Registration of FC709-2 and FC727 Sugarbeet Germplasms Resistant to Rhizoctonia Root Rot and Cercospora Leaf Spot

Sugarbeet (*Beta vulgaris* L.) germplasms FC709-2 (Reg. no. GP-200, PI 599668) and FC727 (Reg. no. GP-201, PI 599669) were developed by the USDA-ARS, Fort Collins, CO, in cooperation with the Beet Sugar Development Foundation, Denver, CO. These lines should provide excellent resistance to root-rotting strains (AG-2-2) of *Rhizoctonia solani* Kühn and moderate resistance to cercospora leaf spot (caused by *Cercospora beticola* Sacc.). They are potential pollinators or populations from which to select pollinators with combining ability for yield. FC709-2 and FC727 were released in 1998 from seed productions 9210124 and 951017, respectively.

FC709-2 is multigerm (*MM*), non-O-type, and pseudo-self-fertile, with 13% green hypocotyls. It is segregating, with approximately 19% male sterility. The sterility is most likely cytoplasmic, because plants had a range of anther types from white, shrunken anthers with no pollen production to full, yellow, dehiscent anthers with normal pollen. However, no progeny testing was done to confirm the basis of sterility. FC709-2 is the result of three cycles of selection within the line 871016. 871016 had one more cycle of selection for resistance to *R. solani* than its parent line, 841034. FC709 (1) was released as a composite of seed from 871016 and 841034. The first cycle of selection for FC709-2 was mass selection for resistance to rhizoctonia root rot in a nursery inoculated with *R. solani* (2). Seed was produced in bulk from surviving roots planted in a field isolation plot where they were reinoculated with *R. solani*. Seed from 28 plants was harvested. Some of this seed was planted into a disease-free nursery and, based on percent sucrose of individual roots, the 9.4% of beets with the highest sucrose (55 beets) were selected. The remaining seed from Cycle 1 was grown in a rhizoctonia-inoculated nursery, and three beets were selected. The three beets were increased in bulk along with the 55 beets selected for high sucrose. Seed was harvested from a total of 33 surviving plants. This Cycle 2 population underwent another cycle of mass selection for resistance to rhizoctonia root rot in an inoculated nursery (2). Seed from the 121 surviving plants was harvested in bulk to produce FC709-2.

FC709-2 had high resistance to rhizoctonia root rot when tested under strong disease pressure (2). Based on disease index (DI) ratings from 1994 through 1997, where a DI of 0 = no root rot and 7 = all plants dead, there were either no significant differences or FC709-2 performed better than the rhizoctonia-resistant controls. In these four years, the DI ratings for the resistant check (FC705-1) were 1.4, 1.4, 1.5, and 3.2, compared with 1.0, 1.5, 0.9, and 2.5 for FC709-2. FC709-2 was always significantly better than the susceptible control (FC901/C817//413). Of all lines tested, FC 709-2 had the lowest DI rating in the very severe epiphytotic of 1997. Percentages of resistant plants (those rated 0 or 1) were 86, 55, 100, and 49 for FC709-2, and 65, 58, 62, and 49 for FC705-1.

FC709-2 showed good resistance to cercospora leaf spot when tested in artificial epiphytotics (3). In three years of testing, it was significantly better than the susceptible control and not significantly different from the resistant control. The following DI ratings (DI of 0 = no leaf spot and 10 = all plants dead) are from the most severe rating (the last of three or four ratings each season). In 1994, 1995, and 1997, DI ratings of FC709-2 were 3.0, 4.3, and 4.2/3.5 (tested in two trials). Ratings of the resistant control (FC504CMS/FC502-2//SP6322-0) were 3.2, 3.5, and 3.8/2.9 for the same respective years, and ratings of the susceptible control (SP351069-0) were 4.5, 6.2, and 7.0/6.5. FC709-2 does not have tolerance to the beet curly top virus (BCTV). As with FC709, field testing of FC709-2 in California revealed a low frequency of plants with some resistance to rhizomania (R.T. Lewellen, personal communication); however, this germplasm is not recommended as a source for rhizomania resistance.

In a 1995 yield trial at Fort Collins, CO, with moderate drought stress, the sucrose yield of FC709-2 was 89% of 'Beta 2398' and 66% of 'Monohikarí' and the percent sucrose was 102% of 'Beta 2398' and 86% of 'Monohikarí'. FC709-2 has not been tested for combining ability. It was released for use as a pollinator for making rhizoctonia root rot- and cercospora leaf spot-resistant hybrids, or as a source population from which such pollinators can be selected.

FC727 is multigerm (*MM*), non-O-type, and has 51% green hypocotyls. FC727 resulted from crossing FC703 (4) (50% of the genetic contribution) to three high-sucrose sources: Polish AJ, ZZ (16%), the Spanish line 'Aula Dei 13' (21%), and 'American Crystal 67-436' (13%). FC727 is the result of eight cycles of mass selection for resistance to rhizoctonia root rot. Within four of these cycles, resistant roots were simultaneously selected for high sucrose of individual roots. The smallest population size was 26 plants and, on average, a selection intensity of 18% for sucrose was used.

FC727 has excellent resistance to rhizoctonia root rot when tested under severe disease pressure (2). There were no significant differences between it and rhizoctonia-resistant controls in DI ratings, and FC727 was significantly more resistant than the susceptible control (FC901/C817//413) from 1994 through 1997. FC727 had mean yearly DIs of 1.4, 1.7, 1.1, and 3.6 (1994– 1997), whereas the highly resistant control (FC705-1) had DIs of 1.4, 1.4, 1.5, and 3.2. Percentages of resistant plants (those rated 0 or 1) were 69, 41, 89, and 16 for FC727 and 65, 58, 62, and 49 for FC705-1.

FC727 has a moderate reaction to cercospora leaf spot. In three years of testing in an artificial epiphytotic of cercospora leaf spot (3), it was significantly more resistant than the susceptible control but, significantly more susceptible than the resistant control. The following DI ratings are from the most severe rating (last of three or four ratings each season). In 1994, 1995, and 1997, DIs of FC727 were 3.8, 4.5, and 4.8. DIs of the resistant control (FC504CMS/FC502-2//SP6322-0) were 3.2, 3.5, and 2.9. DIs of the susceptible control (SP351069-0) were 4.5, 6.2, and 6.5. FC727 does not have tolerance to BCTV.

FC727 had relatively good general combining ability for sucrose yield when used as a pollinator on several diverse CMS lines. FC727 has potential for use as a pollinator or a population from which to choose pollinators with good combining ability. It should contribute to the development of high-sucrose hybrids with resistance to rhizoctonia root rot.

Seed of FC709-2 and FC727 is maintained by the USDA-ARS and, for at least five years, will be provided in quantities sufficient for reproduction upon written request to Sugarbeet Research, USDA-ARS, Crops Research Laboratory, 1701 Center Ave., Fort Collins, CO 80526-2083. Seed of this release will be deposited in the National Plant Germplasm System, where it will be 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.

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References and Notes

1. Hecker, R.J., and E.G. Ruppel. 1988. Registration of rhizoctonia root rot resistant sugarbeet germplasm FC 709. Crop Sci. 28:1039–1040.
2. Ruppel, E.G., C.L. Schneider, R.J. Hecker, and G.J. Hogaboam. 1979. Creating epiphytotics of *Rhizoctonia* root rot and evaluating for resistance to *Rhizoctonia solani* in sugarbeet field plots. Plant Dis. Rep. 63: 518–522.
3. Ruppel, E.G., and J.O. Gaskill. 1971. Techniques for evaluating sugarbeet for resistance to *Cercospora beticola* in the field. J. Am. Soc. Sugar Beet Technol. 16:384–389.

4. Hecker, R.J., and E.G. Ruppel. 1977. Registration of diploid and tetraploid FC 701/4 and FC 703 sugarbeet germplasm. Crop Sci. 17:678.
5. USDA-ARS, Crops Research Lab., 1701 Center Ave., Fort Collins, CO 80526-2081. A joint contribution of the USDA-ARS and the Beet Sugar Development Foundation. Registration by CSSA. Accepted 31 July 1998. *Corresponding author (lpanella@lamar.colostate.edu).

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Registration of Two Early-Maturing Safflower Germplasm Lines with High Oleic Acid and High Oil Content

Early-maturing safflower (*Carthamus tinctorius* L.) germplasm lines, Lesaf 494 (Reg. no. GP-33, PI 603207) and Lesaf 496 (Reg. no. GP-34, PI 603208), with high oleic acid and high oil contents, were developed at the Agriculture and Agri-Food Canada Lethbridge (Alberta) Research Centre. These lines are hereby being released to provide an opportunity for breeding and related research to combine the attributes of earliness, high oleic acid oil, and high oil levels into future cultivars. Both lines are also suitable for birdseed, due to their white achenes.

Lesaf 494 and Lesaf 496 were developed by a pedigree breeding program and were derived from a different single-plant selection in the F_3 generation from the cross Saffire-29-114/3/Rinconada//Saffire/Lesaf 34BW. Single-plant F_4 selections were grown as progeny rows in Chile (1996–1997) and bulked plants from each selected row were advanced to 1997 field tests. These lines combine the earliness of Saffire (1) with the high oil and oleic acid content from the Spanish cultivar Rinconada, developed by a single-seed descent breeding procedure with transgressive segregation identified for yield and oil content in the BC_2F_5 generation (2). The high oleic acid in Rinconada, with the *olol* allele was derived from Oleic Leed (3) (José Fernández-Martínez, personal communication). Saffire-29-114 is a higher-oil selection derived from Saffire and Lesaf 34BW is a mass-selected bulk of early-maturing plants with white flowers, of Indian origin.

Lesaf 494 and Lesaf 496 were field tested under dryland and irrigated conditions in replicated yield tests in 1997. Table 1 compares these lines with three Lethbridge-developed cultivars (Saffire, AC Stirling, and AC Sunset), as well as with S-208, a commercially grown cultivar developed by SeedTec International, Woodland, CA.

Lesaf 494 and Lesaf 496 averaged >420 g kg^{-1} oil and >700 g kg^{-1} oleic acid content in the oil. In general, lower oleic acid and higher linoleic acid content in the oil of safflower lines is expected when grown in southern Alberta than in oil of the same safflower lines grown in a more southerly latitude. Total saturated fatty acids (C16:0, C18:0, C20:0, C22:0, and C24:0), averaged over both the dryland and irrigated trial, were 65 g kg^{-1} for Lesaf 494 and 63 g kg^{-1} for Lesaf 496, compared with 78 g kg^{-1} for Saffire, 82 g kg^{-1} for AC Stirling, 82 g kg^{-1} for AC Sunset, and 81 g kg^{-1} for S-208. Flower colors of both germplasm lines are yellow in early bloom and orange on the maturing head.

Lesaf 494 matured as early as Saffire in the dryland trial and 2 d earlier in the irrigated trial. Lesaf 494 was 8 d earlier than S-208 in the dryland trial and 6 d earlier in the irrigated trial. Yield exceeded that of S-208 significantly in both the dryland and irrigated trials.

Lesaf 496 matured 2 d later than the earliest check in both yield trials, and 2 and 3 d earlier than S-208 in the dryland and irrigated trials, respectively. Yield exceeded that of S-208 significantly in both the dryland and irrigated trials, as well as that of AC Sunset in the irrigated trial.

The safflower breeding program at Lethbridge was terminated in 1997. However, seed of these germplasm lines will be made available upon written request to Dr. R.C. Johnson (rcjohnson@wsu.edu), USDA-ARS Western Regional Plant Introduction Station, Box 646402, Washington State University, Pullman, WA 99164-6434. Appropriate recognition of the source of the development of these germplasm lines (AAFC-LRC) shall be given in any contributions to research, germplasm enhancements, or variety development.

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References and Notes

1. Mündel, H.-H., H.C. Huang, L.D. Burch, and F. Kiehn. 1987. Registration of 'Saffire' safflower. Crop Sci. 27:364–365.
2. Fernández-Martínez, J., J. Domínguez-Gimenez, A. Jimenez, and L. Hernandez. 1986. Use of the single seed descent method in breeding safflower (*Carthamus tinctorius* L.). Plant Breed. 97(4):364-367.
3. Urie, A.L., W.F. Peterson, and P.F. Knowles. 1979. Registration of Oleic Leed safflower. Crop Sci. 19:747.
4. H.-H. Mündel and J.P. Braun, Agric. and Agri-Food Canada Res. Centre, P.O. Box 3000, Lethbridge, AB, Canada T1J 4B1. Registration by CSSA. Accepted 31 Aug. 1998. *Corresponding author (muendel@em.agr.ca).

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Table 1. Safflower yield, days to maturity, oil, oleic acid and linoleic acid, in 1997 trials at Lethbridge, Alberta.

Variety	Yield		Days to maturity		Oil		Oleic acid		Linoleic acid	
	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
	kg ha^{-1}		d		g kg^{-1}					
Lesaf 494	1450	2589	124	129	427	422	733	749	192	178
Lesaf 496	1337		126	132	422	419	772	732	152	196
Saffire	1298	2540	124	131	315	318	100	114	802	799
AC Stirling	1423	2729	128	133	350	344	83	115	818	791
AC Sunset	1389	2165	125	130	338	327	102	102	799	804
S-208	1001	1785	132	135	386	371	103	100	797	809
LSD (0.05)	181	527	2	2.4	1	1.4	101	171	100	169
Reps	4	4	4	4	4	4	2	2	2	2