general combining ability for sugar yield in experimental hybrids. In general, they show nonbolting tendency in over-wintered plantings and have tolerance to virus yellows (VY), caused by *Beet yellows virus* (BYV), *Beet western yellows virus* (BWYV), and *Beet chlorosis virus* (BChV). Except for the intermediate reaction for C930-35, all show high resistance to sugar beet *Erwinia*, caused by *Erwinia carotovora* subsp. *betavasculorum* Thomson et al.

Lines C927-4, C929-62, C930-19, and C930-35 were identified and selected from a program designed to combine multiple disease resistance and factors for productivity. S_1 progeny evaluations followed by testcross hybrid evaluations were used. S_1 progeny evaluation is a useful plant breeding method for identifying and improving traits with additive genetic variance, e.g., most disease resistances and sucrose concentration. Breeding lines with self-incompatibility (S^sS^s) comprise most of the advanced, highly productive sugarbeet germplasm, however, they do not easily lend themselves to this breeding procedure. The program from which these lines were selected was designed to determine if self-incompatible lines could be worked quickly into an S_1 testing program. To accomplish this, self-incompatible lines were crossed onto genetic-male-sterile plants from self-fertile, genetic-male-sterile facilitated, random-mated populations that had been undergoing population improvement. These F_1 population or line hybrids were then used as the source of the S_o plants to produce S_1 progenies. Because seed of population hybrids can be easily produced in large quantities, the S_o plants can be selected after rigorous evaluation for one or more moderate to highly heritable traits. In this scheme, most of the S_o plants will be pollen fertile (*Aa*)

and their S_1 progenies will segregate 3*A*_:1*aa*, giving ample opportunity and flexibility for selecting materials to be used in a continuing line or population improvement program. With the exception of C930-19, only 6 yr were needed to go from the initial crosses to early generation lines with potential for development into parental lines for C927-4, C929-62, and C930-35.

C927-4 segregates for hypocotyl color (*R*). In addition to resistance to rhizomania conditioned by *Rz1*, resistance is also provided from factor(s) from *B. vulgaris* subsp. *maritima* (*Bvm*). C927-4 produces hybrids with intermediate sucrose concentration and high sugar yield. Relative performance of these hybrids is best when grown under rhizomania conditions. C927-4 is moderately susceptible to powdery mildew (caused by *Erysiphe polygoni* DC.) and *Beet curly top virus* (BCTV).

C927-4 was derived from a population cross between populations C918 (PI 578079) (USDA, 1993) and 921. C918 is a multigerm, self-fertile, genetic-male-sterile facilitated, random-mated population. Self-fertile population 921 was developed from crosses between C918 and self-sterile lines R322Y3 and R322R4. Lines R322Y3 and R322R4 are similar to C51 (PI 593694) (improved C50, PI 538251) (Lewellen, 2000) that was developed from composite crosses between sugarbeet and *Bvm*. Theoretically, about 12% of C927-4 would be from *Bvm*. Population C918 is a source for the *Rz1* allele for resistance to rhizomania. C51 contributed additional factors that condition improved resistance and survivability of plants under the combined effects of severe rhizomania and high temperature stress. C927-4 possesses this type of resistance to rhizomania. From the F_1 population hybrid between genetic-male-sterile plants from C918 and fertile plants from 921, individual S_o plants were selected for sucrose concentration under VY inoculated (BYV/BWYV/BChV) conditions and selfed under bags to produce S_1 progeny families. These S_1 progenies were evaluated for resistance to rhizomania at Salinas and Brawley, CA, for performance under VY inoculated conditions at Salinas and Davis, CA and for bolting tendency at Salinas. On the basis of these tests, S_1 progenies were selected, increased in isolation, and testcrossed to a monogerm, cytoplasmic male-sterile line. Line 9927-4VY was selected based on the performance of its experimental hybrid and increased through its genetic-male-sterile segregants to produce line 1927-4 that was released as C927-4.

C929-62 has red hypocotyls (*RR*) and near seed maturity has reddish stems and seedballs. It has moderately high resistance to powdery mildew and is moderately susceptible to BCTV and downy mildew caused by *Peronospora farinosa* (Fr.:Fr.) Fr.]. C929-62 produces hybrids with intermediate sugar concentration and high sugar yield.

C929-62 was derived from a population cross between genetic-male-sterile plants from population C918 and C76-89-18 (PI 593699). Self-sterile line C76-89-18 was advanced from one full-sib progeny that was susceptible to rhizomania but had high sugar yield combining ability and resistance to VY, *Erwinia*, and bolting. It was selected from C31/6 (PI 590799) type germplasm. From the F_1 population hybrid, individual S_o plants were selected for sucrose concentration under VY inoculated conditions and were selfed under bags to produce S_1 progenies. These S_1 progenies were evaluated at Salinas and Davis for performance under VY inoculated conditions and at Salinas for components of sugar yield, resistance to rhizomania, and nonbolting tendency. On the basis of these tests, S_1 progenies were selected, increased, and testcrossed to a monogerm, CMS tester. Line 9929-62VY was selected for further evaluation based on the performance of its experimental hybrid. Line 9929-62VY was increased through its male-sterile segregants to produce line 1929-62 that was released as C929-62.

C930-19 segregates for hypocotyl color. It is moderately resistant to BCTV and powdery mildew and has very high nonbolting tendency. In tests at Salinas and Brawley, its hybrids have moderate to high sugar concentration and sugar yield.

C930-19 was derived from a population cross made in 1995 between population C918 and breeding line C78 (PI 593671). C78 is a rhizomania resistant version of C46/2 (PI 590800). Self-sterile C46/2 has moderate BCTV resistance and has been an important source of pollinators used commercially in California. From the F_1 population hybrid, individual S_o plants were selected for resistance to rhizomania and were selfed to produce S_1 progenies. These S_1 progenies were evaluated at Salinas for components of sugar yield and for resistance to bolting, rhizomania, powdery mildew, and VY. On the basis of these tests, S_1 progenies were selected, increased, and testcrossed to a monogerm, CMS tester. Line 8930-19 was chosen from among this group for further evaluation based on the performance of its experimental hybrid. Over-wintered stecklings from Oregon of 8930-19 were transplanted into a field isolation plot at Salinas. In the absence of an artificially extended photoperiod, stecklings of 8930-19 were very slow to bolt and some plants did not flower. During seed harvest, 30 of these nonflowering plants were saved out of an initial 210 stecklings, regrown in the greenhouse, and vernalized for 140 d, then replanted into a greenhouse isolation chamber with a 24-h photoperiod. Under these conditions, this nonbolting selection from line 8930-19 produced seed. This seed was harvested in bulk without regard to male sterile segregants and called 1930-19. Line 1930-19 was reselected for resistance to rhizomania and selected plants were increased through its genetic-male-sterile segregants to produce 2930-19. Line 2930-19 was released as C930-19.

C930-35 has green hypocotyls (*rr*), is moderately resistant to BCTV and powdery mildew and has high sucrose concentration. C930-35 produces hybrids with high sugar concentration but moderate root and sugar yields.

C930-35 was derived from a population cross made in 1996 between genetic-male-sterile plants from one component of population CZ25 (PI 599343) and breeding line C78. This component of CZ25 was a multigerm, self-fertile, genetic-male-sterile facilitated, random-mated population. It was developed from crosses between breeding sources similar to C918 and high sucrose accessions from Poland. About 25% of the germplasm of C930-35 would be Polish. The Polish germplasm was from $2n = 2x = 18$ chromosome, multigerm, self-incompatible (S^sS^s), type-ZZ lines accessed from Dr. A. Szreder, Hodowla Buraka Cukrowego, Poland, in 1988 for use in the Salinas breeding program. A composite of nine Polish accessions were crossed to genetic-male-sterile plants from a progenitor of population C918 to ultimately produce population CZ25. From the F_1 population hybrid between CZ25 and C78, individual S_o plants were selected for resistance to rhizomania and were selfed in bags to produce S_1 progenies. These S_1 progenies were evaluated at Salinas for components of sugar yield and resistance to bolting, rhizomania, and powdery mildew. At both Salinas and Davis, they were evaluated for sugar yield under VY inoculated conditions. On the basis of these tests, S_1 progenies were selected, increased, and testcrossed to a monogerm, CMS tester. Line 9930-35 was selected for further evaluation based on the performance of its experimental hybrid. Line 9930-35 was increased through its male-sterile segregants to produce line 1930-35 that was released as C930-35.

Lines C927-4, C929-62, C930-19, and C930-35 may be useful

as germplasm sources for further improvements and as sources of combined disease and bolting resistance in highly productive backgrounds. They need to be evaluated as early generation lines for the potential development of pollinators for commercial hybrids. U.S. Plant Variety Protection will not be sought for these lines.

Breeder seed is maintained by the USDA-ARS and will be provided to sugarbeet researchers in quantities adequate for reproduction, on request to the author (rlewellen@pw.ars.usda.gov or rtlewellen@hotmail.com).

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Registration of FC724 Monogerm, O-Type, Sugarbeet Germplasm

Sugar beet (*Beta vulgaris* L.) germplasm FC724 (Reg. no. GP-228, PI 632251) was developed by the USDA-ARS, Fort Collins, CO, in cooperation with the Beet Sugar Development Foundation, Denver, CO. FC724 has high resistance to root-rotting strains (AG-2-2) of *Rhizoctonia solani* Kühn and good to moderate resistance to Cercospora leaf spot (caused by *Cercospora beticola* Sacc.), but is *Beet curly top virus* (BCTV) susceptible. FC724 was developed as a population from which to select monogerm O-type parental lines with enhanced Rhizoctonia resistance. There is no CMS equivalent. FC724 was released in 2003 from seed production 19961014.

FC724 is an O-type germplasm with 12% green hypocotyls (14/116 plants) and is segregating for monogerm (*mm*). It is a product of nine generations of cyclic mass selection for resistance to Rhizoctonia root rot and two cycles of recurrent selection for general combining ability. The approximate genetic contribution of the parents to the original population was 20% 611100-0, 17% FC 601/2, and 63% FC 702 (Hecker and Gaskill, 1972). The original crosses were FC 702 (Hecker and Gaskill, 1972) by selfed progeny lines from FC 601/2 and from 611100-0. Breeding line 611100-0 was developed through a polycross of several BCTV and leaf spot resistant lines: SLC122-0, US22/3 (PI 590708; Murphy et al., 1948), US201 (PI 590678), US22/4 (SL92 = PI 610266; Coons et al., 1955), SL202 (F_2 of US35/2 × US22/4). FC601/2 consisted of selected progeny lines from SL202 × SLC122-0. Because the original crosses were made to male-sterile plants (genetic male sterility-*aa*), it is possible that FC724 is segregating for genetic male sterility, but no male sterile-plants were observed in the last seed production.

Testcross hybrids were produced with Fort Collins breeding lines to test for general combining ability in 1974 and 1977. Remnant, selfed seed from superior lines was recombined after each cycle of testing. The population has gone through nine cycles of selection in the USDA-ARS Rhizoctonia nursery at Fort Collins (Panella, 1998), has been O-type indexed to remove restorer genes, and has been selected for monogerm seed throughout the development process. The smallest population size was 19 plants.

FC724 exhibited excellent resistance to Rhizoctonia root rot when tested under strong disease pressure (Ruppel et al., 1979). FC724's performance was not significantly different from the highly resistant check (FC 705/1) (Hecker and Ruppel, 1985) in disease index (DI) ratings from 1998 through 2001, respectively (DI of 0 = no root rot and 7 = all plants dead). FC724 performed significantly better than the susceptible check (FC901/C817) (Gaskill et al., 1967). FC724 had mean disease indices (DIs) of 2.3, 3.1, 3.1, and 1.7 (1998–2001, respectively), whereas the highly resistant check had DIs of 2.7, 3.3, 3.1, and 1.6, respectively. Percentages of resistant plants (those rated 0 or 1) were 47, 16, 5, and 52 for FC724; 33, 22, 13, and 53 for the highly resistant check and 12, 12, 3, and 44 for the resistant check (FC 703) (Hecker and Ruppel, 1977), (1998–2001, respectively).

FC724 also exhibited resistance to Cercospora leaf spot when tested in an artificial epiphytotic (Ruppel and Gaskill, 1971). In 2 yr of tests, it was significantly better than the susceptible check and not significantly different from the resistant check in 1 yr and had significantly less resistance than the resistant check in the other. The following DI ratings (DI of 0 = no leaf spot and 10 = all plants dead) represent the most severe rating (last of three or four ratings each season). The DIs of FC724 were 4.0 and 3.2; DIs of the resistant check (FC504CMS/FC502-2//SP6322-0) (Coe and Hogaboam, 1971; Smith and Gaskill, 1979) were 2.8 and 2.9; DIs of the susceptible check (SP351069-0) were 6.5 and 5.8, respectively. FC724 does not show tolerance to the BCTV.

In 2002, FC724 was planted in one-row plots, replicated six times at the USDA-ARS Fort Collins Research Farm, on May 3. Plots were 3.04 m long with 56 cm between rows and 20 to 25 cm within-row spacing. Roots were harvested on October 8 and sent to the Western Sugar Co. tare lab in Scotts Bluff, NE, for analyses. The average sucrose concentration and sugar loss to molasses of three commercial varieties—Beta 6045, HM1955, Monohikari—was used as a standard for comparison. Sucrose concentration of FC724 was 96.3% of the standard, and in sugar loss to molasses, FC724 was 97.9% of the standard.

Breeder seed of FC724 is maintained by USDA-ARS and, for at least 5 yr, will be provided in quantities sufficient for reproduction on written request to Sugar Beet Research, USDA-ARS, Crops Research Laboratory, 1701 Center Ave., Fort Collins, CO 80526-2083. Seed of this release has been deposited in the National Plant Germplasm System, where it is available for research purposes, including development and commercialization of new lines or cultivars. The developing organizations request appropriate recognition of the source when this germplasm contributes to a new cultivar. U.S. Plant Variety Protection will not be requested for FC724.

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Registration of T589 and T2100 Sunflower Germplasms with Modified Tocopherols

Two sunflower (*Helianthus annuus* L.) germplasms were jointly developed and released by the Institute for Sustainable Agriculture (CSIC) and the Center of Agricultural Research and Development (CIFA-Junta Andalucía) at Córdoba, Spain, in 2001. T589 (Reg. no. GP-271, PI 632415) has an increased level of β tocopherol in the seed oil. T2100 (Reg. no. GP-272, PI 632416) has an increased level of γ tocopherol in the seed oil. Oil from seeds of cultivated sunflower has no less than 90% of the total tocopherols in the α tocopherol form, which has the lowest antioxidant property of the tocopherols (Demurin et al., 1996). More than 30% of the total tocopherols in the oil of T589 are in the β tocopherol form, whereas more than 85% of the total tocopherols in the oil of T2100 are in the γ tocopherol form. Both traits are associated with improved oxidative stability of the seed oil.

T589 was initially selected from PI 307937, a selection of 'Peredovik' originally collected from the National Institute of Agricultural Research, Madrid, Spain, in 1965, in which seeds with an increased β tocopherol content were identified after nondestructive analysis of half seeds for tocopherol content (Goffman et al., 1999). Fifteen seeds with an α tocopherol content between 647.9 and 862.8 mg kg^{-1} in the oil and a β tocopherol content between 407.9 and 593.4 mg kg^{-1} in the oil were identified after the analysis of 100 seeds of PI 307937. The other 85 seeds had predominantly α tocopherol, with a maximum β tocopherol content of 64.3 mg kg^{-1} in the oil. All the seeds with an increased β tocopherol content produced plants that expressed the character uniformly, with the β tocopherol content ranging from 339.9 to 542.3 mg kg^{-1} in the oil. T589 was developed by bulking an equal number of seeds from these plants. The germplasm was multiplied during the 2000 and 2001 growing seasons, during which the increased levels of β tocopherol were consistently expressed. Crosses of T589 with the standard line HA 89 produced F_1 seeds with a standard tocopherol profile, and F_2 progenies that segregated in a three standard to one increased β tocopherol ratio, indicating that increased β tocopherol content is controlled by a recessive allele at a single locus. T589 has a plant height of 125.6 ± 3.9 cm, a 1000-seed weight of 57 ± 3 g, a seed oil content of 386 ± 21 g kg^{-1}, and flowers 78.3 ± 1.1 d after planting. Plants are nonbranched.

T2100 was a selection from CO-77-256, an old accession of Peredovik from the germplasm collection of the Institute for Sustainable Agriculture at Córdoba. Single-seed analyses for tocopherol content in CO-77-256 identified six seeds with an α tocopherol content ranging from 56.3 to 93.2 mg kg^{-1} in the oil and a γ tocopherol content varying from 919.9 to 1069.4 mg kg^{-1} in the oil. The remaining seventy-two seeds of CO-77-256 had predominantly α tocopherol, with a maximum γ tocopherol content of 101.3 mg kg^{-1} in the oil. All the seeds with an increased γ tocopherol content produced plants that expressed the character uniformly, with a γ tocopherol content ranging from 1051.7 to 1123.5 mg kg^{-1} in the oil. T2100 was developed by bulking an equal number of seeds from plants having increased γ tocopherol content. Similar levels of γ tocopherol were observed in seeds of T2100 when the germplasm was multiplied during the 2000 and 2001 growing seasons. Crosses of T2100 with HA 89 produced F_1 seeds with a standard tocopherol profile, and F_2 progenies that segregated in a three standard to one increased γ tocopherol ratio, revealing that the increased levels of γ tocopherol are controlled by a recessive allele at a single locus. T2100 has a plant height of 101.2 ± 5.0 cm, a 1000-seed weight of 42 ± 2 g, a seed oil content of 400 ± 18 g kg^{-1}, and flowers 74.6 ± 1.2 d after planting. Plants are non-branched.

Sunflower germplasms with tocopherol profiles similar to T589 and T2100 have been reported by Demurin et al. (1996). They developed two inbred lines, LG 15 derived from an open-pollinated cultivar VNIIMK 8931 with a β tocopherol level comprising 50% of the total tocopherol content, similar to T589, and LG 17 derived from the Russian germplasm accession VIR 44 with a γ tocopherol level comprising 95% of the total tocopherol content, similar to T2100. A comparative evaluation of T589, T2100, LG 15, and LG 17 has not been conducted.

Because tocopherols are fat soluble compounds, they act as natural antioxidants of fats and oils (Kamal-Eldin and Appelqvist, 1996). Both β and γ tocopherol exhibit an increased in vitro antioxidant effect compared to α tocopherol (Pongracz et al., 1995). Therefore, T589 and T2100 can be used for developing sunflower lines with improved oxidative stability of the oil. They are also useful for basic and applied research on plant tocopherols. Breeder seed of T589 and T2100 will be maintained by the CSIC and will be provided on request to the senior author. Appropriate recognition is requested if these germplasms contribute to the development of new breeding lines or hybrids. U.S. Plant Variety Protection will not be requested for T589 and T2100.

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Registration of KBNT *lpa*1-1 Low Phytic Acid Germplasm of Rice

The ARS-USDA and the Arkansas Agricultural Experiment Station released KBNT *lpa*1-1 (Reg. no. GP-86, PI 632282), a low phytic acid mutant of rice (*Oryza sativa* L.) in April 2002. The mutant was induced by γ radiation of the Arkansas rice cultivar 'Kaybonnet' (KBNT) (Gravois et al., 1995). The phytic acid portion of seed phosphorus (P) in KBNT *lpa*1-1 is reduced from 71 to 39% and the inorganic portion of seed P is increased from 5 to 32%, with little effect on total seed P (Larson et al., 2000). Phytic acid P is poorly digested by humans and non-ruminant livestock, and also may interfere with nutritional uptake of minerals like calcium, zinc, and iron.

Approximately 4000 seeds of the parent cultivar Kaybonnet were treated with 200 Gy of γ rays in 1994. The M_1 generation was grown at Stuttgart, AR, and about 1000 random panicles were harvested for a panicle-to-row M_2 generation, part of which was grown in a 1994-1995 winter nursery. Panicles from eight or nine plants of each of 347 M_2 rows were harvested for summer 1995 panicle-to-hill plantings. Bulked seeds from each of the 347 M_2 rows were screened for the elevated inorganic P which is associated with reduced phytic acid content using a colorimetric test for inorganic P (Chen et al., 1956). In one row, seeds for low phytic acid were found. Examination of seeds at harvest from the nine M_3 hills of this row showed that two hills apparently were homozygous for the low phytic acid mutation, three hills were heterozygous, and four hills did not have the mutation. In a subsequent mapping population derived from a cross between one of these homozygous mutants and the indica cultivar Zhe 733 (Wenchao and Guohai, 1991), segregations of F_2 plants, as determined by F_3 progeny tests, were 28 homozygous wild-type:81 heterozygous:28 homozygous mutant lines. These data fit ($0.10 < P < 0.25$) the 1:2:1 ratio for a single recessive gene for low phytic acid, which was designated *lpa*1-1. The *lpa*1-1 mutation was mapped to a 2.2-cM interval on chromosome 2L (Larson et al., 2000).

In the 1998 two-location Stuttgart Initial Test 7 (SIT7), KBNT *lpa*1-1 yielded 6680 kg ha^{-1} compared to 7050 and 7810 kg ha^{-1} for Arkansas check cultivars Katy (Moldenhauer et al., 1990) and Drew (Moldenhauer et al., 1998), respectively. KBNT *lpa*1-1 was similar to the two checks for days to heading and lodging, about 10 cm shorter in height, and slightly higher in percent whole milled grain. In the 1999 SIT5, respective direct comparisons of the mutant and its KBNT parent were 7100 versus 8000 kg ha^{-1} grain yield, 87 versus 86 d to heading, 112 versus 110 cm tall, zero lodging for both, 51 versus 52% whole milled grain, and 1.408 versus 1.473 g for 100 milled kernel weight. In the unreplicated Preliminary Tests at Stuttgart in 1999, three entries of KBNT *lpa*1-1 averaged 6990 versus 6680 kg ha^{-1} for two entries of the parent. Thus, on balance, yield of KBNT *lpa*1-1 was about 90% of standard Arkansas cultivars. Amylose contents of the mutant and its parent were both 220 g kg^{-1}.

In a 1998 greenhouse screening, the pattern of reaction to seven blast isolates of KBNT *lpa*1-1 was identical to that of the KBNT parent, i.e., both were susceptible to isolates IB-33 and IE-1K, and resistant to isolates IB-1, IB-49, IC-17, IG-I, and IG-1. Thus, except for low phytic acid and the 10% yield reduction, the phenotype of KBNT *lpa*1-1 was essentially identical to the parent.

Germplasm amounts of seed (≤5 g) of KBNT *lpa*1-1 may be obtained by writing to J. Neil Rutger, Dale Bumpers National Rice Research Center, USDA-ARS, P.O. Box 1090, Stuttgart, AR 72160. Seed also will be placed in the National Small Grains Collection, USDA-ARS, 1691 South 2700 West, Aberdeen, ID 83210, where it is available for research purposes, including development and commercialization of new cultivars. If this germplasm contributes to the development of new cultivars it is requested that appropriate recognition be given to the source.

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Registration of *aromatic se* Rice Germplasm

The ARS-USDA released *aromatic se* (Reg. no. GP-87, PI 632283) rice (*Oryza sativa* L.) in February 2002. The *aromatic se* germplasm was developed at Stuttgart, AR, as a semidwarf (s), early maturing (e) recombinant from a cross between a semidwarf mutant, PI 457917 (experimental designation DM 107-4), and PI 429861, an early maturing mutant released in

Pakistan as the cultivar Kashmir Basmati (Awan, 1984). Both mutants were induced from the tall, late maturing, aromatic Basmati 370 cultivar, as part of a Pakistan PL-480 project completed in 1984. In previous genetic studies, Awan (1984) indicated that each of the individual characters, semidwarfism and early maturity, was recessive in nature. Awan and Cheema (1999) later reported that DM 107-4 has a dwarfing gene nonallelic to the Deo-Geo-Woo-Gen semidwarfing source. The *aromatic se* germplasm retains the aroma and cooking quality of the Basmati 370 source. The germplasm is expected to be useful in breeding semidwarf, early maturing, aromatic rices adapted to the USA.

The cross between the semidwarf, late maturing PI 457917 and the tall, early maturing PI 429861 was made at Stuttgart in winter 1996-1997, and the F_1 transplanted to the field in 1997. In an F_2 generation of over 2000 plants grown in 1998, an estimated one fourth of the population was semidwarf, a similar proportion was as early maturing as the PI 429861 parent and about 1/16 recombined both semidwarfism and early maturity. Over 100 putative semidwarf, early maturing F_2 plants were selected for F_3 progeny tests at Stuttgart in 1999. The selections were uniform for semidwarfism but minor segregation for maturity was still evident. Most lines flowered within 2 to 3 d of the early parent, PI 429861, which flowers about 100 d after planting at Stuttgart. The F_4 generation of 66 lines was grown in the 1999-2000 winter nursery, and the F_5 in the 2000 Stuttgart summer nursery. Fifty-two F_6 lines were selected in the 2000-2001 winter nursery and were reduced to 17 lines in the F_7 generation at Stuttgart in 2001. These 17 lines were grown in a small-plot yield test of four replications, plot size of six rows, 1.2 m long, 0.3 m apart, with the center two rows harvested. The tall, early parent, PI 429861, was included, but not the semidwarf parent which flowers too late to set seed in the field in Arkansas. Yield of the recombinants ranged from 3180 to 4710 kg ha^{-1}, compared to 5880 kg ha^{-1} of the tall parent. The tall parent, which was about 160 cm tall, lodged severely a few days before harvest while the semidwarf early maturing recombinants, which were about 110 cm tall, remained erect. Length of 10 dehulled grains of each of the 17 lines ranged from 6.70 to 7.12 mm, compared to 7.06 mm for the tall, early, parent. For comparison, grain length of nine Basmati 370 accessions acquired from the National Small Grains Collection, but not grown at Stuttgart in 2001, ranged from 6.07 to 6.83 mm. Seeds of the 17 recombinant lines were bulked to form the germplasm release *aromatic se*. In tests for presence of 2-acetyl-1-pyrroline, a major component of aroma, *aromatic se* was similar to the early maturing parent, PI 429861, and with imported basmati rice purchased in Arkansas markets. Amylose contents of *aromatic se* and PI 429861 were 200 g kg^{-1}, and both were intermediate gel types.

Germplasm amounts ($\leq$5 g) of *aromatic se* may be obtained by writing to J. Neil Rutger, Dale Bumpers National Rice Research Center, USDA-ARS, P.O. Box 1090, Stuttgart, AR 72160. Seed of *aromatic se* also will be placed in the National Small Grains Collection, USDA-ARS, 1691 South 2700 West, Aberdeen, ID 83210, where it is available for research purposes, including development and commercialization of new cultivars. If this germplasm contributes to the development of new cultivars it is requested that appropriate recognition be given to the source.

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Registration of Six Semidwarf Mutants of Rice

The ARS-USDA and the Arkansas Agricultural Experiment Station released six induced semidwarf mutants of rice (*Oryza sativa* L.), KBNT 4 (Reg. no. GP-80, PI 632276), KBNT 5 (Reg. no. GP-81, PI 632277), LGRU 12 (Reg. no. GP-82, PI 632278), LGRU 13 (Reg. no. GP-83, PI 632279), ADAR 10 (Reg. no. GP-84, PI 632280), and ORIN 172 (Reg. no. GP-85, PI 632281), in March 1999. The mutants were induced at Stuttgart, AR, in four tall Arkansas rice cultivars, Kaybonnet (KBNT) (Gravois et al., 1995), LaGrue (LGRU) (Moldenhauer et al., 1994), Adair (ADAR) (Gravois et al., 1994), and Orion (ORIN) (Moldenhauer et al., 1992), to obtain semidwarfism in adapted germplasm quickly. These mutants, which have height reductions from 10 to 26% of their tall parents, provide breeding sources of semidwarfism nonallelic to the worldwide semidwarfing gene *sd*1, in tropical japonica germplasm adapted to the southern USA and similar climatic areas. Such mutants provide alternative semidwarfing sources should genetic vulnerability problems arise from widespread use of *sd*1.

Approximately 4000 dry seeds of each parent cultivar were treated with 200 or 250 Gy of γ rays in 1993 or 1994. The M_1 of the medium grain cultivar ORIN was grown in the 1993-1994 Puerto Rico winter nursery, while the M_1 generations of the other three cultivars were grown at Stuttgart in 1994. Because of extremely poor growth in the 1993-1994 winter nursery, only 121 panicles were harvested from the 200 Gy and 60 panicles from the 250 Gy treatment of ORIN. In the three long grain cultivars, ADAR, LGRU, and KBNT, stand reductions in the 250 Gy-treated M_1 generations were so severe that the treatment was abandoned. However, about 1000 random panicles were harvested from each 200 Gy treatment of these cultivars. Each M_1 panicle was sown in an M_2 row in the succeeding summer or winter nursery as appropriate. In the M_2 generation semidwarf selections were made in rows segregating for more than one semidwarf plant per row. Usually about one-fourth of the plants in M_2 rows that were selected had semidwarf plant height, which virtually assured that recessive mutants were being selected. The general criteria in selecting semidwarfs were to look for plants that were 10 to 25% shorter than their parent, but otherwise were normal in appearance.

Allelism tests to *sd*1, the worldwide semidwarf source, were conducted by crossing the M_3 or M_4 semidwarf generation mutants as females to 'Calmochi-101' (C101) (Carnahan et al., 1986), 'S-101' (S101) (Johnson et al., 1989), or 'ED7' (Rutger et al., 1982), three lines known to carry *sd*1 from 'Calrose 76' (CA76) (Rutger et al., 1977). Calrose 76 is itself an induced semidwarf mutant. Height of the three known *sd*1 sources was 80 to 90 cm, which was similar to or slightly taller than the new mutants. All three *sd*1 sources from Calrose 76 have pubescent leaves and hulls, while the new mutants and their parents carry the recessive gene for glabrous leaves and hulls. The F_1 generations were grown in the greenhouse and

checked for pubescence to assure true crosses, but height data were inconclusive under these conditions. The F_2 and F_3 generations were grown in the field. Allelism tests among the six mutants were not conducted.

In an eight-replication characterization test at Stuttgart in 1997, KBNT 4 was 76 cm tall, or 27 cm shorter and 3 d later than its parent. In the cross KBNT 4/KBNT, F_2 plant heights in 1996 ranged from 50 to 125 cm, with a break in the bimodal distribution between 90 and 95 cm, resulting in a segregation of 147 tall:54 semidwarf, a satisfactory fit ($0.50 < P < 0.75$) to a 3:1 ratio indicating a recessive single gene in the mutant. In this same year, the cross KBNT 4/C101 was observed to have a continuous distribution for F_2 plant height ranging from 60 to 130 cm, indicating inconclusive segregation data. In F_3 progeny tests of this cross in 1997, using subjective scoring for height, it was deduced that the F_2 phenotypes had been 115 tall:69 semidwarf:1 double dwarf, where the two semidwarf parental phenotypes could not be distinguished from one another, and where the double dwarfs were 10 to 20 cm shorter than either semidwarf parent. This was not a satisfactory fit ($0.001 < P < 0.005$) to a 9:6:1 ratio for nonallelism, but pooling the semidwarf plus double dwarf groups resulted in a 115 tall:70 pooled group, which was a satisfactory fit ($0.10 < P < 0.25$) to a 9 tall:7 pooled ratio. In the cross KBNT 4/S101, F_2 distributions for height in 1996 again were continuous and thus inconclusive, but in F_3 progeny tests conducted the following year it was deduced that the F_2 plant phenotypes had been 106 tall:45 semidwarf:9 double dwarf. This was a marginal fit ($0.025 < P < 0.05$) to a 9:6:1 ratio for nonallelism. However, in a new F_3 population of the cross KBNT 4/S101, tested in the summer 2002, it was deduced that F_2 plant phenotypes had been 171 tall:114 semidwarf:19 double dwarf, a satisfactory fit ($0.25 < P < 0.50$) to a 9:6:1 ratio for nonallelism. The recessiveness of the new semidwarf in the cross to its parent, plus the segregations in the crosses to known *sd*1 sources, indicates that KBNT 4 carries a recessive semidwarfism gene nonallelic to *sd*1.

In a genotype × nitrogen (N) fertility test at Stuttgart in 1996, with N levels of 112, 168, 224, and 280 kg ha^{-1}, KBNT 4 had similar yield potential as its parent at the two lower levels, but suffered a yield decline at the two higher levels while the parent remained stable. Neither the mutant nor the parent showed lodging, even at the highest N level. The lack of a positive response to N by the semidwarf was unexpected, as similar work in California with semidwarfs showed that semidwarfs were more yield-responsive to increased N than were tall cultivars (Brandon et al., 1981). Averaged over three trials conducted in Arkansas in 1996 and one trial at Beaumont, TX, in 1997, KBNT 4 yielded 6120 compared with 7020 kg ha^{-1} for its parent. Lodging, observed only in one trial, was 45% for both the mutant and its parent. In an inoculated versus noninoculated sheath blight test at Stuttgart and Pine Tree, AR, in 1997, inoculated plots of KBNT 4 showed 10% yield reduction because of disease as compared with 2% yield loss in its parent. The greater loss in yield appeared to be due to a greater proportion of the culm in the semidwarf being infected than in the parent.

In the 1997 characterization test, KBNT 5 was 79 cm tall, or 24 cm shorter, and 3 d later than its parent. In the cross KBNT 5/C101, subjective scoring of F_2 plant segregation was 72 tall:47 semidwarf:10 double dwarf, a satisfactory fit ($0.75 < P < 0.90$) to a 9:6:1 ratio for nonallelism. Averaged over three tests conducted in Arkansas and Texas during 1996 and 1997, KBNT 5 yielded 6250 compared with 6790 kg ha^{-1} for its parent. Lodging, observed only in one test, was 45% for both the mutant and its parent. In the 1997 sheath blight inoculation test, KBNT 5, like KBNT 4, showed greater yield reduction (20%) than its parent (2%) because of disease.

In the 1997 characterization test, LGRU 12 was 82 cm tall, or 23 cm shorter, and 4 d later than its parent. In the cross LGRU 12/C101, subjective scoring of F_2 plant segregation was 87 tall:56 semidwarf:3 double dwarf, a satisfactory fit ($0.10 < P < 0.25$) to a 9:6:1 ratio for nonallelism. Averaged over four tests in Arkansas, LGRU 12 yielded 8230 compared with 8090 kg ha^{-1} for its parent. Lodging, observed only in one test, was zero compared with 45% for its parent.

In the 1997 characterization test, LGRU 13 was 83 cm tall, or 22 cm shorter, and 3 d earlier than its parent. In the cross LGRU 13/C101, subjective scoring of F_2 plant segregation was 79 tall:45 semidwarf:4 double dwarf, a satisfactory fit ($0.10 < P < 0.25$) to a 9:6:1 ratio for nonallelism. Averaged over five tests in Arkansas and Texas in 1996 and 1997, LGRU 13 yielded 8470 compared with 8360 kg ha^{-1} for its parent. In the 1997 sheath blight inoculation test, LGRU 13 showed a 9% yield reduction compared with a 2% increase in yield for its parent.

In the 1997 characterization test ADAR 10 was 88 cm tall, or 16 cm shorter, and 1 d earlier than its parent. In the cross ADAR 10/C101, subjective scoring of F_2 plant segregation was 65 tall:48 semidwarf:2 double dwarf, a satisfactory fit ($0.10 < P < 0.25$) to a 9:6:1 ratio for nonallelism. In the 1996 two-location SIT 2, severe lodging, 50% for ADAR 10 and 80% for its parent, resulted in a yield of 7540 kg ha^{-1} for the mutant compared with 3770 kg ha^{-1} for its parent. In the 1997 two-location SIT 2, ADAR 10 showed zero lodging compared with 40% for its parent, and 8500 versus 7600 kg ha^{-1} for the parent. Thus weak straw characterizes both the mutant and its parent and should be considered when using this germplasm for breeding purposes.

In the 1997 characterization test ORIN 172 was 83 cm tall, or 9 cm shorter, and 1 d later than its parent. In the cross ORIN 172/ORIN, there was a continuous distribution of F_2 plant segregation from 60 to 105 cm, so segregation data were inconclusive. In 1997 F_3 progeny tests, lines segregated in the ratio 41 tall:55 segregating (tall and semidwarf):30 semidwarf, a satisfactory fit ($0.10 < P < 0.25$) to a 1:2:1 ratio for a recessive single gene in the mutant. In the cross ORIN 172/ED7, F_2 tests were again inconclusive, but in 1997 F_3 progeny tests it was deduced that the F_2 plant phenotypes had been 105 tall:78 single dwarf:4 double dwarf, a satisfactory fit ($0.05 < P < 0.10$) to a 9:6:1 ratio for nonallelism. Similarly, in the cross ORIN 172/S101, F_2 tests were inconclusive, but from 1997 F_3 progeny tests it was deduced that F_2 plant phenotypes had been 75 tall:57 single dwarf:3 double dwarf, a satisfactory fit ($0.10 < P < 0.25$) to a 9:6:1 ratio for nonallelism. In the genotype × N test at Stuttgart in 1996, ORIN 172 showed a similar pattern of yield decline at the highest N level as its parent, but as with the KBNT 4 and KBNT entries, no lodging was observed with ORIN 172 and ORIN. Averaged over six tests in Arkansas and Texas in 1996 and 1997, ORIN 172 yielded 7710 compared with 7980 kg ha^{-1} for its parent. Lodging, observed only in one test, was 43% in both the mutant and its parent. In the 1997 sheath blight test, ORIN 172 showed 8% yield reduction compared with 4% reduction for its parent.

Apparent amylose contents of the KBNT, LGRU, and ADAR mutants were similar to those of the parent cultivars (210–230 g kg^{-1}), and amylose content of the ORIN mutant was similar to that of its parent (130–150 g kg^{-1}). Grain dimensions of the mutants were similar to their respective parents. In general, each mutant was similar to its tall parent except for being shorter.

Germplasm amounts of seed (≤5 g) of the above lines may be obtained by writing to J. Neil Rutger, Dale Bumpers National Rice Research Center, USDA-ARS, P.O. Box 1090, Stuttgart, Arkansas. Seed also will be placed in the National Small Grains Collection, USDA-ARS, 1691 South 2700 West, Aberdeen, ID 83210, where it is available for research purposes, including development and commercialization of new cultivars. If this germplasm contributes to the development of new cultivars it is requested that appropriate recognition be given to the source.

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