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and

BEET SUGAR DEVELOPMENT FOUNDATION
DENVER, COLORADO

REGISTRATION OF FC1018, FC1019, FC1020 AND FC1022 MULTIGERM SUGARBEET GERMPLASMS WITH MULTIPLE DISEASE RESISTANCE

The USDA, Agricultural Research Service (ARS), in cooperation with the Beet Sugar Development Foundation (BSDF), announces the release of FC1018, FC1019, FC1020, and FC1022 (PI 658059, PI 658060, PI 658061, PI 658062, respectively) sugarbeet germplasm. These germplasm were developed in the breeding program of Drs. L. Panella and K. M. Webb, USDA-ARS, Fort Collins, Colorado and Dr. R. T. Lewellen, USDA-ARS, Salinas California. All four germplasms are multigerm sugarbeet populations in fertile cytoplasms, segregating for self-sterility, multigermity, and hypocotyl color.

FC1018 (PI 658059) has excellent resistance to root-rotting strains (AG-2-2) of Rhizoctonia solani Kühn and carries the Rz1 gene, which confers resistance to some strains of Beet necrotic yellow vein virus (BNYVV), the causal agent of rhizomania. FC1018 has shown a moderate tolerance to cercospora leaf spot (CLS), caused by Cercospora beticola Sacc., to Beet curly top virus (BCTV), and to Aphanomyces cochlioides Drechsl., which causes aphanomyces root rot (aphanomyces black root). FC1018 has shown favorable yield characteristics when evaluated as a line and a pollinator in experimental hybrids in two trials grown under rhizomania conditions at Salinas in 2006. It is a population from which to select disease-resistant, multigerm pollinator parents.

FC1019 (PI 658060) carries the Rz1 gene, which confers resistance to some strains of BNYVV and has shown resistance to BCTV. It has shown a moderate tolerance to rhizoctonia root rot, to CLS, and to aphanomyces root rot. FC1019 has shown excellent root yield when evaluated as a line and pollinator in experimental hybrids in two trials grown under rhizomania conditions at Salinas in 2006. It is a population from which to select disease-resistant, multigerm pollinator parents.

FC1020 (PI 658061) carries the Rz1 gene, which confers resistance to some strains of BNYVV. It has good resistance to rhizoctonia root rot and moderate resistance to CLS, BCTV, and aphanomyces root rot. FC1020 has good field performance for sucrose yield. It is a population from which to select disease-resistant, multigerm pollinator parents.

FC1022 (PI 658062) carries the Rz1 gene, which confers resistance to some strains of BNYVV. It showed a moderate tolerance to BCTV. FC1022 has moderate susceptibility to CLS, aphanomyces root rot, and to rhizoctonia root rot. When tested at Salinas, CA, under rhizomania conditions, FC1022 had good sucrose content. It is a population from which to select disease-resistant, multigerm pollinator parents, and, because of a large percent monogerm (45%) seedballs and O-type parentage, it should be possible to select monogerm, O-type, CMS maintainer lines from this germplasm.

FC1018, FC1019, and FC1022 sugarbeet germplasms were released from 05-FC1018, 05-FC1019, and 05-FC1022 seed lots, respectively, and were tested under those designations. FC1020 sugarbeet was released from 07-FC1020 and bulk increases of 07-FC1020, 08-FC1020, and 09-FC1020. It was tested under all of these designations.

FC1018 resulted from the cross of (C931 (PI 636340)) x (FC709-2 (PI 599668)). FC709-2 has excellent resistance to rhizoctonia root and crown rot and good resistance to cercospora leaf spot, is mostly self-sterile and multigerm. C931 has moderate resistance to a broad spectrum of diseases including BCTV, virus yellows, powdery mildew, Erwinia (caused by Erwinia carotovora betavasculorum Thomsen et al.), and contains the Rz1 gene for resistance to rhizomania. The seed of this cross was bulk increased for two generations. It then was planted in the Spence field nursery (Salinas, CA) in April, 2004, spaced, inoculated with Cercospora beticola Sacc., but the rhizomania infection was natural. After 180 days, mother roots (MR) were dug, and individual roots were visually selected for freedom from disease (cercospora, rhizomania), for size and shape, then run through sugar lab and selected for percent sucrose (FC1018 had 18.5% sucrose). These roots were vernalized, and seed was harvested in bulk in 2005 and designated as 05-FC1018.

In the mild Cercospora epidemic in 2008 Betaseed nursery, FC1018 showed significantly better performance than the susceptible check and was not significantly different from the Betaseed tolerant non-hybrid check or the USDA-ARS tolerant check. In 2008, FC1018 was significantly better than FC1019 and FC1022. In the more severe epidemic of 2006, FC1018 performed intermediately, significantly more resistant than the susceptible check but also, significantly less resistant than the tolerant check. FC1018 shows a moderate tolerance to CLS. In 3 years testing in the USDA-ARS rhizoctonia root rot nursery at Fort Collins, CO, FC1018 was not significantly different from the highly resistant control and was significantly better than the susceptible control. FC1018 has excellent resistance to rhizoctonia root rot. In the BSDF BCTV nursery, FC1018 was significantly better than the susceptible check in 2006 but not in 2008. In the more severe aphanomyces evaluation of 2006, at the second reading, FC1018 was significantly more resistant than both susceptible checks but significantly less resistant than the tolerant check. In 2008, FC1018 was significantly better than the susceptible check and not significantly different from the tolerant check. FC1018, under rhizomania conditions at Salinas in 2006, had a significantly higher sugar yield than the susceptible check ('Roberta', rzrz), and percent sucrose not significantly different than the Beta 4430R (an Rz1 check). In general, hybrids outperform lines in yield because of the heterosis achieved in the hybrid.

FC1019 resulted from the cross of ('FC712' (PI 590766)) x C931. FC712 is mostly self-sterile and multigerm. It was an attempt to combine nine of the best sources of resistance to rhizoctonia root and crown rot available within the ARS Fort Collins breeding program and has excellent resistance to this disease. This cross was an attempt to combine another source of the rhizoctonia resistance with the resistance to rhizomania and other spectrum of disease resistances of C931. Seed of this cross was bulk increased for two generations. It, then, was planted in the Spence field nursery (Salinas, CA) in April, 2004, spaced, inoculated with Cercospora beticola Sacc., but the rhizomania infection was natural. After 180 days, mother roots (MR) were dug and individual roots were visually selected for freedom from disease (cercospora, rhizomania), for size and shape, then run through sugar lab and selected for percent sucrose (FC1019 had 18.0% sucrose). These roots were vernalized and seed was harvested in bulk in 2005 and designated as 05-FC1019.

In the CLS evaluation of 2008, FC1019 was significantly more resistant than the USDA-ARS susceptible check but not the Betaseed susceptible check and significantly less resistant than the tolerant and moderately tolerant checks. In the more severe epidemic of 2006, FC1019 was significantly more resistant than the susceptible checks but significantly less resistant than the tolerant checks and one or two moderately susceptible checks. FC1019 is moderately susceptible to CLS. In 2006 and 2008 in the BSDF BCTV nursery, FC1019 performed significantly better than the susceptible check and not significantly different from the resistant check. FC1019 showed resistance to BCTV. In the more severe aphanomyces evaluation of 2006, at the second reading, FC1019 was significantly more resistant than both susceptible checks. In 2008, it was significantly more resistant than the susceptible check and not significantly different from the tolerant check. FC1019 showed a moderate tolerance to aphanomyces. In 2 of 3 years of testing in the USDA-ARS rhizoctonia root rot nursery at Fort Collins, CO, FC1019 was significantly more resistant than the susceptible check and in 2 of 3 years it was not significantly more susceptible than the resistant checks. FC1019 showed a moderate resistance to rhizoctonia root rot. FC1019, in two trials grown under rhizomania conditions at Salinas, CA, in 2006, had a significantly higher sugar yield than the susceptible check ('Roberta', rzrz), and percent sucrose not significantly different than the Beta 4430R (an Rz1 check). In both trials FC1019 outperformed FC1018 in sugar yield, because of the high root yield component. In general, hybrids outperform lines in yield because of the heterosis achieved in the hybrid.

FC1022 resulted from the cross of (FC709-2 x FC907) x C391. FC907 is a breeding line originating from (FC607 (PI 590837) x FC701 (PI 590661))BC4, with FC607 as the recurrent parent, to combine the CLS resistance of FC607 with the multigerm trait of FC701. FC907 has good resistance to CLS and no resistance to rhizoctonia root rot. It is over 90% monogerm. (FC709-2 x FC907) was bulk increased for two generations, mass selected for resistance to rhizoctonia root rot, and the selected roots were self pollinated to produce selfed families. These families were screened for the resistance to CLS, and the top 25% of the families recombined, and bulk increased for two generations. This seed was planted in the Spence field nursery (Salinas, CA) in April, 2004, spaced, inoculated with Cercospora beticola Sacc., but the rhizomania infection was natural. After 180 days, mother roots (MR) were dug and individual roots were visually selected for freedom from disease (cercospora, rhizomania), for size and

shape, then run through sugar lab and selected for percent sucrose (FC1022 had 20.2% sucrose). These roots were vernalized, and seed was harvested in bulk in 2005 and designated as 05-FC1022.

In the CLS evaluation of 2008, FC1022 was significantly better than the susceptible checks and significantly less resistant than the tolerant and moderately tolerant checks. In the more severe epidemic of 2006, FC1022 was significantly better than the susceptible checks but significantly less resistant than the tolerant checks and one of two moderately susceptible checks. FC1022 is moderately susceptible to CLS. In the BSDF BCTV nursery, FC1022 was significantly better than the susceptible check in 2006 but not in 2008. FC1022 showed a moderate tolerance to BCTV. In the more severe aphanomyces evaluation of 2006, at the second reading, FC1022 was significantly better than one of the susceptible checks but not the other. In 2008, FC1022 was significantly more resistant than the susceptible check but did perform as well as the tolerant check. FC1022 showed a moderate susceptibility to A. cochlioides. In 3 years of testing in the USDA-ARS rhizoctonia root rot nursery at Fort Collins, CO, FC1022 scored more resistant, but not significantly, than the susceptible check. FC1022 was moderately susceptible to rhizoctonia root rot. FC1022, in two trials grown under rhizomania conditions at Salinas in 2006, had a significantly higher sugar yield than the susceptible check ('Roberta', rzrz), and percent sucrose not significantly different than the Beta 4430R (an Rz1 check). In both trials FC1022 outperformed FC1018 in sugar yield, because of a higher percent sucrose component. In general, hybrids outperform lines in yield because of the heterosis achieved in the hybrid.

FC1020 is a selected combination of FC1018, FC1019, and FC1022. Seed of 05-FC1018, 05-FC1019, and 05-FC1022 was planted in the Spence field nursery (Salinas, CA) in April 2006, spaced, inoculated with Erwinia and Cercospora beticola Sacc., and again, rhizomania infection was natural. After 180 days, mother roots were dug and individual roots were visually selected for freedom from disease (Erwinia, CLS, rhizomania), for size and shape, then run through sugar lab and selected for % sucrose (in November). Selected mother roots of 05-FC1018 (17 MR), 05-FC1019 (16 MR), and 05-FC1022 (16 MR) were vernalized in the cold room at 6°C for 120 d. All 49 of the roots were planted together in an isolation chamber, bulk increased in 2007, and designated as 07-FC1020, which was released. In 2008, 54 vernalized stecklings of 07-FC1020 were increased in an isolation chamber without selection. This increase was designated as 08-FC1020. In August 2008 seed of 08-FC1020 was planted in the Salinas, CA steckling field and 47 vernalized stecklings bulk increased without selection to produce 09-FC1020. These seed productions should not differ in gene frequency from 07-FC1020.

In the CLS evaluation of 2008, FC1020 performed intermediately, significantly better than the susceptible check but, also, significantly worse than the tolerant check. It performed better than FC1019 and FC1022 but was significantly less resistant than FC1018. FC1020 showed a moderate tolerance to CLS. In the BSDF BCTV nursery of 2008, FC1020 was intermediate in performance, not significantly more resistance than the susceptible check but not significantly different from the resistant check. FC1020 showed a moderate tolerance to BCTV. In 1 year testing in the USDA-ARS rhizoctonia root rot nursery at Fort Collins, CO, FC1020 was not significantly different from the highly resistant control and was significantly more resistant than

the susceptible control. FC1020 has good resistance to rhizoctonia root rot. In the 2008 Betaseed aphanomyces screening, FC1020 was significantly more resistant than the susceptible check and not significantly different from the tolerant check. FC1020 showed a moderate tolerance to aphanomyces root rot. FC1020 segregates, at a low frequency (18%), for monogermity. In two trials grown under rhizomania conditions at Salinas, CA, in 2008, FC1020 had a significantly higher sugar yield than the susceptible check and was not significantly different from Beta 4430R. In one of these tests, FC1020 had percent sucrose not significantly different from Beta 4430R, and in the other test, FC1020 was not significantly different in percent sucrose from any of the controls. Generally in yield tests, hybrids outperform lines in yield because of the heterosis achieved in the hybrid.

Breeder seed of FC1018, FC1019, FC1022, and FC1020 is maintained by USDA-ARS and will be provided in quantities sufficient for reproduction upon written request to Sugarbeet Research, USDA-ARS, Crops Research Laboratory, 1701 Center Avenue, Fort Collins, CO 80526-2083. Seed of these releases will be deposited in the National Plant Germplasm System where it will be available for research purposes, including development and commercialization of new varieties/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 FC1018, FC1019, FC1022, and FC1020.

Signatures:

Executive Vice President
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11/8/09
Date

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Deputy Administrator, Crop Production and Protection
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12/4/09
Date