# The Contribution of Quality Inspections to the Improvement of the Quality of the Dutch Flowerbulbs and Access to Export Markets

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**Abstract**

**The Dutch Flowerbulb Inspection Service (BKD) was founded in 1923 on the request of some *Narcissus* growers. The reasons to start the inspections are still valid: the improvement in the quality of bulbs and to insure free access to export markets. Inspection of bulbs in the European Union (EU) is based on the EU-directive for the trade of propagation material of ornamentals. In the Netherlands, implementation took place according to existing inspection schemes and criteria of the BKD. All lots of flowerbulbs are inspected and classified. Lots that do not meet the standards are not classified and are expelled from further propagation. For the various crops, the quality inspections by the BKD have been and still are an important stimulus for the increase in quality of individual lots. If a grower wants to use his lot of *Lilium* for propagation, there is an obligatory ELISA-test for LMoV (Lily Mottle Virus) and LSV (Symptomless Lily Virus). This system has greatly contributed to the quality of lilies. Within a period of 10 years the average LMoV level has dropped to 0.4% and LSV has dropped to 2.3%. In 1992 the BKD started an obligatory test on TSWV (Tomato Spotted Wilt Virus) for *Dahlia* tubers used for propagation. In 2003, 90% of the tested lots were found free of TSWV. The inspection of all flowerbulbs and the results of these inspections has insured access to markets in almost all countries, even to those countries with very strict import regulations and standards such as Australia, Japan, and the USA. For these and other countries, the BKD inspection system has insured that the importation of Dutch Flowerbulbs is possible.**

## INTRODUCTION TO THE BKD

The history of the inspection of flowerbulbs in The Netherlands goes back to 1923, in which year a voluntary field inspection of *Narcissus* started at the request of growers. They were concerned about the threat of a possible embargo of the export of *Narcissus* bulbs to the USA because of *Ditylenchus dipsaci*. Within three years all *Narcissus* growers participated in this voluntary program. Inspection of *Narcissus* was followed by inspection of *Hyacinthus* in 1929 for *D. dipsaci*. In the 1930's, the BKD was appointed by national law to perform field inspections on this quarantaine organism. Until 1979, the inspection of flowerbulbs was a voluntary program. In 1980, the situation changed with the national Plant Quality Act. With this act, the BKD became responsible for doing quality inspections in all flowerbulbs.

The BKD was founded in 1923 as a non governmental inspection service, which it still is today. The BKD is an independent foundation with the official task of carrying out quality and quarantine inspections in flowerbulbs. The goal of the BKD is to improve the quality of flowerbulbs in The Netherlands. This goal is implemented by yearly inspections of all lots of flowerbulbs according to strict standards for viruses, fungi, bacterial diseases and trueness to type. The BKD has inspection and classification schemes for most all commercially grown flowerbulbs.

Although the BKD is an independent foundation, this doesn't mean it is completely free to introduce new inspection schemes and standards or change schemes or standards. The BKD operates under the supervision of the Ministry of Agriculture, Nature and Food Quality. All changes in the quality inspection schemes have to be approved by this

Ministry. Since 1997, the BKD has been certified according to ISO 17020/1725.

Although more and more flowerbulbs are grown outside The Netherlands, in countries like Chile, New Zealand and France, the BKD is the only specialised inspection service in the world with a broad knowledge on diseases in flowerbulbs. The BKD receives questions from countries around the world about things such as inspection schemes and symptoms of virus diseases on bulbs.

## LEGAL ASPECTS

The organisation and the work of the BKD is based on national and EU legislation.

The basis for quality inspections is the EU directive on the trade of propagation material of ornamental plants (98/56/EG). This directive prescribes that all traded lots of flowerbulbs should be inspected at least once during the growing season and that the lots should be practically free from diseases and pests. The BKD not only inspects lots on quality aspects but also on quarantine pests. These quarantine pests are described in the EU Phytosanitary directive (2000/29/EG).

Important elements in the national Plant Quality Act relating to the BKD include:

- the BKD is appointed to perform quality inspections, so the BKD has an official governmental task and is therefore under supervision of the Dutch Ministry of Agriculture;
- all growers must be registered with the BKD and they have to inform the BKD yearly at the beginning of the growing season where they have planted their bulbous crops;
- since growers and trade organization took the initiative to form an obligatory quality inspection program in the late 1970's. So the Ministry had the opinion that these organisations then should take the responsibility for this inspection service by forming a board bulb industry representatives with responsibility for oversight of the BKD.

The EU directive on the trade of propagation material of ornamentals and the Plant Quality Act are the legal basis for the quality inspection of flowerbulbs. These require:

- a yearly inspection of the lots according to strict inspection protocols;
- inspection and classification of propagation material and saleable bulbs;
- establishment of tolerances for the most important diseases and pests, with differing tolerances for the various classes;
- classification of lots based on field inspections and in some cases sample inspections. If a lot is rejected, in some cases the propagation material has to be destroyed;
- the usage of the bulbs, both propagation material and saleable sizes, depends on its classification.

This system has been and still is the basis for the improvement in the quality of the flowerbulbs in The Netherlands.

## PRINCIPLES OF QUALITY INSPECTIONS

Each year, growers of flowerbulbs are obliged to inform the BKD of the lots of each genus and variety they have planted and the location of each field. Based on this information, the inspectors plan the field inspections. Each crop has its own inspection scheme and standards. Most crops are inspected twice during the growing season. The timing of inspection is not based on a strict calendar date, but is determined by the disease(s) on which the stock has to be inspected. BKD field inspections are based on symptoms which are not visible on dry bulbs. Based on the level of diseases in a lot, the lot is classified or rejected if it doesn't meet the minimal standards. If a lot is rejected due to a virus, the propagation material has to be destroyed and the saleable sized bulbs can be traded on the local market. The use of the classified lots, propagation material and saleable bulbs is shown in Table 1.

## STRUCTURE OF THE ORGANIZATION

The BKD inspects about 21,000 ha of flowerbulbs yearly. In Tables 2 and 3 the inspected areas for the spring flowering and summer flowering crops are given. The BKD employs a total of 90 persons and is managed by a director, who is also the secretary of the

board. The largest department is the one of the inspectors. There are 43 inspectors, each one working in a specific region of the country. The inspectors also inspect samples in the greenhouses and on test fields. During the spring period, 45 people are hired as assistant inspector for a period of two to four months. Most of these people have worked on a part time basis for the BKD for several years. Laboratory tests are also part of the inspections schemes. Each year 5,000 *Tulipa* samples, 6,000 *Lilium* samples and 300 *Dahlia* samples are processed. Throughout the year, 12 employees work in the laboratory. During the peak seasons, additional people are hired for a short period.

**Case 1: The Development of TBV in Tulipa**

The BKD inspects all *Tulipa* lots in the field. If the lot is only inspected visually in the field the highest reachable classification is class ST: the lowest classification. In this case the propagation material can not be traded. If a grower wants a higher classification for a lot so it can be sold as propagation material, a sample of this lot is taken before planting. From all varieties a sample is planted in a greenhouse and inspected on the same aspects as in the field. Some varieties, mostly white and yellow flowering cultivars, are difficult to inspect visually for TBV (Tulip Breaking Virus) and a DAS-ELISA test for TBV is part of the inspection process ('ELISA-varieties'). The results of these sample inspections determine the maximum classification of the lot. In Table 4 the average TBV-levels found by DAS-ELISA in the period between 1998 and 2004 are given.

Through 1999, the average TBV level detected by DAS-ELISA was at a low and stable level. Analysis of individual results showed that levels varying from very low percentages to high percentages were found. High means more than 6%, in the same cases up to 30% TBV was detected by DAS-ELISA. These were the results of the samples for which the grower wanted a higher classification than ST for his lot. The BKD came to the conclusion that the TBV level in the non tested lots, maximum class ST, would be much higher than in the tested lots. Therefore, the policy was developed that all lots should be tested for TBV by DAS-ELISA and that lots with a high TBV level had to be rejected and the propagation material destroyed. In the year 2000, this program was started with the varieties 'Monte Carlo' and 'Yokohama'. In the period after flowering leaf samples were taken and tested by DAS-ELISA. If more than 6% was detected the lot was rejected and the propagation material had to be destroyed. This additional TBV test was also done in 2001 and 2002. The results of these tests are given in Table 5.

Since 2000, the average TBV-level increased (Table 4). The varieties 'Monte Carlo' and 'Yokohama' have a significant influence on this increase, but the increase is not totally due to these two varieties. The BKD have come to the conclusion that high TBV levels occur in all ELISA varieties. Therefore the BKD has changed the inspection scheme for TBV in this group of varieties. Since 2004, an obligatory DAS-ELISA test has been part of the inspection scheme. If more than 6% TBV infection is found in a sample by DAS-ELISA, the lot is rejected. This also means that the propagation material has to be destroyed under supervision of the BKD inspector. It is premature to say whether these steps will lead to a significant decrease in the average level of plants infected with TBV.

**Case 2: The Development of LMoV and LSV in *Lilium***

*Lilium* bulbs are mostly propagated by scaling. *Lilium* growers are only allowed to use those lots which are tested by DAS-ELISA on LMoV and LSV. The lots can only be used for propagation if the maximum levels of these viruses detected is 1% for LMoV or 10% for LSV. This system has been part of the inspection scheme for *Lilium* since 1973. This system started with LSV and later LMoV was added. The BKD also inspects *Lilium* lots visually for LMoV, not LSV. For *Longiflorum* and LA and LO hybrids, an obligatory test for LSV and LMoV for all lots is part of the classification scheme. LMoV is no longer a serious problem; field inspections indicate that few LMoV infected plants are found and only a few lots are rejected because of a too high degree of LMoV infected plants. Less than 1% of the inspected lots don't meet the standard for LMoV for the highest field classification (class ALG) with a maximum of 0.5% LMoV infection based on a visual

inspection.

The obligatory DAS-ELISA test for LSV and LMoV in propagation material counts for all groups: Asiatics, Orientals, *Longiflorum*, LA, AO and LO hybrids and species. In Tables 6 and 7 the results of these tests are given.

The average LMoV and LSV levels are currently at very low levels. For Asiatics, there has been an increase of the LMoV level: 2002 0.3% and 2003 0.6%. This increase was caused by only six samples with high testing results. Without these six samples the average LMoV level would be about 0.3% in 2003.

Through the 1990's, growers used large aphid proof and aphid free greenhouses to grow their propagation material. Due to the use of virus free planting material from tissue culture and to the lots in the field with low virus levels, greenhouses are used less for the production of high quality propagation material since this material can now be obtained from field grown lots.

**Case 3: The Development of TSWV in *Dahlia***

Until 1991, the BKD had a visual inspection program for TSWV in *Dahlia*. It was known that an infection did not always lead to a clear symptom on the leaves of the plant. In 1991, some importing countries came to the conclusion that Dutch lots of *Dahlia* didn't meet their standards because of high levels of TSWV. The TSWV levels had to go down otherwise various countries would stop importing Dutch *Dahlia* tubers.

The first step taken by the BKD was developing a DAS-ELISA test for TSWV in *Dahlia*. There was antiserum of TSWV available and tests were done to determine what the best method was to test for this virus in *Dahlia*. Within one year, a test was developed by the BKD. Starting in 1992, the inspection scheme was changed to include an obligatory DAS-ELISA test on tubers meant for propagation. Inspectors take samples of lots and only lots in which a maximum of 5% TSWV is detected, can be used for propagation. It is also possible to test the tubers individually. In this case the growers only use TSWV-free tubers for propagation. Most growers have their lots sampled and tested individually. This has led to a significant decrease of TSWV in Dutch *Dahlia* (Table 8). Now there is no longer any visual inspection for TSWV.

With the obligatory DAS-ELISA test of lots for propagation, there is an almost TSWV-free *Dahlia* production system in The Netherlands. Testing has shown that the re-infection rate is very low, so there is no longer a necessity for yearly tests of tubers. If in the DAS-ELISA test no TSWV is detected, the lot is released from testing of the propagation material for a period of three years. In almost all situations, when such a lot is tested again no TSWV is found.

**ACCESS TO EXPORT MARKETS**

The reason the inspection service for flowerbulbs was started in 1923 was to meet import regulations of the USA. Nowadays, the BKD inspection system still has a great role in maintaining the export possibilities for flowerbulbs. Some countries, like the USA, Japan and Australia, ask for additional 'guaranties' concerning the quality of imported lots. The BKD can't give these guaranties, but provides a reliable inspection for these countries in order that lots meet the standards by insuring that all lots are inspected according to a strict inspection scheme by qualified, independent inspectors.

**Tables**

Table 1. Use of bulbs as propagation material based on classification.

| | Propagation material | Saleable sized bulbs |
|---|---|---|
| High classification (I, II or ALG) | Own use and traded to other growers for propagation | Propagation material: Own use and traded to other growers for propagation |
| Low classification (ST) | Only own use | Propagation material: Only own use |

Table 2. Areas of spring flowering crops in 2004.

| Crop | Area (in ha) |
|---|---|
| *Tulipa* | 10,772 |
| *Narcissus* | 1,760 |
| *Hyacinthus* | 1,102 |
| *Iris* | 465 |
| *Muscari* | 194 |
| *Allium* | 159 |
| *Hyacinthoides* | 22 |
| *Scilla* | 37 |
| *Puschkinia* | 8 |
| *Anemone blanda* | 40 |
| *Nectaroscordum* | 8 |
| Total | 15,261 |

Table 3. Areas of summer flowering crops in 2003.

| Crop | Area (in ha) |
|---|---|
| *Lilium* | 4,312 |
| *Gladiolus* | 1,117 |
| *Dahlia* | 400 |
| *Zantedeschia* | 108 |
| *Begonia tuberosa* | 67 |
| *Hippeastrum* | 91 |
| Total | 6,095 |

Table 4. Average TBV-levels (%) in *Tulipa* (DAS-ELISA) between 1996 and 2004.

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|
| All ELISA varieties | 1.3 | 1.3 | 1.2 | 1.2 | 1.4 | 1.5 | 1.6 | 2.1 | 2.1 |
| 'Monte Carlo' | 2.0 | 2.4 | 2.0 | 2.2 | 2.8 | 2.9 | 2.9 | 3.9 | 4.8 |
| 'Yokohama' | 1.6 | 1.6 | 1.8 | 1.8 | 2.2 | 2.3 | 2.2 | 2.7 | 2.4 |
| All ELISA varieties excluding 'Monte Carlo' and 'Yokohama' | 1.1 | 1.1 | 1.0 | 1.0 | 1.1 | 1.2 | 1.4 | 1.9 | 1.3 |

Table 5. Average TBV levels (%) found by DAS-ELISA in leaf samples of ‘Monte Carlo’ and ‘Yokohama’.

| Variety/growing season | 2000 | 2001 | 2002 |
|---|---|---|---|
| ‘Monte Carlo’ | 6.9 | 7.4 | 7.3 |
| ‘Yokohama’ | 5.4 | 4.3 | 5.6 |

Table 6. Average LmoV levels (%) in *Lilium* (DAS-ELISA) between 1993 and 2003.

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Asiatics | 0.4 | 0.4 | 0.3 | 2.3 | 0.9 | 0.3 | 0.4 | 1.2 | 0.1 | 0.3 | 0.6 |
| LA hybrids | 0.2 | 0.2 | 0.4 | 0.8 | 0.8 | 0.8 | 0.5 | 0.3 | 0.2 | 0.5 | 0.2 |
| Longiflorum | 1.5 | 1.5 | 1.5 | 2.0 | 1.6 | 1.3 | 1.5 | 0.7 | 0.6 | 0.8 | 0.5 |

Table 7. Average LSV levels (%) in *Lilium* (DAS-ELISA) between 1994 and 2003.

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|
| Asiatics | 7.1 | 6.6 | 8.7 | 7.8 | 4.1 | 3.8 | 2.8 | 2.8 | 3.9 | 2.5 |
| Oriental hybrids | | | 9.9 | 7.8 | 6.0 | 5.7 | 3.8 | 3.5 | 3.0 | 2.2 |
| LA hybrids | 6.0 | 7.9 | 15.0 | 16.9 | 14.6 | 8.6 | 6.1 | 4.9 | 4.2 | 4.0 |
| Longiflorum | 6.8 | 6.4 | 9.9 | 7.8 | 5.9 | 4.4 | 3.0 | 1.6 | 1.4 | 1.2 |

Table 8. Development of the TSWV levels (%) in *Dahlia* (DAS-ELISA): categories of TSWV level in the tested samples.

| TSWV level(%) | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 18 | 34 | 59 | 59 | 72 | 79 | 70 | 81 | 82 | 89 | 82 | 90 |
| 0.1-5 | 32 | 40 | 28 | 28 | 21 | 17 | 19 | 13 | 12 | 9 | 7 | 9 |
| 5.1-10 | 14 | 11 | 4 | 5 | 3 | 2 | 5 | 3 | 1 | 1 | 2 | 1 |
| > 10 | 36 | 15 | 5 | 8 | 4 | 2 | 6 | 3 | 5 | 1 | 9 | 0 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Number of tested samples | 1,609 | 999 | 1,265 | 562 | 615 | 890 | 434 | 519 | 451 | 625 | 223 | 363 |