

Epidemiology of potato diseases

Especially on potato brown rot

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Background

Under EC rules (See Directive 77/93/EEC as amended, on protective measures against the introduction of harmful organisms into the Community) a Member state that “considers that there is an imminent danger of the introduction into its territory of *Pseudomonas solanacearum* (Smith) Smith [P.S. (Smith)], the cause of potato brown rot, from a third country,...may temporarily take any additional measures necessary to protect itself from that danger”. In March and April of 1996 France , Finland , Spain and Denmark banned imports of potatoes from Egypt on the basis of continued interceptions of potato containing P.S. (Smith).

By Decision 96/301/EC of May 3, 1996 the European Commission (EC) imposed a series of “additional restrictions” on imports of potatoes from Egypt . The “additional restrictions” required that in order to be imported into the EU, each “lot” of Egyptian potatoes (or every 25 tons) coming from a “qualified area” (areas certified by Egypt as areas in which “*Pseudomonas solanacearum* (Smith) Smith is not known to occur) must be :

1. sampled (at least 200 tubers) immediately prior to shipment and found to be free from any symptoms of brown potato rot;
2. tested for the latent infection with *Pseudomonas solanacearum* (Smith) Smith of each consignment with one sample for each “area” represented in the consignment with a minimum in any case of five samples;
3. harvested, handled and bagged separately “area by area” including “reasonably separate” use of machinery;
4. prepared in “lots” composed of potatoes harvested in one single area;
5. labeled on each bag with the relevant code for each “qualified area” and each lot number;
6. accompanied by an official Egyptian phytosanitary certificate indicating lot number and “qualified area” code number as well as an official statement that the required testing has been conducted

In addition, the EU designated authorized points of entry and officials in charge of entries of the potatoes. These officials were to be notified in advance of each entry as to likely time of arrival and amount. Potatoes arriving at the designated port of entry must then be inspected and tested by lot (at least as in 1 and 2 above). The lots must remain separate and could not be marketed or used until “it has been established that the presence of *Pseudomonas solanacearum* (Smith) Smith was not suspected or detected...” The list of “qualified areas”

could then be adjusted by the Commission based on results of these procedures. Finally, the potatoes were to be labeled to prevent them from being planted.

In the 1996/97 potato import season there were “considerable numbers” of Egyptian potatoes intercepted with brown rot. In response the EC strengthened the provisions of 96/301/EC. By Decision 98/105/EC the Commission banned Egyptian potato imports unless they met more stringent requirements which now included provisions that:

1. potatoes destined for the EU be produced in fields located in “qualified areas” declared by Egypt to have never had any outbreak of *Pseudomonas solanacearum* (Smith) Smith
2. the qualified areas must be tested for the bacteria and found free of it prior to planting;
3. potatoes must be inspected in the field for brown rot and found free from any symptoms in laboratory tests;
4. potatoes must be accompanied by documentation at the packing station stating their origin by area
5. potatoes must be sampled at the packing station for symptoms of brown rot with 10% of 70kg sacks to be inspected and 50% of larger sacks (at least 40 potatoes sampled per sack) .
6. 2% of sacks must be sampled after packing and found free of symptoms;
7. at least one sample per area in each consignment must be tested under a EU authorized test for latent infection;
8. potatoes must be exported by an officially registered exporter;
9. where “typical or suspect” symptoms of brown rot are detected at the port of entry all lots in the same consignment from the same area to be held until presence of *Pseudomonas solanacearum* (Smith) Smith is “refuted” by approved EU tests
10. testing at the point of entry for latent infection also must be done on samples from each area and the potatoes shall be held until it is established that presence of the bacteria was not confirmed.

During the 1997/98 import season Finland and Denmark banned imports of Egyptian potatoes. On August 11, 1998 the Commission responded to continued complaints of brown rot shipments by adopting new measures in Decision 98/503/EC. In this Decision the Commission eliminated the concept of “qualified areas” (those in which outbreak of P.S. (Smith) was not known to have occurred) and replaced it with “pest free area” (an area in which such an outbreak was known not to have occurred). Such areas were to be designated in accordance with UN Food and Agriculture Organization (FAO) standards. No imports of potatoes were allowed which did not come from these certified “pest free areas”. Egyptian potatoes imported into the EU were also to be grown from potatoes directly of EU origin or “once grown from such potatoes, produced in an approved pest free area” tested for latent infection immediately prior to planting...”. Additional certification requirements were also imposed on packing stations, most notably that stations used for packing potatoes for export to the EU must handle only potatoes eligible for EU export and no others. Even imports from “pest free areas” would be banned if more than 5 interceptions of P.S. (Smith) were found in lots imported into the EU during the season. Article 1.3 of Decision 98/503 is the provision

that provides for the cutting off of shipment after 5 interceptions; this article does not discuss the basis for choosing the number five. Decision 98/503 and the other EC decisions also do not discuss the extent to which measures provided for are based on risk assessments. On 22 September 1998, the EU, under the provision for notification of Article 7 and Annex B of the SPS Agreement, notified the WTO of the implementation of the Commission Decision 98/503/EC as an emergency measure (G/SPS/N/EEC/63).

In the 1998/99 import season there were again a “number of interceptions” of P.S. (Smith) infected potatoes from Egypt and imports of Egyptian potatoes were prohibited on April 3, 1999.

As a result of this ban Egypt further strengthened its harvesting, handling and packing regime administered by the central administration for plant quarantine (see below). Egypt also improved measures taken against exporters violating EU potato export regulations and adopted a new more tightly regulated control system for “pest free areas” (see Ministerial Decrees No. 61 and 95 of 2000 and No. 1317 of 2001 as well as regulations thereunder). Based on these changes and assurances, on November 30, 1999 the EC issued Decision 1999/842/EC which re-allowed imports of Egyptian potatoes from designated “pest free areas” on essentially the same conditions as in 98/503/EC.

In the 1999/2000 potato season only one interception of P.S. (Smith) was found in Egyptian potato exports to the EU. By Decision 2000/568/EC of 8 September 2000 the Commission allowed continued imports from “pest free areas” on the same terms as in 1999/842/EC. On 13 October 1998, the EU, under the provision for notification of Article 7 and Annex B of the SPS Agreement, notified the WTO of the implementation of the Commission Decision 98/503/EC as an emergency measure (G/SPS/N/EEC/97).

During the 2000/2001 season “a number” of interceptions of P.S. (Smith) occurred and Egyptian potato imports were again banned on May 5, 2001. The EU reassessed its position and obtained new assurances from Egypt of strict control measures within “pest free areas” and confirmation of measures against exporters who violated regulations on EU potato exports. In addition, Egypt submitted a detailed contingency plan explaining measures applied when brown rot is found within Egypt or in consignments of Egyptian potatoes at EU entry points (see below). Based on this information, the EU allowed imports of potatoes in the 2001/2002 season from designated “pest free areas” in Egypt on the same substantive terms as contained in Decision 2000/568/EC.

Potato Brown Rot

Brown rot is a disease of potatoes caused by the bacterium *Ralstonia solanacearum* (Smith) Smith, formerly called *Pseudomonas solanacearum*. The bacterium has a wide distribution in the tropics, sub-tropics and warm temperate regions where it is one of the main factors limiting potato production.

R. solanacearum is a strictly aerobic, non-spore forming, Gram-negative organism, with a wide and diverse host range affecting several hundred plant species from 44 families, including the *Solanaceae*, *Compositae* and *Leguminosae*. Host plants of economic importance include potato, tomato, tobacco, pepper, eggplant, groundnut and banana. In addition, several ornamental plants and weeds can act as host reservoirs of infection. *R. solanacearum* has been divided into five races, based on host range, and five biovars based on biochemical tests. Of the five races, 1 and 3 cause symptoms on potato, with major yield losses from rotting tubers (brown rot) and wilting with subsequent death of the plant (bacterial wilt).⁽¹⁾ Race 3 is adapted to pathogenesis at lower ambient temperatures and is believed to have originated in the temperate highlands of Peru and Bolivia. It is closely associated with

the potato, and is responsible for the present brown rot outbreaks in Europe and North Africa .

The Disease

There is no risk to human health from potato brown rot disease. Infection of the potato plant commonly occurs *via* the soil, where bacteria enter the root system of the plant at root emergence points, at wound sites, e.g. caused by nematode activity or soil particle abrasion, or *via* infected mother tubers. The pathogen enters the vascular system and under favorable conditions cell numbers increase and spread up the stem and to tubers. In warmer regions, where transpiration rates are high, the disease usually manifests itself as a general wilting of the stem (bacterial wilt). In cooler regions, wilting may be less evident or absent. Where symptoms develop, brown staining is seen in the tissues of cut tubers, caused by cell-wall-degrading enzymes produced by the bacteria. Bacterial ooze may also exude from the potato and, in severe cases, from the eyes resulting in soil sticking to the exterior of the tubers. As disease progresses a general rot may develop. Tubers may also harbor latent infections .

Brown Rot has caused up to 50% loss of potato crops in Burundi and up to 75% in Florida. Crop loss is only part of the overall economic loss due to the disease. As it is a quarantine organism there can be large costs due to disease testing and administration of seed production to control the disease.

Resistance, or more accurately tolerance, to the disease has been observed in potato. A major source of resistance to *R. solanacearum* has been from *S. phureja*, but resistance genes from other potato species, including *S. tuberosum*, have been identified and used. Tolerance, in potatoes that harbor relatively large populations of *R. solanacearum* in the absence of disease symptoms, increases the risk of spread through trading infected tubers.

Spread and survival

The most important means of both short- and long-distance dispersal of *R. solanacearum* race 3 is through the movement and growing of infected seed potatoes. The disease can also be spread by trade in ware potatoes, *via* irrigation water, plant debris, mechanical transmission, insects, root-to-root transmission, wind and rain, wounding during cultivation practices and by nematodes.

The survival of *R. solanacearum* race 3 in the environment is not well understood. However, protecting the organism from desiccation and antagonism by other microorganisms can prolong this survival. *R. solanacearum* tends to persist longer in wet but well-drained soil, in the deeper soil layers (>75 cm), or in the presence of alternative crops, weed hosts or groundkeepers. Soil survival is reduced by extreme cold and the presence of antagonistic microorganisms.

R. solanacearum infects alternative hosts including solanaceous weeds, which increases the likelihood of survival. Although disease symptoms may not develop in these hosts, bacteria continue to multiply and may become a source for re-infection of potatoes. Race 3 has been shown to survive and multiply in the roots of the secondary hosts Bittersweet (*Solanum dulcamara*) and Deadly Nightshade (*Solanum nigrum*) growing in rivers in a number of European countries⁽⁶⁾. This survival in secondary hosts, as well as in groundkeepers, could make crop rotation ineffective.

Egyptian Potato Exports to the EU

Potatoes are Egypt's largest horticultural export. In most recent years the EU has accounted for about 70% - 90% of Egyptian potato exports. In 1998 the total value of potato exports to the EU was about 63 million Euros, about 42.7% of Egypt's agricultural exports to the EU and 3.1% of total exports to the EU.

The total value of Egyptian potato exports fell from a peak value of US\$ 102.12 million in 1995 to \$US 7.7 million in 2000. Although 2000 exports may be unusually low, exports were over US\$40 million in both 1998 and 1999, even these numbers are a 56% decline over the period. This represents a drop in tonnage from approximately 419,000 metric tons to 48,500 tons.^{1[1]} Potato exports to the EU followed a similar pattern falling to a near decade low of 110,000 tons in 1999/2000 (and presumably much lower in 2000/2001) down from a peak of over 300,000 tons in 1995/96.

Between 1995 and 1998 acreage under potato production in Egypt decreased by about 40% to approximately 60,000 feddan. Potatoes for export to the EU are produced during the Winter season from September to March. In 1999/2000 approximately 13,300 feddan were eligible for EU exports, down from 18,300 the previous year. ^{2[2]} From a peak of 98 in 1995, interceptions of P.S. (Smith) in Egyptian potato imports to the EU declined to between 50 and 75 from 1996 to 1998 with only one in 1999/2000 and a rise in 2000/2001 as noted above.

Potato Plant Health System in Egypt

Egypt's current plant quarantine laws are based on a 1966 plant protection law; detailed provisions have subsequently been issued in various orders and decrees by the Minister of Agriculture.

The Central Administration for Plant Quarantine (CAPQ) of the Ministry of Agriculture is the responsible authority for plant health in Egypt. The CAPQ has recently undergone reorganization and set up a new Directorate for Internal Plant Quarantine with 10-12 inspectors. Staff is expected to double in the near future.

CAPQ inspectors are in charge of field inspections for potato brown rot. The Head of CAPQ is also head of the Potato Brown Rot Project (PBRP). PBRP is funded by the EU and aims to improve brown rot control. The project has focused on training, epidemiology and setting up a central laboratory specifically for brown rot. The project employs about 50 persons. Most of the staff of the project and CAPQ generally, hold at least bachelors degrees in science

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90% of Egyptian potato exports pass through the port of Alexandria. The phytosanitary service of the Directorate of Mediterranean Harbors employs 144 inspectors (2000), of which about 60 are responsible for potato inspections at packing stations.

Should a positive sample be obtained in field testing, measures ranging from partial to complete closure of an entire basin for EU export are taken depending on the circumstances. If infested potatoes originate in a pivot (150 feddans divided in 16 sections) the subsection in which the potatoes originated and two neighboring subsections are closed. In cases of positive pre-export laboratory tests the infested lot is taken off the export market and other packing stations are alerted as to the "pest free area" (PFA) of origin. Measures used for positive field samples are also applied.

If brown rot potatoes are intercepted at a point of entry in the EU, Decree 61/1999 establishes that the potato export company and the packing station are immediately suspended from exporting. An investigation is conducted and, if the exporter or packer can show he was not responsible for the problem, exports may be resumed, if not, he is suspended from exporting for the rest of the season. Should a packing station have two interceptions in a season it will be closed for the rest of the season without investigation. Plant quarantine inspectors working in a packing station from which brown rot originates are immediately suspended if they have released the infected potatoes.

Egypt imports seed potatoes which are inspected and transported to licensed storage facilities where they are further inspected and sampled (200 potatoes per 25 tons). Potatoes are released if certified free from brown rot. These potatoes are used for seed multiplication in PFAs during the summer season and held in cold storage until planting. Potatoes for EU export are grown in the Winter season. All producers, packers and exporters must be registered.

Both seed and export potato production is subject to an extensive regime for sampling and laboratory testing. Farmers seeking to produce either seed for export potatoes or export potatoes must apply for permission to the Ministry of Agriculture. If the fields proposed are in a PFA permission is granted. Field inspections for seed are carried out 35 days after planting. These inspections include laboratory tests for P.S. (Smith). Inspectors supervise each truckload which leaves the field and each load received at a packing station includes a "harvest report" for inspectors there. Machinery is generally not moved outside a PFA but if it is it is disinfected with formulin.

At the packing station teams of at least three inspectors do visual inspections and sampling. Inspectors are accommodated by the company, but inspection teams are rotated every two weeks. Truckloads arriving at the packing station are verified to ascertain that they correspond to their documentation. If so, they are allowed to enter the packing station for visual inspection. At least 2% of the potatoes are inspected. After packing, a random sample of 200 potatoes per 25 tons is taken for laboratory testing. All potatoes remain at the station until the laboratory certifies the samples free from P.S. (Smith). A final visual inspection is carried out before shipping to the port of exit. Every truckload of potatoes transported from both the field and the packing station is accompanied by a detailed report containing information on origin, variety, weight, number of bags, vehicle registration, date and time of departure. One copy of this report stays with the field or station inspector, one goes with the load and one is sent to CAPQ headquarters. At the port, documentary and identity checks are done along with a final visual inspection before loading on board ships (20kg per lot). In order for PFAs to be approved, extensive documentation including detailed maps, cropping pattern, irrigation sources and other relevant information must be submitted to the EU Standing Committee on Plant Health. This process can result in approval delays of several months.

According to the successful system the potato exporting season 2007-2008 was completely free from any interception cases of potato brown rot disease.

References

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