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New sources of resistance to race Ro1 of the Golden nematode (*Globodera rostochiensis* Woll.) among reputed duplicate germplasm accessions of *Solanum tuberosum* L. subsp. *andigena* (Juz. et Buk.) Hawkes in the VIR (Russian) and US Potato Genebanks

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Abstract

Cultivated *Solanum tuberosum* L. subsp. *andigena* is well known as a rich source of valuable traits for potato breeding, especially for resistance to diseases and pests. The golden potato cyst nematode, *Globodera rostochiensis* Woll., is considered to be one of today's most serious hindrances to potato production in Europe and North America. Thus, the breeding of new cultivars that have resistance to PCN is of great importance. The USPG (USA) and VIR (Russian) potato genebanks, as well as others, maintain many samples of primitive cultivated and wild potato species originating from Latin America. Many of these samples are assumed to be genetically duplicated because the material in both genebanks came from the same original source. A joint investigation of new genotypes of subsp. *andigena* forms resistant to potato cyst nematode (PCN) was carried out on samples of subsp. *andigena* at VIR with reputed duplicate samples at USPG. After careful screening, 14 samples which possessed resistance to PCN were identified. A high level of this resistance was transmitted to sexual progeny at a high frequency for all of the selections. Eleven of the accessions found to be resistant have reputed duplicates in USPG that were not previously known to be resistant. Thus, this research not only broadens the choice of parents available for resistance breeding, but identifies model materials for future research to test the parity of PCN resistance among reputed duplicate samples in the two genebanks.

Abbreviations: PCN – Golden potato cyst nematode, *Globodera rostochiensis* Woll.; RAPD – Random Amplified Polymorphic DNA; USPG – US Potato Genebank (see Bamberg's affiliation)

Introduction

Potato cyst nematode continues to inflict significant damage on potato production in some Eastern European countries. Control is very difficult and expensive because PCN lives and overwinters in soil where chemical control is difficult and expensive. Thus, the best method known for controlling PCN is to create potato cultivars with genetic resistance.

A practical method of breeding potatoes with resistance became possible after the work of C. Ellenby (1954), who first began to evaluate the potato germplasm in the Commonwealth Potato Collection (CPC) in the United Kingdom. He was the first to find resistance to nematodes in *S. tuberosum* L. subsp. *andigena* (Juz. et Buk.) Hawkes, a tetraploid species cultivated in Latin America. Resistant accessions were CPC 1673, 1685, 1692, and 1595.

In the decades following, further investigations were carried out in different countries (Rothacker and Stelter 1957; Ross 1986) regarding the nature of resistance in subsp. *andigena* Hawkes. An active form of immunity was found in which larvae hatch on roots, but are unable to complete the cyst development cycle.

Resistance to pathotype Rol in subsp. *andigena* Hawkes is determined by a single dominant gene, H1 (Toxopeus and Huijsman 1952, 1953; Huisman 1955, 1960; Cole and Howard 1957; Rothacker and Stelter 1957). However, resistance genetics may be much more diverse (Ross 1969). Resistance to other nematodes has also been derived from subsp. *andigena* (Brodie et al. 1991).

Resistance from the H1 gene has been incorporated into several commercial varieties (e.g., Plaisted et al. 2001) that are available as parents for breeding. Germplasm with resistance to multiple races of PCN has also been developed (Brodie et al. 2000).

During the last three decades more than 40 samples possessing resistance to PCN were discovered among the collection of 2690 subsp. *andigena* accessions at the N. Vavilov Research Institute (VIR) (Kiru and Sdvizhkova 1999). However, of the approximately 850 accessions of subsp. *andigena* at the US Potato Genebank (USPG), only nine have been reported to be resistant (Hanneman and Bamberg 1987; Bamberg et al. 1994). Identifying a broader array of resistance sources opens the door for research to determine if useful variation in Ro1 resistance is present in these materials.

The USPG and VIR potato genebanks, as well as others, maintain many samples of primitive cultivated and wild potato species originating from Latin America (Hijmans and Spooner 2001). In many cases, genebanks have reputed duplicates (Huaman et al. 2000). Such accessions originated from the same initial source population and are identified as being the same material, so evaluation data from one genebank is often attributed to the duplicated sample in other genebanks. Such sharing of evaluation data between genebanks is a great benefit to breeders since it lessens the need for duplicate screening. The duplicate sample within a breeder's own country is also much more readily accessible, since quarantine testing of potato germplasm from other countries is usually required. However, since duplicate samples have been stored and propagated sexually under different conditions, they may not be true duplicates in the genetic sense. Indeed, significant differences in the presence of DNA markers have been demonstrated for subsp. *andigena* from VIR and USPG (Bamberg et al. 2001).

The main objective of this study was to screen accessions from the VIR subsp. *andigena* collection for resistance to PCN, and thus expand the diversity of parental material available for use in resistance breeding (Howard et al. 1970). In addition, since the accessions tested had reputed duplicates in the USPG, finding resistance would identify materials in USPG with potential resistance which would serve as a model system for testing the parity of reputed duplicates with respect to expression of an economic trait.

Materials and methods

The evaluation was conducted at VIR using 115 of the 144 subsp. *andigena* accessions in the VIR potato genebank with reputed duplicates in USPG (Bamberg et al. 1996). The 115 seed populations tested in this experiment included 34 different forms originating in Argentina, Peru, Bolivia, Colombia, Mexico and Ecuador. Plants were evaluated for resistance to PCN race Ro1 after artificial infection. Inheritance of resistance was then tested in the progeny of the selected tuberlings.

The plant materials were evaluated in a greenhouse with 14 h light (2000 lux) at 20–23 °C. They were grown in pots with a diameter of 10 cm. Each pot was filled with soil, and infected with 500 cysts with viable larva. Each of the 115 populations was represented by five tuberlings in the initial evaluation. Accessions were considered resistant only if all five clones were resistant. In this way, 14 accessions were found to be resistant. Clones within each