Breeding for Resistance to Bacterial Wilt of Potatoes in Brazil

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Introduction

Bacterial wilt (BW), caused by *Ralstonia solanacearum*, is one of the most important diseases of potato (*Solanum tuberosum*) in Brazil, where the crop is mostly grown in latitudes from 20° to 32°S. Even in cooler regions, if warm spells are associated with high soil moisture, losses may reach up to 50%; in addition, BW is the main cause of rejection of fields for seed certification purposes (Lopes et al. 1990). Both races 1 and 3 of *R. solanacearum*, which can attack potatoes, are present in Brazilian soils. Race 3 is found mainly in the southern and southeastern states, where the temperature is lower, therefore more suitable for potato production. Race 1 is widely distributed, including sites where race 3 prevails (Lopes et al. 1993). Within race 1, biovar III is found mainly in warm regions of the north and northeast of the country (Reifschneider and Takatsu 1985), thus not commonly associated with potatoes.

Partial disease control has been achieved with crop management measures such as time of planting, field selection, crop rotation, certified seeds, and use of more resistant cultivars. The German cultivar Achat became the most popular cultivar grown in Brazil in the last 10 years, in part due to its partial resistance to BW (Lopes and Giordano 1983; Lopes and Quezado-Soares 1994); however, its acceptance has dropped considerably recently due mainly to its poor cooking qualities. Interestingly, all 13 Brazilian varieties selected in the state of Rio Grande do Sul, where bacterial wilt occurs endemically, were statistically more susceptible than 'Achat', which probably was never exposed to the disease during selection (Lopes et al. 1993).

Approaches

With the objective of developing a BW-resistant cultivar as an alternative to 'Achat', genotype selection for BW-resistance at EMBRAPA-Hortaliças began in 1987 through a cooperative project with the International Potato Center (CIP), Lima, Peru. Since then, approximately 80,000 clones obtained from true seeds received from CIP or produced at Embrapa-Hortalicas, later cloned in Brasília, have been evaluated. From these, around 1,500 clones selected for tuber traits were evaluated for resistance to the disease. Materials received from CIP consisted of

populations combining resistance from accessions of *Solanum sparsipilum*, *S. chacoense*, *S. microdontum* and *S. phureja* (Schmiediche 1986; also see chapter by French, this volume). The accessions derived from *S. phureja* were originally selected at the University of Wisconsin, in the first systematic potato breeding program for resistance to BW (Rowe and Sequeira 1967).

Previous to screening for BW-resistance, genotypes as true-potato seeds received from CIP or from the national breeding program were cloned in the greenhouse. The clones were then multiplied and selected in a BW-free field in Brasilia for tuber characteristics such as shape, color, and eye-deepness. Evaluation for BW-resistance consisted of exposing the selected clones to a field naturally infested with race 1, biovar I of *R. solanacearum*. Because root-knot nematodes may interfere with BW resistance (Jatala et al. 1988), they were controlled with nematicides applied in the soil at planting. The experiments were carried out as completely randomized block designs with at least four replications and six plants per plot. Disease incidence was assessed weekly after first symptoms are observed and the Areas Under the Disease Progress Curves (AUDPC) were compared through cluster analysis. Only clones grouped together with 'Achat' and/or 'Cruza 148', the resistant controls, were selected for further characterization of glycoalkaloid content, plant cycle, yield, resistance to other diseases, etc.

Tubers of "resistant" clones harvested in the infested plot were stored under high temperature (around 30 C) until sprouting and then transversally cut for observation of vascular discoloration and bacterial ooze. Apparently healthy tubers were planted in pots with sterile soil in the greenhouse (21-34 C) and the plants checked periodically; this procedure allowed detection of possible latent infection, which is to be avoided, if possible, since it allows disease spread due to tubers produced by symptomless plants (Ciampi et al. 1980).

Results

Most of the BW-resistant clones selected so far have been meristem-tip cultured and indexed for viruses, and are available to breeders in Brazil and elsewhere. Since 1995, the 30 most resistant clones (Table 1) have been used at EMBRAPA-Hortaliças in crosses involving cultivars with good market acceptance and/or clones/cultivars possessing interesting characteristics such as resistance to other diseases, high dry matter content and high yield. These clones will be planted in infested fields in Paraná and Rio Grande do Sul, southern Brazilian states, where race 3 of the pathogen prevails, in order to assess the stability of the resistance.

Interesting crosses are shown in Table 1, such as Serrana x 84.36.29 and BWH-87.289 x XY-9 or XY-13, which yielded three selected clones each, indicating that they are good parentals either for tuber characteristics or for BW resistance or both. Clones derived from *Solanum phureja*, BR63.76 and MS 35.22, together with XY-9 and 386095.19 also showed good combining ability and should be used in future crosses. Cruza 148, used in many crosses for its good resistance, is not a good parent because of the bad tuber quality it confers on its progeny and also because it is very susceptible to latent infection (E. French, personal communication).

'Achat', which is the other control resistant cultivar, despite having excellent tuber characteristics, did not flower in several environments, and therefore could not be used in crosses. German cultivars Rheinhort and Fina, progenitors of 'Achat', are being tested for flowering and BW resistance. The BP genotypes, which were previously selected by CIP in the Philippines for resistance to race 3, also showed good resistance to race 1 in Brasilia (Quezado-Soares et al 1997).

Table 1. Selected genotypes for bacterial wilt resistance in the field at Embrapa-Hortaliças up to 1997[1]

Genotype	Pedigree	Origin	Year of selection
309.75G.6	-	CIP	1994*
386097.02	BW2TD.1 x 378676.4	CIP	1994*
388104.02	BR63.76 x XY.9	CIP	1994*
388285.12	MS35.22 x XY.9	CIP	1994*
309.95 x 386095.19/7	309.95 x 386095.19	CNPH	1994*
Cruza 148 x 386095.19/3	Cruza 148 x 386095.19	CNPH	1994*
Monte Bonito x 386095.19/3	Cruza 148 x 386095.19	CNPH	1994*
7B.16	7B (O.P.)	CNPH	1994*
589009-07	Serrana x 84.194.12	CIP	1995
589015-04	Serrana x 84.36.29	CIP	1995
589015-05	Serrana x 84.36.29	CIP	1995
589015-09	Serrana x 84.36.29	CIP	1995
591045-31	Serrana x 85.37.38	CIP	1995
591033-01	HP 364.21 x 84.194.30	CIP	1995
591033-04	HP 364.21 x 84.194.30	CIP	1995
591045-03	Serrana x 85.37.38	CIP	1995
591106-17	B.71.240.2 x J.40	CIP	1995 and 1996
800966 (cv.Prisca)	Industrie x Parnassia	CIP	1995
BP88166-02 (cv.13CJb)	P-5 x BR-112.113	CIP	1995
BP88166-05 (cv.13DKb)	P-5 x BR-112.113	CIP	1995
BP88068-03 (cv.13DDa)	ASN-69.1 x AVRDC-1287.19	CIP	1995
385147-59	B71-240.2 x Y-84.012	CIP	1996
389464-23	CBR63.5 x XY-6	CIP	1996
391768-07	BWH-87.176 x XY-9	CIP	1996
391783-01	BWH-87.289 x XY-9	CIP	1996
391783-06	BWH-87.289 x XY-9	CIP	1996
391784-01	BWH-87.289 x XY-13	CIP	1996
388104-12	BR63.76 x XY.9	CIP	1996

1994*, Comparative assays of selected clones from 1988 to 1992.
[1] Cultivars Achat and Cruza 148, previously selected as resistant to races 1 and 3, were used as controls.

Future Prospects

A set of cultivars were selected to be crossed with the genotypes in Table 1, either because of their combining ability for tuber characteristics or because of their resistance to other pathogens. Some of these varieties are: Serrana, Monte Bonito, Contenda, Catucha, Baronesa, Desirée, Monalisa, BR-2, Baraka, Granola, Atlantic, Itararé, Marijke, Omega, Roxy, Rheinhort, Cherokee and Kennebec.

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