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Registration of FC301, Monogerm, O-type Sugarbeet Population with Multiple Disease Resistance

Sugarbeet (*Beta vulgaris* L.) germplasm FC301 (Reg. no. GP-247, PI 634210) was developed by the USDA-ARS at Fort Collins, CO, and Salinas, CA, in cooperation with the Beet Sugar Development Foundation (BSDF), Denver, CO. FC301 is a germplasm with a moderate frequency of the *Rz1* allele conferring resistance to rhizomania (caused by *Beet necrotic yellow vein virus*). It has been selected for resistance to Cercospora leaf spot caused by *Cercospora beticola* Sacc., and has moderate resistance to black root (caused by *Aphanomyces cochlioides* Drechsl.) and the *Beet curly top virus* (BCTV). FC301 is a population from which to select disease resistant, monogerm, O-type parents to infuse multiple disease resistance on the female side of hybrids. There is no CMS equivalent. FC301 is released from Salinas seed production 01-FC123, and has been tested as 00-FC123 and 01-FC123.

FC301 is an O-type germplasm segregating for self-sterility (S^s), hypocotyl color (94% *R*-), and monogerm (90% *mm* in seed harvested from monogerm plants). FC301 was developed from progeny of two original crosses. The first cross was 'C890'*aa* (Lewellen, 1998) in isolation with two pollen donors—'FC607' (Smith and Ruppel, 1980) and 'FC604' (Smith and Ruppel, 1979) (approximately 50 F_1 plants). The second cross was 'C859'*aa* (Lewellen, 1995) in isolation with the same two pollen donors (approximately 50 F_1 plants). F_1 seed from populations was combined for bulk increase of the F_2 after germination testing to make the parental contribution equal from both female parents. The F_2 seed was planted in Fort Collins and 90 mother roots were harvested and selfed. Seventy-five selfed families (derived from 75 of the 90 F_2 roots) were produced and planted in the Cercospora leaf spot nursery in Fort Collins and in the BCTV nursery in Kimberly, ID. Based on performance in these nurseries, three populations were developed—two containing the best five families for leaf spot resistance or BCTV resistance and one population containing the five families that had the best performance in both nurseries. Mother roots were dug from the Fort Collins Cercospora leaf spot nursery and seed was produced in the greenhouse.

These three populations were sent to Salinas, where simultaneous selection was made for rhizomania resistance, resistance to Erwinia root rot (caused by *E. carotovora* subsp. *betavasculorum* Thomson et al.) and to powdery mildew (caused by *Erysiphe polygoni* DC.), agronomic performance, and percentage sucrose. The selected roots from these three populations were bulked after selection and interpollinated. The resulting seed was separated into monogerm and multigerm, forming two populations, 99–1,2,3 *M* and 99–1,2,3 m, respectively. Seed from the monogerm population was split and some was sent to Oregon for steckling production and some was planted in the Salinas rhizomania nursery. Stecklings were obtained from Oregon in March 2000, and, from these, fertile, monogerm plants were selected near anthesis, selfed to produce S_1 progeny, and crossed simultaneously to an annual CMS tester. Seventeen F_1 hybrids were indexed for O-type at Salinas in December 2000 and found to be uniformly male-sterile, suggesting that fertility restorer genes were only present in the S_1 families at only a low frequency, and, therefore, no O-type selection was made. Seed of the population, 00-FC123 (which consisted of progeny of 99-FC1,2,3m selected from the rhizomania nursery and bulk increased), and the S_1 progenies were planted in the Oregon steckling nursery and the Salinas rhizomania nursery in August 2000. From the Salinas rhizomania nursery, S_1 plants from within S_1 progenies [Rzm FC123-#(c)] and plants from the 00-FC123 population were selection for resistance to rhizomania (Rzm 00-FC123).

Concurrently, seed from the original Fort Collins population, which had been selected strictly for leaf spot resistance in the field and reselected for leaf spot resistance (19991012) using the leaf disk method (Koch and Jung, 1998), was planted in the Salinas rhizomania nursery and Oregon steckling nursery. In March 2001, vernalized, selected plants from Salinas and stecklings from Oregon were pooled and recombined by harvesting seed from the male-sterile plants of all three phases. There was nearly equal representation from the new Fort Collins Cercospora leaf spot population [Rzm 19991012 (35) and the 19901012 stecks (150)], the S_1 lines [populations Rzm FC123-#(c) (136) and FC123-#(c) (150)], and the populations selected from the rhizomania nursery [populations Rzm 00-FC123 (24) and 00-FC123 (168)]. Seed from the male-sterile plants was harvested separately and the composite called 01-FC123. 01-FC123 seed was released as FC301. Half-sib family grow outs indicated that the male-sterility was mixed genetic male-sterility (*aa*) and genetic-cytoplasmic male-sterility (CMS). Progeny testing could be used to identify and separate genetic sterility from CMS, and to isolate a near equivalent CMS counterpart to the male-fertile, O-type.

In a greenhouse test for resistance to sugar beet root aphid (*Pemphigus* sp.) at Shakopee, MN, in 2003, FC301 was not different from the susceptible control (2.88 and 3.07, respectively) although there were a number of roots (5/16) which were scored as 1 (1 = free from aphids to 4 = heavily infested with aphids) (not statistically analyzed). When tested in Fort Collins, CO, and Rosemount, MN, in 2002 and 2003 for resistance to Cercospora leaf spot in an artificial epiphytotic (Ruppel and Gaskill, 1971), the scores were either intermediate (significantly more resistant than the susceptible check and significantly less resistant than the resistant check) or not significantly different from the resistant check. The same level of resistance was seen when tested at Shakopee, MN, in 2003 for resistance to Aphanomyces root rot—the scores were either intermediate (significantly more resistant than the susceptible check and significantly less resistant than the resistant check) or not significantly different from the resistant check. In the BSDF curly top nursery at Kimberly, ID, in 2003, FC301 had a DI of 4.3 over three replications (not statistically analyzed) compared to 'US H11' with a DI of 3.3 and 'Monohikari' with a DI of 7.0 (1 = no damage to 9 = plant dead). When tested at Fort Collins, CO, in 2003 for resistance to rhizoctonia root rot under strong disease pressure (Ruppel et al., 1979) the FC301 population was not significantly different from the susceptible check.

In observation and evaluation tests at Salinas in 2002 to 2003, FC301 was moderately susceptible to powdery mildew; intermediate in reaction to Erwinia root rot with 50 to 65% resistant plants; and moderately resistant to intermediate for bolting tendency in fall plantings. Sucrose concentration was moderately low in comparison to a group of monogerm populations and inbred lines.

Breeder seed of FC301 is maintained by USDA-ARS and will be provided in quantities sufficient for reproduction on 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 varieties or cultivars. We request that appropriate recognition be made of the source when this germplasm contributes to a new cultivar. U.S. Plant Variety Protection will not be requested for FC301.

L. Panella* and R.T. Lewellen

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L. Panella, USDA-ARS, Crops Res. Lab., 1701 Center Ave., Fort Collins, CO 80526-2083; R.T. Lewellen, U.S. Agric. Research Stn., Salinas, CA 93905-3018. A joint contribution of USDA-ARS and the Beet Sugar Development Foundation. Registration by CSSA. Accepted 31 May 2005. *Corresponding author (Lee.Panella@ars.usda.gov).

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677 S. Segoe Rd., Madison, WI 53711 USA