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Standard for seed potatoes

Revision of Annex IX (Sampling tubers for virus testing) *

The following document contains the proposal prepared by the working group (led by New Zealand and the United Kingdom, with Australia, France, Germany, Netherlands and South Africa) to revise Annex IX of the Standard. The Specialized Section is invited to discuss and adopt the document.

* Submitted on the above date to include all contributions.

Paper on Sample Sizes

1. Background to the topic

The 44th session of the Specialized Section on Seed Potatoes (Geneva, 29-31 March 2017) considered a paper on sample sizes. It was agreed that Annex IX of the Standard would become a "Sampling annex" and that a working group should work on the integration of Table 1 and the amended Table 4 of the paper (without its right hand column) into the Standard (Table 1 of INF.1 would not be included). A working group led by New Zealand with the collaboration of Australia, France, Germany, Netherlands, South Africa and the United Kingdom would prepare a proposal for the 2018 session of the Specialized Section.

Modifications to Annex IX are proposed below. These changes make the Annex a general guide to sample sizes for tuber testing and field inspection. The focus on sampling for virus testing of tubers remains in sections 2, 3 and 4 and a new section 5 has been added to include the tables for field inspection sample sizes. Sampling for tuber inspection is not included, as a rate of 20 kg per 10,000 kg is already specified in section III D of the Standard.

2. Modifications to the Standard

Note: It is recommended that the text of the Standard be modified as follows.

Modifications to Annex II B (2)

Note: Modifications to this section were agreed in Oulu (Extended Bureau, 2015), and adopted by the Specialized Section and the Working Party in 2016. A new proposal was discussed at the 2017 session of the Specialized Section in 2017.

The DA shall specify the inspection procedures. In general, the procedures should allow the inspector to inspect at random a representative sample of plants from a crop.

The number of plants inspected should be sufficient to ensure that, with an appropriate level of confidence, the tolerances given in Annex II A are not exceeded [This change was adopted in 2016]. **Table** ~~YY~~ **5 and 6 in Annex IX provide guidance on the number of plants to sample and maximum allowable number of each fault in each sample size.**

The number of plants affected by the diseases listed in annex II, section A, points 2 and 3 and those not true to variety or of another variety (annex II, section A, point 4) should be recorded separately in the field inspection report and each expressed as a percentage of the total number of plants inspected in the ~~crop~~ sample.

Observation of symptoms of the diseases specified in Annex II A 5, during inspection, or at any other time, will result in the crop being rejected, if confirmed by appropriate diagnostics [This change was adopted in 2016].

Modifications to Annex IX

~~Sampling tubers for virus testing~~ **Sample sizes for tuber testing and field inspection**

1. Introduction

When undertaking field inspection or testing seed stocks for virus, ~~In testing seed stocks for the incidence of virus,~~ it is seldom feasible to **inspect or** test the entire ~~stock~~ **crop** or stock, so a test is done on a sample ~~from the stock~~. Ideally, only seed ~~stocks~~ with ~~infection levels~~ **faults** below the tolerance would be accepted and those above the tolerance rejected.

However, taking a sample ~~from a stock~~ means that only an estimation of the actual incidence of ~~virus~~ **faults** can be made.

The reliability of this estimation will vary with the size of the sample relative to the size of the **crop or** lot, and the population standard which is set for the test. Defining an acceptable population standard for any sample entails two types of risk.

The first is that of rejecting a **crop or** stock containing ~~less virus~~ **fewer faults** than the tolerance and is often described as the "grower's" risk. The risk of accepting a **crop or** stock containing more ~~virus~~ **faults** than the tolerance is known as the "buyer's" risk. From the point of view of classification authorities, this could also be described as the risk of passing a **crop or** stock which fails to meet the official tolerances.

The choice of ~~analytical~~ **testing** technique may also have a bearing on the precision of the result, in particular the use of bulking of individual samples into one laboratory analysis. Bulking will have an impact on the confidence interval of the test.

Such testing makes a number of important assumptions, which are, primarily, that the ~~infected tubers~~**faults** are distributed homogeneously ~~in the stock~~ and that **plants and** tubers **to be inspected or tested** are sampled randomly. In addition, the choice of the size of sample ~~to be tested~~ will need to be balanced by other practical factors, such as cost, available facilities, labour, logistics of handling samples, seed stock size, etc.

The following tables and graphs illustrate some of the principles involved in **establishing sample sizes for inspection and testing** ~~sampling tubers for testing for virus~~.

2. Confidence limits for virus testing

3. Probability of classifying stocks to meet specified virus tolerances

4. Bulking of samples for ~~analysis~~ virus testing

5. Sample sizes for field inspection

Tolerances for faults detected during field inspection are specified in Annex II A. Annex II B states that the number of plants inspected should be sufficient to ensure that, with an appropriate level of confidence, the tolerances given in Annex II A are not exceeded. Determination of the "appropriate level of confidence" is at the discretion of the Certifying Authority, and the following tables are provided for guidance purposes.

Confidence levels

One approach to determining an appropriate number of plants to inspect during field inspection is to determine an appropriate confidence level and inspect the number of plants required to be sure that, if no faults are found, the tolerance has not been exceeded. For example, if a Certifying Authority wishes to be 95% confident that the 0.1% tolerance for a fault in a crop has not been exceeded, a minimum of 3000 plants need to be inspected with no faults found (Table 5).

Table 5: Rounded minimum sample size (along with no faults in sampled plants) required for statistical proof that the true level of faults is less than the specified maximum, at confidence levels of 90%, 95% and 99%.

Specified maximum level of disease	*Minimum sample size (along with NO disease in sampled plants) required for statistical proof that the true level of disease is less than the specified maximum, at confidence level:*		
	90%	*95%*	*99%*
0%	A census (100% sample) of all plants is required for proving this is the case.		
0.01%	23,100	30,000	46,100
0.1%	2,310	3,000	4,610
0.2%	1,150	1,500	2,300
0.25%	920	1,200	1,840
0.5%	460	600	920
0.8%	290	380	580
1%	230	300	460
1.5%	160	200	310
2%	120	150	230
6%	40	50	75

For faults with higher tolerances, the number of plants to be inspected to be 95% confident that the tolerance has not been exceeded may seem quite small. For example, to be 95% confident that a tolerance of 1% has not been exceeded, only 300 plants need to be inspected. However, it is important to recall that the statistical validity of inspection requires that faults are evenly distributed through the crop, and that the plants sampled for inspection are selected randomly. Neither of these criteria are likely to be fully met in field inspections and, to compensate, a larger number of plants may need to be inspected.

Confidence intervals

Another way of measuring confidence in an inspection result is to apply a confidence interval, based on the inspection sample size and the number of faults found. This is useful where the number of faults is close to the tolerance, where a standard level of confidence is not specified by the Certifying Authority, or where the actual sample size is below that required to be 95% confident of meeting the tolerance. The buyer can review the number of plants sampled, and the number of faults found, and determine the upper confidence interval.

For example, if a 0.5% tolerance applies to a crop this is the same as 5 faults per 1000 plants. If 1000 plants are inspected and 5 faults are found, the crop passes inspection. Similarly, if 3000 plants are inspected 15 faults are allowed. However, there is less confidence in the accuracy of the inspection result when fewer plants are inspected. In this example, the true number of faults when 1000 plants were inspected could be as high as 1.02%, but only as high as 0.77% when 3000 plants are inspected (Table 6).

Table 6. Upper limit of the 95% confidence interval (one-sided) for tolerances at differing inspection sample sizes and numbers of faults detected.

Required tolerance (Annexe XI)	*Inspection sample size (actual number of plants inspected*	*Number of faults detected (arithmetically allowable)*	*Upper limit of 95% confidence interval (% faults)*
0.50%	1000	5	1.05
	3000	15	0.77
	6000	30	0.68
0.40%	1000	4	0.91
	3000	12	0.65
	6000	24	0.56
0.20%	1000	2	0.63
	3000	6	0.39
	6000	12	0.32
0.10%	1000	1	0.47
	3000	3	0.26
	6000	6	0.20
0.05%	1000	0	0.30
	3000	1	0.16
	6000	3	0.13
	7000	3	0.11
0.01%	1000	0	0.30
	3000	0	0.10
	6000	0	0.05
	10000	1	0.05
	25000	2	0.03