on dry-weight basis were 39.6 and 22.9%, respectively, for R01-416F and 39.9% and 22.2%, respectively, for R01-581F.

U.S. Plant Variety Protection will not be pursued for R01-416F and R01-581F soybean germplasm lines. Seeds of R01-416F and R01-581F are available from the Soybean Breeding and Genetics Program at the University of Arkansas, 115 Plant Science Building, Fayetteville, AR 72701. Small quantities of seeds will be available for research purposes and cultivar development from the corresponding author. It is requested that appropriate recognition be made if these germplasm lines contribute to the development of a new germplasm line or cultivar. Seeds of R01-416F and R01-581F will also be deposited in the USDA Soybean Germplasm Collection.

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Registration of CN927-202, CN926-11-3-22, and CN921-306 Sugarbeet Cyst Nematode Resistant Sugarbeet Lines

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Sugarbeet (*Beta vulgaris* L.) breeding lines CN927-202 (Reg. No. GP-260, PI 640420), CN926-11-3-22 (Reg. No. GP-261, PI 640421), and CN921-306 (Reg. No. GP-262, PI 640422) are partially inbred lines that appear to have moderate to high resistance to sugarbeet cyst nematode (SBCN) (*Heterodera schachtii* Schmidt). These lines were developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation (BSDF) and the California Beet Growers Association. They were released in 2006. For these lines, the source of resistance appears to be *B. vulgaris* L. subsp. *maritima* (L.) Arcang germplasm from composite cross C50 (PI 564243) (Lewellen and Whitney, 1993) through C51 (PI 593694) (Lewellen, 2000), also called breeding line R22 (PI 590791) in the Salinas breeding program. These three partially inbred lines have C51 parentage in common. Because C51 was developed from a composite cross involving about 60 accessions of *B. vulgaris* subsp. *maritima*, the original wild beet source of resistance to SBCN could not be identified, nor to date is the exact inheritance of this SBCN resistance known. But it appears to be one or a few major genes with dominant gene action; that is, the experimental hybrids with these or similar lines and sources have nearly the same level of resistance to SBCN as the lines themselves (Lewellen and Pakish, 2005). The allelic relationships among these three lines for their resistance to SBCN also have yet to be determined. Neither is the genic or allelic relationship to the SBCN resistance segregating in CN12 (PI 636338) (Lewellen, 2006a) and likely from WB242 (PI 546413) and CN72 (PI 636339) (Lewellen, 2006a) released in 2005 known. This resistance is not the $Hs\text{-}1^{pro\text{-}1}$ gene transferred to sugarbeet from the hard-seeded species *B. procumbens* Moq. (section Beta Procumbens) (Savitsky, 1975).

CN927-202 is homozygous for red hypocotyls (*RR*), multigerm (*MM*), self-fertile (S^f), segregates for genetic male sterility (a_1a_1), and it has a high frequency of *Rz1* for resistance to *Beet necrotic yellow vein virus* (BNYVV), the cause of rhizomania. CN927-202 was selected from C927-4 (PI 628756) (Lewellen, 2004). CN927-202 theoretically has 12.5% of its germplasm from *B. vulgaris*

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subsp. *maritima*. Wild beets were initially crossed to breeding line C54 (PI 590802) at Salinas in 1984 to produce population R22 (= C50). After multiple cycles of improvement for agronomic type and resistance to rhizomania and virus yellows (caused by *Beet yellows virus* and *Beet chlorosis virus*), improved R22 (= C51) was crossed to an early version of C931 (PI 636340) (Lewellen, 2006b) to produce population 5921 in 1995. Population 5921 was again backcrossed to C931 population to produce population 6927. Individual plants of 6927 were selfed in 1997 to produce a set of S_1 progenies from which 7927-4 was selected. After intraline recombination and improvement, 1927-4 was produced and released as C927-4 in 2002. Because field tests at Salinas and Brawley, CA, indicated that there appeared to be high resistance to an unidentified soil-borne problem, which was subsequently identified as *H. schachtii*, C927-4 was selfed to produce S_1 progenies, including 2927-4-202. Progeny 2927-4-202 was selected after being tested at Salinas and Brawley under rhizomania and SBCN conditions and observed to have relatively high performance, particularly under SBCN conditions (Lewellen and Pakish, 2005). The S_1 progeny 2927-4-202 was bulk increased in 2004 to produce 4927-202. A second bulk increase was made in 2005 to produce 5927-202, released as CN927-202.

As line 4927-202, CN927-202 was tested at Salinas and Brawley under rhizomania and severe SBCN conditions. It gave high per se and experimental hybrid performance for sugar yield, suggesting that it had resistance to both rhizomania and SBCN. In 2004–2005, individual plants of 4927-202 were evaluated in greenhouse tests for reaction in *H. schachtii*-infested soil. Compared with susceptible checks and based on cyst counts, 10 out of 10 plants produced relatively low numbers of nematodes. In subsequent tests in the greenhouse in 2005 and 2006, plants in this line again showed moderate to high resistance to cyst nematode, and matured cysts appeared to be partially filled. In 2004–2005 tests at Brawley under severe nematode conditions but free of BNYVV, the experimental hybrid 4927-202H50 = (F_1CMS[C790-68CMS {Lewellen and Skoyen, 1987} × C790-15 {Lewellen, 1994}] × CN927-202) yielded 12,500 kg ha^{-1} sugar (lsd.05 = 1040) and 14.83% sucrose (lsd.05 = 0.56) with 0% bolting (lsd.05 = 1.3) compared with the mean of six advanced experimental and semicommercial hybrids with *Hs-1* $^{pro-1}$ resistance from *B. procumbens* of 10,640 kg ha^{-1} sugar, 13.90% sucrose, and 0.4% bolting. In this same test, the mean of the two most widely grown commercial hybrids in the Imperial Valley was 8300 kg ha^{-1} sugar, 14.40% sucrose, and 0% bolting. The canopy score used to assess general plant health at harvest was 1.1 (lsd.05 = 0.5) for CN927-202H50, 2.6 for the mean of the six semicommercial *Hs-1* $^{pro-1}$ hybrids, and 3.5 for the mean of the two commercial hybrids based on a scale of 1 to 5, where 1 = estimate of expected appearance under healthy conditions and 5 = very poor appearance or dead. Soil cores were taken from field plots in midseason on 25 Jan. 2005, and total counts of *H. schachtii* were made. For CN927-202H50, the counts were 34 eggs + larvae gram^{-1} of soil, for the mean of three of the *Hs-1* $^{pro-1}$ hybrids checked, 20 eggs + larvae gram^{-1} of soil, and for the two commercial hybrids, 65 eggs + larvae gram^{-1} of soil. In an adjacent test of lines per se, CN927-202 had better sugar yield performance than any other entry, including the commercial hybrid checks, suggesting highly effective field resistance to SBCN.

CN927-202 may approach parental line usefulness when hybrids are grown under SBCN conditions. At this time, however, CN927-202 is primarily being released as a source of resistance to SBCN derived from *B. vulgaris* subsp. *maritima*. CN927-202 segregates for reaction to *Fusarium* spp. that causes stalk blight and crown and root rot.

CN926-11-3-22 is homozygous for green hypocotyls (*rr*), multigerm (*MM*), self-fertile (*S*^{f}), and has a high frequency of *Rz1* for resistance to BNYVV. CN926-11-3-22 was developed specifically because of its apparent resistance to *H. schachtii*. It is estimated that C926-11-3-22 has about 2% of its germplasm descending from *B. vulgaris* subsp. *maritima* through C51. C51 was crossed to C37 (PI590715) (Lewellen et al., 1985) in 1992 to produce the equivalent of a BC_1F_1 population. After four additional backcrosses to recurrent sugarbeet population C931 involving selection for plant type, components of yield, and resistance to rhizomania, BC_5 F_1 population 7926 was produced in 1997. After one cycle of recombination, population 8926 was produced. Tests at Brawley under high temperature, rhizomania conditions showed that at a low frequency, plants with unusually high vigor and performance occurred within this population. In an attempt to isolate and understand this response under the Brawley test conditions, individual plants from population 8926 were selfed. One of these S_1 progenies, called 9926-11, segregated for this resistance response in progeny tests in 2000. Individual plants from 9926-11 were selfed, and one S_2 progeny 1926-11-3 selected. From 1926-11-3, the S_3 progeny 2926-11-3-22 was produced and tested at Brawley in 2003. Based on its reaction to what by then was believed to be resistance to SBCN, the S_3 was increased in bulk to produce 4926-11-3-22. Line 4926-11-3-22 was tested in the field at Brawley and in the greenhouse at Salinas in 2005. An experimental hybrid 4926-11-3-22H5 = (C833-5CMS [Lewellen, 2002] × CN926-11-3-22) was also produced and evaluated in field trials at Brawley. Plants from partially inbred line 4926-11-3-22 were increased at Salinas in 2005 to produce line 5926-11-3-22, released as CN926-11-3-22. Line CN926-11-3-22 and its experimental hybrid are continuing to be evaluated at Salinas and in disease nursery trials.

CN926-11-3-22 may be homozygous for resistance to *H. schachtii*. In tests in the greenhouse in *H. schachtii*-infested soil, 10 out of 10 plants showed low rates of nematode reproduction based on cyst counts as compared to susceptible checks. In the same field test at Brawley mentioned above for CN927-202 in which the hybrid of CN927-202 yielded 12,500 kg ha^{-1} sugar, the experimental hybrid of CN926-11-3-22 gave 11,900 kg ha^{-1} sugar, 15.4% sucrose, and 0% bolting and had a canopy score of 1.4. Like CN927-202, in the adjacent test at Brawley of lines per se, partially inbred CN926-11-3-22 was not significantly different in yield compared to the hybrid checks. In a companion nondiseased trial at Brawley, the experimental hybrid CN926-11-3-22H5 was nearly equal to the mean of the SBCN susceptible commercial hybrid checks for sugar yield and superior for sucrose concentration. Greenhouse tests under SBCN conditions suggested that CN926-11-3-22 was more resistant to *F. oxysporum* f.sp. *betae* than were entries derived from C927-4.

CN926-11-3-22 approaches commercial parental line traits when the hybrids are grown under both diseased (SBCN and/or rhizomania) and nondiseased conditions. Tests to determine reactions to other diseases and pests are underway. CN926-11-3-22 may have the same or different source of resistance to SBCN as CN927-202, both likely coming from wild sea beet. Hybrids produced with CN926-11-3-22 may be useful in regional, national,

and international trials to evaluate the efficacy and usefulness of this source of resistance to reduce damage from cyst nematode.

CN921-306 is homozygous for green hypocotyls (*rr*), multigerm (*MM*), self-fertile (*S*), and has a high frequency of *Rz1* for resistance to BNYVV. CN921-306 was specifically identified and selected because of its apparent resistance to *H. schachtii*. It is estimated that CN921-306 has about 27% of its germplasm from *B. vulgaris* subsp. *maritima* sources. Unlike CN927-202 and CN926-11-3-22, CN921-306 retains obvious wild beet traits. It is easier bolting and segregates for annualism (*B*). Seed stalks are lax and readily lodge. One of the wild beet components of CN921-306 came through C51. The other sources are C26 (PI610488) (Lewellen, 2000) and C27 (PI610489) (Lewellen, 2000). C26 and C27 are improved populations that are approximately half sugarbeet and half *B. vulgaris* subsp. *maritima* from collections made in France, the UK, Ireland, and northern Europe (Panella and Lewellen, 2007). Genetic male-sterile plants from population 8926 (see CN926-11-3-22 above) were crossed to C26 and C27 in 2000 to produce population 0921. Population 0921 was selected for resistance to rhizomania and improved for agronomic traits and components of sugar yield to produce population 2921 in 2002. Population 2921 segregated at a low frequency in tests at Brawley for high vigor under high temperature, SBCN/rhizomania conditions similar to the source populations of CN927-202 and C926-11-3-22. Individual plants from 2921 were selfed, and based on progeny tests in 2004, S_1 progeny 3921-306 was increased to produce 5921-306, released as CN921-306. Less is known about CN921-306 except that in the S_1 progeny tests, it was superior in yield performance and apparent resistance to SBCN compared with C927-4. In greenhouse SBCN tests at Salinas in 2004–2005, 8 out of 10 plants showed moderate to high resistance to *H. schachtii*. In 2006 tests, again about 80% of the plants had relatively low cyst counts. The relationship of this resistance to that found in CN927-202 and CN926-11-3-22 has not been determined. Currently, populations are being searched for specific molecular genetic markers in this and the CN927-202, CN12, and CN72 sources of SBCN resistance. CN921-306 may be useful as a potential source of resistance to cyst nematode that may or may not be different from other released sources.

Breeder seed of CN927-202, CN926-11-3-22, and CN921-306 is maintained at the USDA, ARS, U.S. Agricultural Research Station, Salinas, CA, and will be provided on written request to sugarbeet breeders in sufficient quantities for reproduction. Genetic material of these releases has been deposited in the National Plant Germplasm System. U.S. Plant Variety Protection will not be requested for these lines.

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