ADDENDUM AND UPDATE TO: QUANTITATIVE PEST RISK ASSESSMENT FOR THE POTATO BROWN ROT BACTERIUM *RALSTONIA SOLANACEARUM* (RACE 3 BIOVAR 2) IN FRESH POTATO IMPORTS TO NORWAY FROM EGYPT

PATHWAY ORIGIN	EGYPT
PATHWAY	FRESH POTATOES FOR CONSUMPTION
PEST RISK ASSESSMENT AREA	NORWAY
PEST ORGANISM	RALSTONIA SOLANACEARUM (RACE 3 BIOVAR 2)
COMMISSIONED BY	THE NORWEGIAN SCIENTIFIC COMMITTEE FOR FOOD SAFETY
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CONTENTS

Abbreviations

PBRP	Potato Brown Rot Project, Dokki, Cairo
PBRP/ARC	Potato Brown Rot Project of the Agricultural Research Centre, Dokki, Cairo
PFA	Pest Free Area
PRA Area	Pest Risk Assessment Area
SANCHO	Director General Health and Consumer Protection (Santé et protection des consommateurs), European Union

Summary

This report provide an assessment of the contents in the two documents by Janse *et al.* (2003) and PBRP/ARC (2004) in order to update the pest risk assessment of Rafoss & Sletten (2004) with the relevant data and information found in these documents. Moreover, the previous pest risk assessment is also updated with an assessment of the effect of adding an import control testing procedure in the importing country according to the procedure described by Anonymous (1998).

Based on this information, i.e. Janse *et al.* (2003) and PBRP/ARC (2004), it was decided to continue the approach of estimation of infection frequency based on experienced interceptions, i.e. reported findings of *Ralstonia solanacearum* in potato consignments from Egypt. An alternative approach would be to construct a mathematical model for failure in the Egyptian pest free potato production system. The documents of Janse *et al.* (2003) and PBRP/ARC (2004) provide a comprehensive documentation that could be used for this purpose. However, the documents also provide the information that an estimate of frequency of infected lots, based on a mathematical model for a properly working system, would not be reliable. Investigations, and trace back studies of the interceptions, show for several cases, that they were not generated by a properly working system, but rather by broken routines or fraud.

The revised estimate for the likelihood of entry of *R. solanacearum* to Norway through import of ware potatoes from Egypt is that infested lots will arrive at a rate of 0.0025, i.e. twentyfive lots per ten thousand lots imported. Imposing a control testing programme in Norway has the potential to reduce the average rate of infested lots to 0.0013, i.e. thirteen lots per ten thousand lots imported.

Latest news for the brown rot situation in the Egyptioan potato exports, collected from the reporting related to the United Kingdom imports of Egyptian potatoes tells at the time of writing that approximately 14,000 tonnes of Egyptian potatoes has been imported so far (early April), which is a similar amount to 2004 for the UK. Furthermore, all consignments has been inspected for potato brown rot and there has been one finding in this year's imports.

1 Introduction

This report represents an addendum and an update to a previous risk assessment report (Rafoss & Sletten, 2004) entitled "Quantitative Pest Risk Assessment for the potato brown rot bacterium *Ralstonia solanacearum* (race 3 biovar 2) in fresh potato imports to Norway from Egypt". The objectives of the present work, were to update the information regarding the potential for entry of *R. solanacearum* to the PRA area of Norway, through import of potatoes from Egypt, with the information about the situation for the pathogen at the pathway origin provided by the documents of Janse *et al.* (2003) and PBRP/ARC (2004). Janse *et al.* (2003) reports an audit by member states of the European Union on interception of potato brown rot on ware potatoes originating in Egypt from the export season 2003, and PBRP/ARC (2004) contain the Egyptian file of the investigations of the EU interceptions of potato brown rot in potato imports originating in Egypt for the 2003/2004 export season. Another objective of the present work was to conduct an assessment of the introduction of a import control.

1.1 THE EGYPTIAN POTATO PRODUCTION SYSTEM FOR EXPORT TO EU

Briefly described, the system for production of potatoes for export to the EU and seed certification starts with a "summer loop" based on imported seed potatoes from EU-countries. Planting takes place in spring/early summer. After harvest the certified seed potatoes are kept in cool storage until planting in the "winter loop" in October/November. Both the system for multiplication of seed potatoes and the system for growing of ware potatoes for export take place in designated pest free areas.

1.2 PEST FREE AREAS FOR *RALSTONIA SOLANACEARUM*

New Pest Free Areas (PFA) are established on new land on sandy soil. Weeds, soil and water are tested for *Ralstonia solanacearum*. There are requirements to the use of manure and compost, on irrigation and on the machinery used in the production. Except for some places of production in PFA in Nubaria which are irrigated by surface water, pivot irrigation (based on ground water) is most common. A book with descriptions of all PFA's is prepared each year and is presented for approval by SANCO. Visual symptoms for brown rot are carried out in the crops after harvesting. In cases where *Ralstonia solanacearum* is detected, the contingency plan is set into force. No potato crops are allowed in contaminated fields for a period of 3 years.

1.3 CONCLUSIONS FROM THE PBRP AUDIT MISSION REPORT BY THE EU

The main conclusions, made by Janse *et al*. 2003, and identified as highly relevant and critical for the Norwegian Food Safety Authority are the conclusions no. 3, 7, 8 from chapter 1 of the report. The essence of these conclusions are that there is still a general attitude at the Potato Brown Rot Project (PBRP) that brown rot control can be achieved primarily by screening and testing (either for visual or latent infections). Moreover, according to Janse *et al*. 2003, it seems to be a prevailing idea at packing stations that when the EU "5 interceptions" limit (a limit of number of interceptions for EU export) have been reached and a ban will be imposed, it does not matter anymore which potatoes are exported, because the border will close soon anyway. PBRP staff members have been reluctant to provide and discuss with the EU, records of outbreaks of brown rot found as a result of their own investigations, even not specifically related to export productions.

1.4 CONCLUSIONS AND ACTIONS TAKEN BY THE PBRP

The PBRP/ARC (2004) report actions that has been taken, possibly as a response to the EU audit (Janse *et al*. 2003) such as:

- Prohibition of execution of duties for responsible inspectors for the two next seasons because of serious negligence in inspection of the ware potatoes
- Cancellation of transport contracts
- Separation of handling of pivot and buffer zone
- Warning and stopping production companies and packing stations by Ministerial Decision

Besides this PBRP/ARC (2004) reports immediate actions taken after obtaining the interception notifications from the EU:

- Halting all movements of potatoes from the basin of crop production concerned until confirmationis obtained from the EU
- As preventive measures:
    - Disinfection of packing station tools, machineries and equipment
    - Disinfection of potato harvesting machines and other equipment

Regarding the back tracing, investigations and explanations for the 11 interceptions of *R. solanacearum* detected in the EU-countries in the Egyptian potato exports of the 2003/2004 season, 6 of the 11 interception cases could not be explained. For the remaining 5 cases there were found traces of negligence of phytosanitary routines or even tendencies towards cheating or fraud.

2 Quantitative information and potential of entry

The PBRP/ARC (2004) report provide valuable data for estimation of the *R. solanacearum* situation in Egyptian potato exports. On the assumption that routine sampling and testing procedures have been followed, e.g. as described in the EU control directive (Anonymous, 1998), it is possible to use the data for interceptions of *R. solanacearum* to calculate an overall likelihood of entry.

Regarding the selection of risk modelling approach, in light of the information summarised above, two main alternatives appear. One is to calculate the entry potential for the pathogen to the PRA area based on a mathematical model for failure in the Egyptian pest free potato production system. The documents of Janse *et al.* (2003) and PBRP/ARC (2004) provide, and refers to, comprehensive documentation of organisational structure, of monitoring & control system for the potato production, and of regulations for the export of ware potatoes to the EU, that could be used for this purpose. The other alternative is to base the estimation of infection frequency on experienced interceptions, i.e. reported findings of *R. solanacearum* in potato consignments originating in Egypt.

While the latter alternative represents a quite conservative approach, the former alternative presuppose a properly working pest free potato production system which has been shown not to always be the case (Janse *et al.,* 2003; PBRP/ARC, 2004). Investigations and trace back studies of the interceptions, show for many of the cases, that they were not generated by a properly working system, but rather by broken routines or fraud.

Ideally, on the other hand, given a properly working pest free potato production system which is working as designed, estimation of the likelihood of entry of *R. solanacearum* to Norway should be based on a mathematical model for the entire Egyptian production system for pest free export production of potatoes. Such a model is likely to yield a very low estimate for the frequency of *R. solanacearum* infested lots in the Egyptian potato export.

2.1 STATISTICS BEHIND SAMPLING FOR *R. SOLANACEARUM*

The EU sampling rule of 200 tubers per 25 tons is commonly referred to give an 87% probability of detecting at 1% level of infection.

$$\mathbf{P_{sampling}} = 1 - (1 - d)^n$$

Described in words the above formula says that the probability of the event of missing to sample an infected tuber (1 – d), where d is the level of infection, repeatedly 200 times $(1 - d)^{200}$ is approximately equal to 0.13 or 13%. The other outcome, i.e. the event that the 200 tuber sample will contain one or more infected tubers will be $1 - (1 - 0.1)^{200} = 1 - 0.13 = 0.87$ or 87%. The use of the above formula relies on the assumptions of binomial sampling:

(1) that the population (lot) to be sampled is very much larger than the size of the sample
(2) either that the tubers are randomly distributed in the lot, or that the sample is take randomly throughout the lot

If any of the above assumptions are compromised, the efficiency of the sampling procedure ($\mathbf{P_{sampling}}$) will be lowered. The effect of clustering of diseased tubers within the lot, or the heterogeneity of disease incidence according to the terminology of Madden & Hughes (1999), can be taken account of, but requires data on the degree of/for clustering/heteogenity. Unfortunately, to the authors knowledge, no studies or data for of clustering of diseased tubers in potato lots infested with *R. solanacearum* have been published.

2.2 EGYPTIAN POTATO EXPORTS TO EU-COUNTRIES AND INTERCEPTIONS

The tables 1 and 2 below reports detected findings of *R. solanacearum* infected potato lots in the Egyptian potato export to EU-countries. Table 1 report detected findings in different EU-countries in the 2003/2004 export season, while table 2 reports total number of detected findings over the last six export seasons. Both tables are reproduced from the PBRP/ARC (2004) report.

Table 1. Egyptian potato exports and findings detected for different EU-countries in the 2003/2004 export season (reproduced from Annex no. 3 in PBRP/ARC, 2004)

Country	Exports (Ton)	Confirmed findings	Rejected amount (Ton)	Rejected amount (%)
Greece	84689.30	4	91.5	0.11 %
Italy	56844.86	Repetation (Greece)[1]	72.4	0.13 %
Germany	50083.03	0	0.0	0.00 %
NL	24314.09	5	175.0	0.72 %
UK	15837.27	2	49.0	0.31 %
France	922.55	0	0.0	0.00 %
Belgium	550.00	0	0.0	0.00 %
Total	233241.10	11	387.9	0.17 %

Table 2. Egyptian potato exports to EU-countries and the detected findings for brown rot for the export seasons from 1998/1999 to 2003/2004 (reproduced from Annex no. 4 in PBRP/ARC, 2004)

Export season	Exports (Ton)	Interceptions	Interceptions (%)
1998/1999	197310	52	0.0264
1999/2000	109437	1	0.0009
2000/2001	128261	8	0.0062
2001/2002	166129	7	0.0042
2002/2003	198383	13	0.0066
2003/2004	233241	11	0.0047

Interpreting interceptions as the number of potato lots detected to be infected with *R. solanacearum*, average lot sizes for rejected lots in table 1 range from 22.9 to 35.0 tons for Greece and the Netherlands, respectively. The latter calculation is obtained by dividing rejected amount on the number of confirmed findings. Average lot size for all rejected lots in table 1 is 35.3 tons. Comparing table 1 to table 2, both tables report the same number of interceptions for the 2003/2004 export season, namely 11 detected findings. However, the "Interceptions (%)" column of table 2, which is simply obtained by:

$$\frac{\text{Interceptions}}{\text{Exports (Ton)}} = \text{Interceptions (\%)}$$

yielding a figure expressing the number of interceptions per ton exported.

[1] Difficult to interpret. Same material repeatedly controlled in Italy after first being detected in Greece? Decided to interpret as 0 confirmed findings for Italy.

2.3 ESTIMATION OF THE LIKELIHOOD OF ENTRY

A key point for the calculation of the amount of infected material that may enter the PRA area through an import activity is the counting units applied to the plant material. Detected findings of *R. solanacearum* in the trade is recorded and reported as "interceptions", which refers to number of lots found to be infected. However, it is not straightforward how this "interception" information should be interpreted and transferred to an estimate of entry potential for the pathogen through potato import to the PRA area. Interceptions are potato lots detected as infested with the pathogen. But, the method of detection is not perfect. The Egyptian sampling and testing programme reports an average sampling efficiency of 70% and a test sensitivity of 70% (personal communication by letter on the 27th of October 2004 from Dr. Safwat El-Haddad, Director of the Potato Brown Rot Project in Egypt). Assuming independency of the sensitivity of the test and the efficiency of the sampling procedure, the probability of detecting an infested lot is $0.7 \times 0.7 = 0.49$, i.e. approximately 50% probability of interception. In lack of studies on this subject, these figures are assumed to be valid in the following text.

For estimation of the likelihood of entry, the rate of infested lots to total number of lots can be used, but relies on the assumption that the infection level in infested lots is independent of lot size. Although, the efficiency of the binomial sampling rule is independent of lot size as long as the lot is much bigger than the sample, the sample size requirement set by Anonymous (1998) is to take sample sizes proportional to the lot size (presumably to mend the potential for breaking the second requirement listed in section 2.1). However, the lot size will be important for the amount of infected material that may enter the PRA area, which would increase with the size of the lots. With an infection level of 1% of the tubers, import of an infested 250 ton lot will provide the Norwegian market with 2500 kg of diseased potato tubers, compared to 250 kg of diseased potato tubers for a 25 ton lot. In terms of supermarket bags/consumer units, commonly sized 2.5 kilograms in Norway, 1000 bags of the 100,000 bags made from a 250 tonnes lot will contain diseased tubers (if infected tubers are perfectly sorted), compared to 100 bags if the lot had was sized 25 tonnes.

For the risk assessment, expression of the likelihood of entry as the frequency of entry of infested potato lots is somewhat vague. Because of the lack of information on infection level, i.e. the proportion of infected potato tubers in the infested potato lots, the expression of the likelihood of entry of *R. solanacearum* to the PRA area as the frequency of entry of infested potato lots is vulnerable to variations in lot size. Thus, in order to be usable as a measurement of likelihood of entry, e.g. rate of entry of infested lots, the lot size term has to be standardised. In the following calculations, a common potato lot size of 25 tonnes are assumed, corresponding to the commonly referred unit of measurement for potato lots, e.g. the EU sampling scheme of 200 potato tubers per 25 tons. Moreover, the selection of a lot size of 25 tons for the calculations, corresponds quite good with the lot sizes derived from table 2 as well.

Table 3 reports calculations of expected rate of *R. solanacearum* infestations of Egyptian export potato lots based on the most recent export season data for the Egyptian potato export given in table 1. The calculations are made according to the detailed example given in the appendix of Rafoss & Sletten (2004). Table 3 also reports in its last row the previous estimate of expected rate of *R. solanacearum* infestation in the Egyptian export potato lots (Rafoss & Sletten, 2004).

Table 3. Calculation of the total number of lots exported and estimated expected rate of *R. solanacearum* infestation in the Egyptian export potato lots.

Country	Confirmed findings	Assumed lot size (ton)	Number of lots	Infested lots (assumed)	Expectation	Cumulative expectation
Greece	4	25	3388	8	0.0027	0.0027
Italy	0	25	2274	0	0.0004	0.0016
Germany	0	25	2003	0	0.0005	0.0012
NL	5	25	973	10	0.0113	0.0022
UK	2	25	633	4	0.0079	0.0025
France	0	25	37	0	0.0257	0.0025
Belgium	0	25	22	0	0.0417	0.0025
Totals from EU-countries	11		9330	22	0.0025	0.0025
Egypt (internal control)[2]	2	233.24	9400		0.0002	

The results from the calculations presented in table 3 show that the use of an assumed lot size of 25 tonnes yielding a total export of 9330 lots deviates only slightly from the figure of 9400

[2] The information on which the estimate of the rate of *R. solanacearum* infestation in the Egyptian export potato lots where based in Rafoss & Sletten (2004), as provided by personal communication by letter on the 27th of October 2004 from Dr. Safwat El-Haddad, Director of the Potato Brown Rot Project in Egypt

lots reported by Dr. Safwat El-Haddad (personal communication by letter on the 27th of October 2004 from Dr. Safwat El-Haddad, Director of the Potato Brown Rot Project in Egypt).

The graphs in figures 1, 2 and 3 reflects the calculations of uncertainty about the frequency of infestation of *R. Solanacearum* in Egyptian potato export lots based on data from table 1. The uncertainty about the frequency of infestation is expressed as probability density plots, where the area under the curve equals 1, i.e. all possibilities.

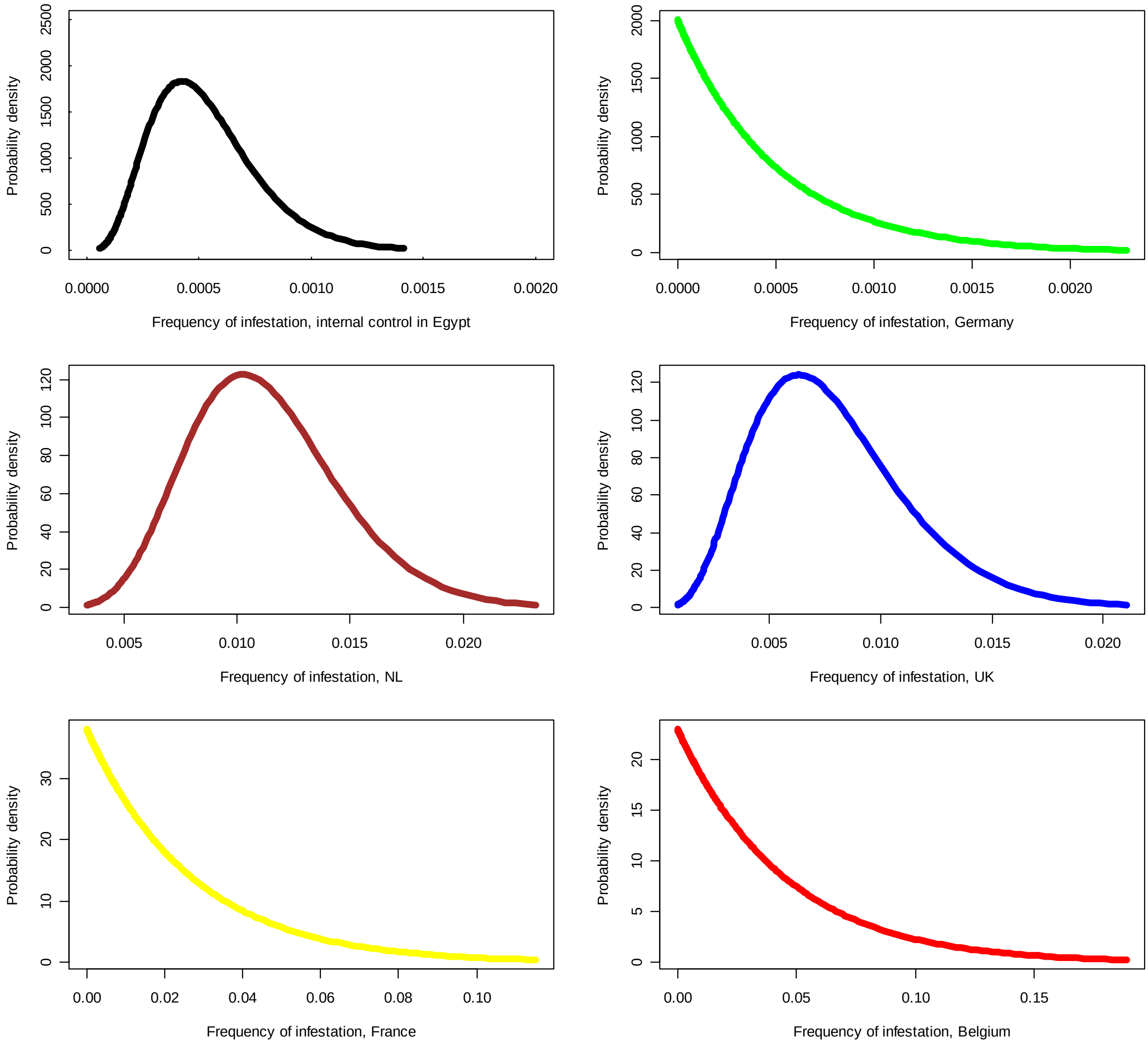

Figure 1. Probability densities expressing uncertainty about the frequency of *R. Solanacearum* infested potao lots in Egyptian potato exports, based on detected findings in the imports to EU-countries

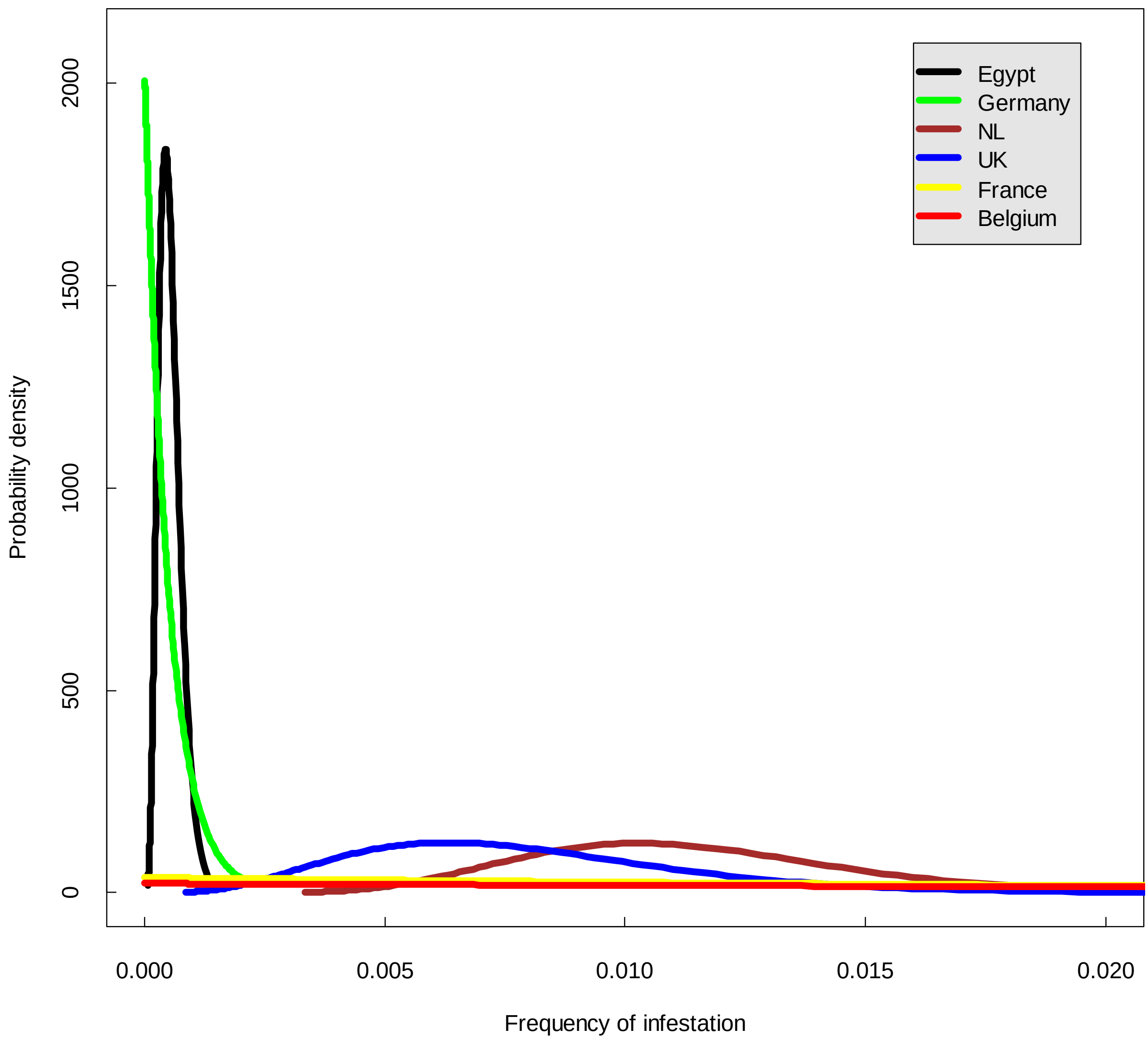

Figure 2. The probability densities from figure 2 pooled in a common figure and plotted on the same scale.

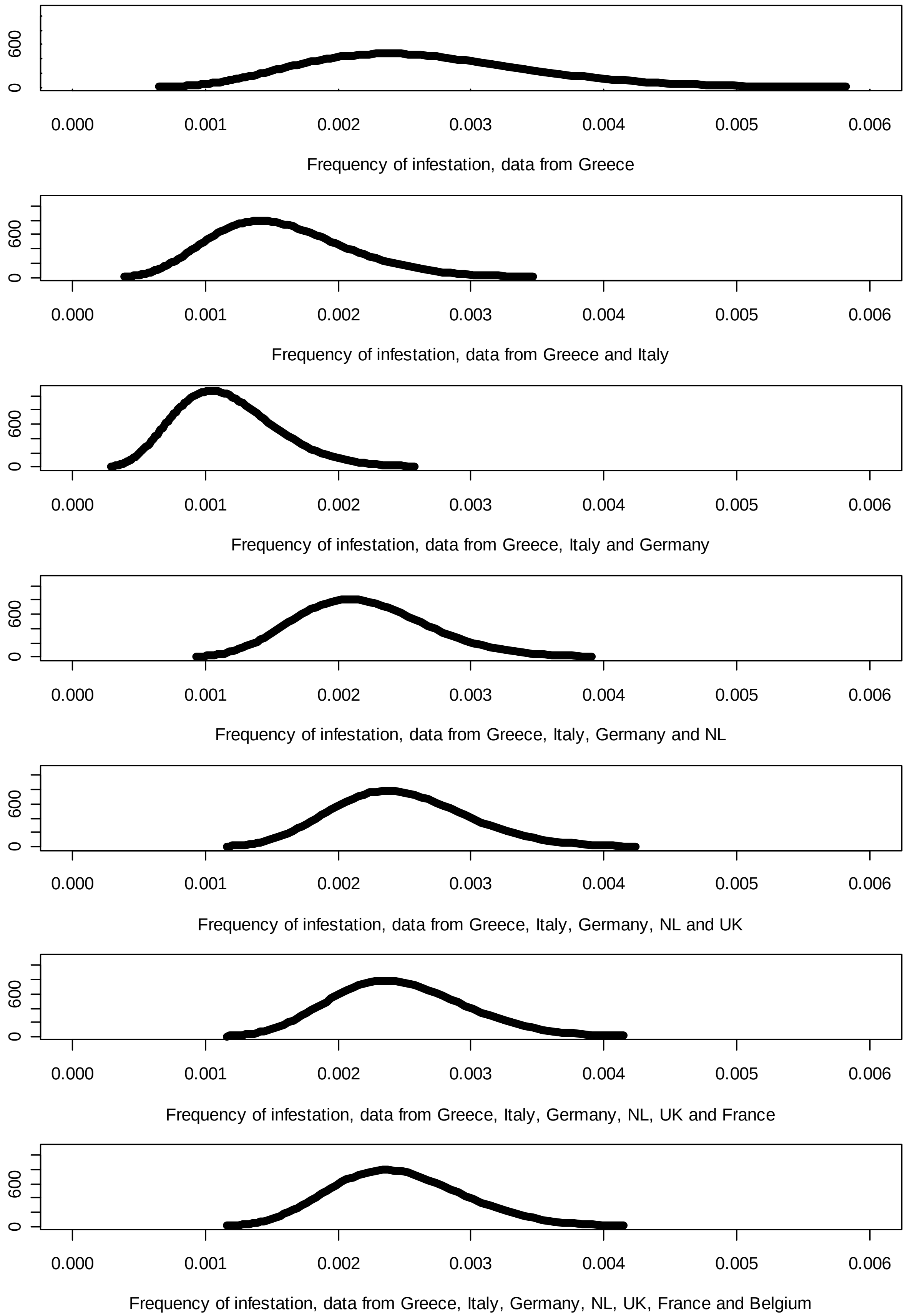

Figure 3. Probability densities for uncertainty about the frequency of *R. solanacearum* infested potato lots in Egyptian potato exports created by adding data cumulatively from table 1 sequentially for each country

2.4 EFFECT OF TESTING IMPORTS IN NORWAY

Introducing the risk management procedure of following the phytosanitary procedure for *R. solanacearum* with sampling of 200 potato tubers per 25 tonnes and testing for visual symptoms and latent infection (Anonymous, 1998) would yield the sampling efficiency discussed in section 2.1. In absence of published studies or data on common infection levels in *R. solanacearum* infested potato lots, the expert opinion expressed by Dr. Safwat El-Haddad (personal communication by letter on the 27th of October 2004 from Dr. Safwat El-Haddad, Director of the Potato Brown Rot Project in Egypt) of an on average efficiency of the sampling procedure equal to 70% seems plausible. This efficiency level corresponds to an approximate infection level of 0.006 or 0.6% in infested potato lots when other sampling conditions are ideal.

$$\mathbf{P}_{\text{sampling}} = 1 - (1 - 0.006)^{200} \approx 0.7$$

Regarding the $\mathbf{P}_{\text{diagnosis}}$ the immuno fluorescence (IF) test is reported to need 10^3 to 10^4 cells per ml. In practice the sensitivity of this test is about 70% (personal communication by letter on the 27th of October 2004 from Dr. Safwat El-Haddad, Director of the Potato Brown Rot Project in Egypt). The probability of detection based on these figures will be:

$$\mathbf{P}_{\text{detection}} = \mathbf{P}_{\textbf{sampling}} \times \mathbf{P}_{\textbf{diagnosis}} = 0.7 \times 0.7 = 0.49$$

Factors that disturb the sampling routines and their reliability such as practical constraints of obtaining access to all parts of consignments as mentioned previously will apply to a Norwegian control and testing programme as well.

To summarise the expected rate of entry of 25 infested lots per 10,000 lots imported could be reduced to 13 infested lots per 10,000 lots imported.

$$\mathbf{P}_{\text{detection}} \times \mathbf{P}_{\textbf{dentry in exports}} = 0.49 \times 0.0025 = 0.0012$$

2.5 BROWN ROT SITUATION IN THE EGYPTIAN POTATO EXPORTS 2005

Latest news for the brown rot situation in the Egyptioan potato exports have been collected from the United Kingdom imports (Anonymous, 2005). At the time of writing, approximately 14,000 tonnes of Egyptian potatoes has been imported so far to the UK (early April). All consignments has been inspected for potato brown rot and there has been one finding in this year’s imports.

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