

## Notas Científicas

### Reaction of arracacha genotypes to the root soft rot caused by *Pectobacterium chrysanthemi*

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**Abstract** – The purpose of this paper was to screen thirty-two arracacha genotypes for their reaction to root soft rot. Twenty roots of each genotype were inoculated with two *Pectobacterium chrysanthemi* isolates in a randomized experiment (10 roots/isolate). After inoculation, roots were individually wrapped with PVC film and kept at 26°C in closed plastic bags. Soft rot lesions were recorded after 36 hours and genotypes were grouped in four classes of susceptibility by cluster analysis: 10 were less susceptible, 16 intermediate, 3 susceptible and 3 very susceptible. All the tested arracacha genotypes showed only variation in the degree of susceptibility.

**Index terms:** *Arracacia xanthorrhiza*, Peruvian carrot, resistance, disease.

### Reação de genótipos de mandioquinha-salsa à podridão-mole das raízes causada por *Pectobacterium chrysanthemi*

**Resumo** – O objetivo deste trabalho foi avaliar a reação de 32 genótipos de mandioquinha-salsa à podridão-mole das raízes. Vinte raízes de cada genótipo foram inoculadas com dois isolados de *Pectobacterium chrysanthemi* em um experimento casualizado (10 raízes/isolado). Após a inoculação, as raízes foram embaladas com filmes de PVC e mantidas a 26°C em sacos de plástico. As lesões de podridão-mole foram avaliadas após 36 horas e os genótipos agrupados em quatro classes de suscetibilidade por análise de agrupamento: 10 foram menos suscetíveis, 16 intermediários, 3 suscetíveis e 3 muito suscetíveis. Todos os genótipos avaliados demonstraram apenas variação no grau de suscetibilidade.

**Termos para indexação:** *Arracacia xanthorrhiza*, batata-baroa, resistência, doença.

Arracacha (*Arracacia xanthorrhiza* Bancroft) is a typical South American vegetable root crop from the Andean region, which was probably introduced in Brazil at the beginning of the 20<sup>th</sup> century. Arracacha is grown and consumed mainly in the South-Southeast regions of Brazil. In 2001, production was estimated in 120,000 t and the planted area reached 13,000 ha. This vegetable is regarded as a rustic, non-demanding crop by most farmers, because few diseases and pests occur during the long 8–10 month cycle (Santos & Carmo, 1998; Santos et al., 2000; Henz, 2001).

During summer, the soft rot caused by *Pectobacterium* spp. in arracacha roots can cause losses of up to 100% in only three days (Henz, 2001). The disease is known as “mela”, the Portuguese word that better describes the sticky soft rot of the roots. The three

most important pectolytic bacteria, *Pectobacterium carotovorum* subsp. *carotovorum* (=Pcc), *P. carotovorum* subsp. *atrosepticum* (=Pca) and *P. chrysanthemi* (=Pchr), are involved in the disease in Brazil (Romeiro et al., 1988; Henz, 2001). In general, Pcc was considered as the most important subspecies causing soft rot in arracacha roots in Brazil (Lopes & Quezado-Soares, 1997), but Pchr was determined as the prevailing species in the summer epidemic outbreaks registered in São Paulo at the CEAGESP wholesale market, the main trade center of fruits and vegetables in the country (Henz, 2001).

There are few possibilities for controlling soft rot, considering the prevailing handling system used for washing, grading and packing arracacha roots in Brazil. Most of the arracacha commercialized in São Paulo is

grown in the states of Paraná, Minas Gerais and Santa Catarina. After harvest, the product is transported at night by trucks in 32 kg plastic trays from distances ranging from 400 to 700 km to packing houses located in Piedade and Tapiraí counties, 150 km away of the wholesale market of São Paulo (Santos et al., 2000; Henz, 2001). Presently there is not any chemical product officially registered to control diseases or pests in arracacha at the Brazilian Ministério da Agricultura, Pecuária e Abastecimento. As soft rot progresses very quickly under conducive conditions, preventive measures seem to be the best strategy to reduce the disease incidence (Henz, 2001). The identification of less susceptible arracacha genotypes can be important altogether with other measures.

Breeding new arracacha cultivars is incipient in Brazil, and one of main constraints is the lack of genetic diversity available (Sediyama et al., 2000). Important agronomical traits for arracacha are presently poorly exploited by research. In the first attempts of breeding a new arracacha cultivar, yield, precocity and regional adaptation were the most important characteristics to be pursued by plant breeders. Fortunately, the root-knot nematode (*Meloidogyne* spp.) and the soft rot caused by *Pectobacterium* are the few diseases presently considered as limitant to arracacha in Brazil (Henz, 2001). The narrow genetical base represented by the three cultivars grown in the country can be threatened by new or emerging pests and diseases. Cultivars 'Amarela Comum' and 'Branca' probably represent more than one genotype, as they have been cultivated in Brazil since the introduction of arracacha. Farmers usually maintain their own mother plants in the field or simply replant cormels from the harvested plants (Santos et al., 2000). Genotypes originated from botanical seeds of yellow-root plants collected in Brazilian arracacha farms showed a great genetic variability for many agronomical traits, such as crop cycle, yield, number, size and color of roots and root shelf life, and were considered highly heterozigous by Hermann (1997).

The reaction of vegetable crops to soft rot is closely related to the screening method, selection of species/subspecies of *Pectobacterium*, characterization of the aggressiveness of isolates, definition of inoculum concentration and incubation conditions. Apparently, the reaction of potato tubers to the three main pectolytic *Pectobacterium* was independent of the species/subspecies chosen (Austin et al., 1988; Wolters & Collins, 1994), and the same was observed in carrot roots

by Michalik et al. (1992). In these papers, isolates of *Pcc* or *Pchr* were proven to be more aggressive at 22–30°C when compared to *Pca*. A similar approach was developed for the *Pectobacterium* × arracacha pathosystem, in which inoculation techniques, inoculum concentration, differences in isolate aggressiveness and methods of disease evaluation were studied (Henz, 2001).

The objective of this paper was to screen 32 arracacha genotypes from the 'Embrapa Hortaliças' germplasm collection for their reaction to *Pectobacterium chrysanthemi*, the main subspecies involved in root soft rot in Brazil.

The arracacha genotypes were grown under field conditions in Brasília, DF, Brazil, during a period of ten months following the technical recommendations for the region (Santos & Carmo, 1998; Santos et al., 2000). Each genotype was grown in a split plot experimental design, with ten plants/row and four replicates. After harvest, roots were hand washed and kept at laboratory room condition (22–25°C and 55–75% RH) for four hours to dry superficially.

Two isolates of *Pectobacterium chrysanthemi* of high (B11) and intermediate (B12) aggressiveness (Henz, 2001) were previously selected for this trial. The *Pchr* isolates were cultivated in Petri dishes containing the medium of Kado & Heskett (Klement et al., 1990) and kept at 27°C during 24 hours. Inocula were prepared by suspending bacterial cells in sterile water, and the inoculum concentration adjusted to 10<sup>8</sup> cfu/mL by spectrophotometer (wavelength of 550 nm, 52% of transmittance) through a calibration curve previously obtained (Henz, 2001). Each isolate was inoculated in ten roots of each genotype at two different points, in a randomized design. The inoculation technique consisted of a wound made by a sharp metal needle (0.3 cm of diameter and 1.2 cm deep) at the distal and proximal ends, approximately 5 cm from each other, and the deposition of 15 µL of inoculum. After 1 hour, roots were individually wrapped in PVC films, packed together in closed plastic bags and stored during 36 hours at 26°C. Check treatments consisted of two roots of each genotype inoculated with sterilized water. Evaluation was made by measuring the average diameter of the soft rot lesion, and clones were grouped in classes of susceptibility based on the average diameter of soft rot lesion caused by the two *Pchr* isolates by the cluster analysis of SAS software (SAS Institute, 1985).

The soft rot lesion diameter after 36 hours of inoculation ranged from 1.7 to 3.4 cm; checks treated

with sterilized water showed no symptoms (Table 1). All the 32 arracacha genotypes inoculated with the two isolates of *Pchr* were considered susceptible. The average diameter of soft rot lesions caused by the *Pchr* isolate B11 (high aggressiveness) was 8.7% larger when compared to those caused by the isolate B12, except for four arracacha genotypes (96003, 96031, 96386, 96406). The soft rot diameter of the lesions caused by isolate B11 ranged from 1.97 cm in the clone 94257 (yellow roots) to 3.4 cm in the genotype Ecu1216 from Ecuador, a white root clone. Interaction between the reaction of the arracacha clones and the two *Pchr* isolates was not consistent and the two lesion diameters were used to perform a cluster analysis.

Arracacha genotypes were separated into four groups by cluster analysis, average Euclidean distance and single

linkage method (SAS Institute, 1985), accordingly to the soft rot lesion diameter (Table 2). Ten clones were considered as less susceptible (soft rot lesion from 1.7 to 2.3 cm of diameter), 16 were intermediate (2.1 to 2.5 cm), three were susceptible (2.4 to 2.8 cm), and three were very susceptible (2.4 to 2.8 cm).

According to Pérombelon & Salmond (1995), there is no resistance or immunity to *Pectobacterium* spp. in cultivars of agricultural plants considered hosts of this group of pectolytic bacteria, only variation in the degree of susceptibility. In the potato  $\times$  *Pectobacterium* pathosystem, attempts to categorize the reaction of cultivars not always produced consistent results, probably due to problems such as the different inoculation techniques used, maturity of tubers, contamination of

**Table 1.** Root color and reaction of arracacha genotypes of the Embrapa Hortaliças breeding program to two isolates of *Pectobacterium chrysanthemi*.

Genotype <sup>(1)</sup>	Root color	Pchr B12 <sup>(2)</sup> Ølesion (cm)	Pchr B11 <sup>(3)</sup> Ølesion (cm)	Class of susceptibility <sup>(4)</sup>
46	Yellow	1.9	2.3	Less susceptible
90134	Light yellow	1.9	2.1	Less susceptible
92592	Yellow	2.7	2.8	Susceptible
92659	White	2.4	2.6	Susceptible
92739	White	2.3	2.3	Intermediate
94045	Dark yellow	2.2	2.5	Intermediate
94088	Yellow	3.1	3.1	Very susceptible
94120	Yellow	2.2	2.4	Intermediate
94175	Yellow	1.9	2.2	Less susceptible
94257	Yellow	1.8	1.9	Less susceptible
94348	Yellow	2.1	2.3	Intermediate
94368	Yellow	1.8	2.2	Less susceptible
94594	Yellow	1.8	2.3	Less susceptible
96003 <sup>(5)</sup>	White	2.3	2.0	Intermediate
96004	Orange	2.1	2.3	Intermediate
96006	White	2.2	2.5	Intermediate
96031 <sup>(5)</sup>	Yellow	2.4	2.3	Intermediate
96058	White	2.1	2.3	Intermediate
96071	White	2.1	2.3	Intermediate
96073	Yellow	1.7	1.9	Less susceptible
96085	Creamy	1.9	2.0	Less susceptible
96088	Orange	2.1	2.3	Intermediate
96127	Creamy	2.9	3.0	Very susceptible
96186	Creamy	2.0	2.1	Less susceptible
96187	Creamy	1.7	1.9	Less susceptible
96366	Creamy	2.0	2.2	Intermediate
96386 <sup>(5)</sup>	Creamy	2.2	2.1	Intermediate
96388	White	2.1	2.3	Intermediate
96405	Yellow	2.6	2.8	Susceptible
96406 <sup>(5)</sup>	Yellow	2.2	2.1	Intermediate
Ecu1182	White	2.2	2.6	Intermediate
Ecu1216	White	2.9	3.4	Very susceptible

<sup>(1)</sup>The thirty first genotypes were originated in Brazil; Ecu1182 and Ecu1216, were from Ecuador. <sup>(2)</sup>B12: *Pchr* isolate of medium aggressiveness.

<sup>(3)</sup>B11: *Pchr* isolate of high aggressiveness. <sup>(4)</sup>Classes of susceptibility defined by cluster analysis (average Euclidian distance, single linkage method).

<sup>(5)</sup>Isolate B12 was more aggressive than isolate B11 in this genotype.

**Table 2.** Cluster analysis of the reaction of 32 genotypes of arracacha (*Arracacia xanthorrhiza*) inoculated with two isolates of *Pectobacterium chrysanthemi*.

Class of susceptibility <sup>(1)</sup>	Number	Genotype (CNPH #)
Less susceptible	10	46, 90134, 94175, 94257, 94368, 94594, 96073, 96085, 96186, 96187
Intermediate	16	92739, 94045, 94120, 94348, 96003, 96004, 96006, 96031, 96058, 96071, 96088, 96366, 96386, 96388, 96406, Ecu1182
Susceptible	3	92592, 96405, 92659
Very susceptible	3	94088, 96127, Ecu1216

<sup>(1)</sup>Classes of susceptibility defined by cluster analysis (average Euclidian distance, single linkage method).

tubers and other causes. Based on this, the results reporting the reaction of vegetable crops to *Pectobacterium* can be assumed as less susceptible or more tolerant to soft rot, although some clones obtained from crosses of *Solanum tuberosum* and other species or subspecies of the genus *Solanum* can really have high levels of resistance (French & De Lindo, 1979; Wolters & Collins, 1994). There are other papers reporting differences of susceptibility to soft rot, including potato cultivars (Wastie et al., 1988), lettuce, sweet-potato, peppers and Chinese cabbage.

Among the arracacha genotypes selected for this trial, two white-rooted genotypes were from Ecuador and the other 30 genotypes were S1 lines, originated from the yellow-root clone 90134, collected in 1985 at a farm in the "Núcleo Rural da Vargem Bonita", Brasília, DF, Brazil. The S1 lines showed variability for many botanical and agronomical traits, such as yield, number, size and colour of roots. The selection of arracacha genotypes with less susceptibility to *Pchr* can be an important complementary measure to reduce the potential of postharvest losses and minimize the summer epidemic outbreaks of soft rot.

The 32 arracacha clones reacted differently to the inoculation, nevertheless none of them was considered resistant to *Pectobacterium chrysanthemi*. Based on this, it is possible to select clones less susceptible to soft rot among the germplasm of arracacha.

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