ATO

Aspergillus niger on onions from New Zealand

A study carried out for Harmsen & De Groot and Marine Survey Bureau H.A. van Ameyde B.V.

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Confidential

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1. Introduction

The vessel M.S. Snoekgracht arrived in Vlissingen on June 9th 2000 from New Zealand. M.S. Snoekgracht was partly loaded with dry onions of the yellow skin type. The voyage had taken 47 days including a delay of 8 days. Upon arrival in Vlissingen, the onions were severely affected with *Aspergillus niger.*

ATO was assigned as an independent scientific research company by the two survey companies Harmsen & De Groot and Marine Survey Bureau H.A.van Ameyde to answer the following questions:

1. Could the Aspergillus explosion have been caused by the 8 days delay of the vessel?
2. Would there have been an Aspergillus explosion 'now' if the vessel had not had any delay?

For this study, Harmsen & De Groot represents two of the receivers of the onions, namely Van Dijk Delft and Van der Lans. Marine Survey Bureau H.A. van Ameyde B.V. represents the shipping company Spliethoff.
Both Van Dijk Delft and Van der Lans obtain their onions from the trading company RPD in New Zealand. The vessel has also carried other parcels of onions from New Zealand to Vlissingen. After discharge, a large part of the onions carried by the M.S. Snoekgracht were rejected by the Plant Protection Service.

This report shows the results of the study carried out by ATO.

2. Input information provided by the two commissioning companies

The results of the study are based on specific input information. The input information was provided through Harmsen & De Groot and Van Ameyde.

Scope of the study

- This study concerns the onions of Van Dijk Delft and Van der Lans only.
- The position of the specific onion lots in the vessel is regarded as not relevant.

Voyage

- M.S. Snoekgracht left on April 23rd 2000 from Tauranga in New Zealand and arrived in Vlissingen on June 9th 2000 (47 days journey).
- Between May 10th 2000 and May 18th 2000 the M.S. Snoekgracht was delayed because of engine problems (8 days delay).
- During that period the vessel was anchored/berthed at Christobal (Panama canal).
- The fresh air ventilation had been running the whole voyage including during the delay in Panama.

Onion lots and growers

- The onions meant for Van Dijk Delft and for Van der Lans consisted of a number of lots.
- Each lot consisted of onions from various growers.
- For each grower, the onions were packed in bins and bags of 1100 kg each.
- The onions are traceable to grower's level up to the packing houses in The Netherlands. At the packing houses, the onions might have been mixed during grading and packing.
- The onions of some growers showed more *Aspergillus* at arrival in Vlissingen than the onions of other growers. The overall picture showed that more onions have been affected by *Aspergillus niger* than usual upon arrival in Europe.

3. Description of the damage

Figure 1 shows a typical picture of an *Aspergillus niger* infection on onions. The onion in the picture belongs to the damaged cargo of the M.S. Snoekgracht and the photograph was taken at ATO on July 3rd 2000.

Figure 1. Typical picture of damage caused by *Aspergillus niger* on an infected onion of the M.S. Snoekgracht

ATO has not seen the onions at discharge. After discharge, part of the onions of Van Dijk Delft and Van der Lans were rejected by the Plant Protection Service.
A representative of ATO, S. P. Schouten, saw part of the affected onions in the stevedores sheds in Vlissingen and at the packing house of the onion grading company Monie (Nieuwdorp, Netherlands) ±1 week after arrvival of the vessel. On June 30th 2000, another representative of ATO, J.J. Polderdijk, saw part of the onions at Monie and at MSP, another onion grading company in Nieuwdorp. At that time, most of the onions had already been graded one or more times.

Monie and MSP expected to outgrade at least 30-50% of the onions before they would be accepted by the Plant Protection Service. In the stores, high temperatures (±30 °C) were used with strong air circulation to dry the onions. This drying treatment in combination with extra grading activities caused some extra damage to the papery scales (bald onions).

The impression of J.J. Polderdijk was that part of the onions showed clusters of black spores, some only a few and some so severe that it resembled soot (see figure 1). Part of the onions showed either an initial phase or an advanced phase of decay (soft rot bacteria). This caused a unpleasant smell.
At the moment of visiting, drying and activities were only carried out at Monie's. Many fruit flies were present in the bins with onion that were being dried.

4. Records on temperature and relative humidity

The figures 2-4 show graphs of the records of the average measured temperature and relative humidity at tweendeck 1 and 3 and outside.

Figure 2. Average temperature (°C) during shipping tweendeck hold 1, lower hold 1 and outside.

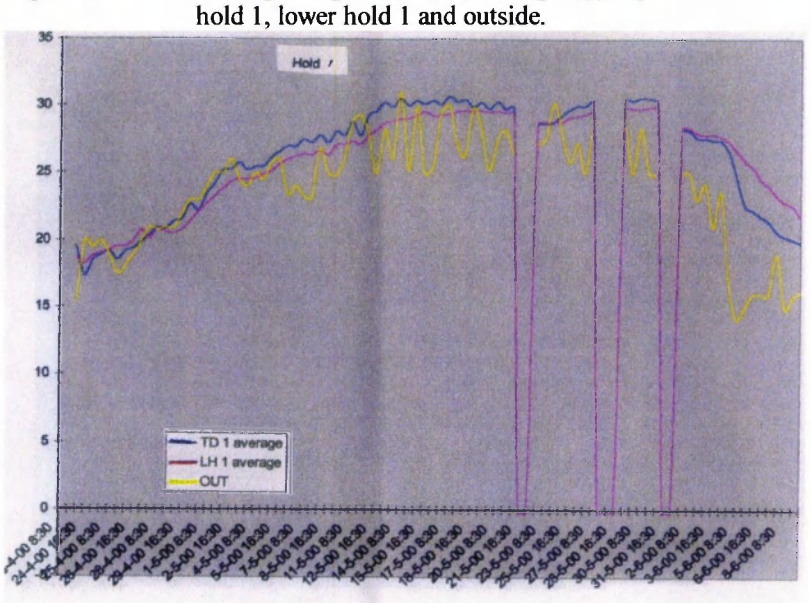


Figure 3. Average temperature (°C) during shipping tweendeck hold 3, lower hold 3 and outside.

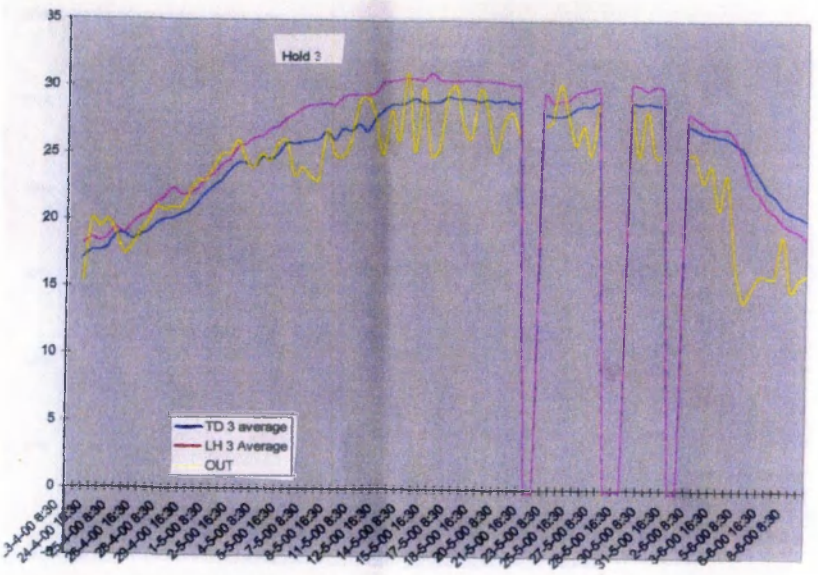
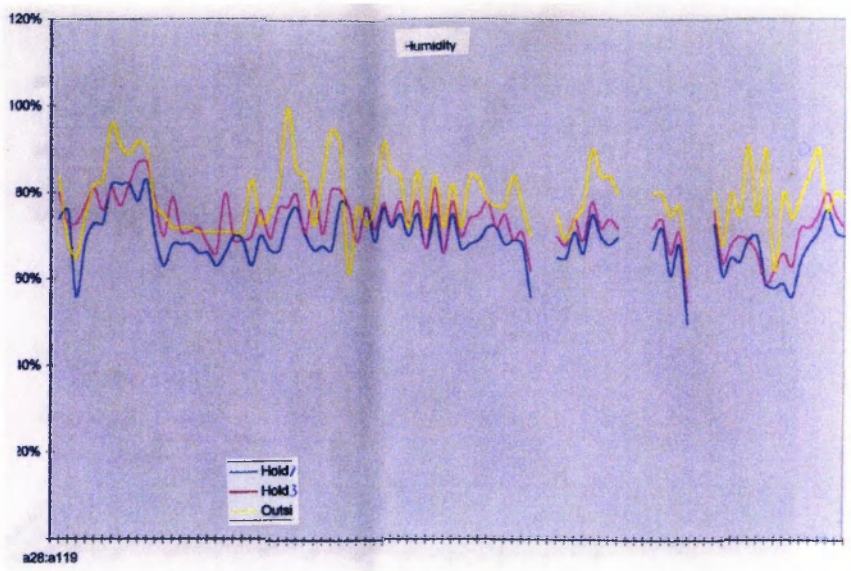


Figure 4. Average %relative humidity tweendeck hold 3, lower hold 3 and outside.



The figures show that the temperature of the air around the onions had been above 25°C from ± May 6th 2000 until ±June 5th 2000. During the delay in Panama, the temperature had been around 30°C. The relative humidity of the air around the onions had been ±65%-80% during most of the shipping period without remarkable deviations. The temperature outside had fluctuated more and had been lower compared to that inside. The relative humidity outside had been higher compared to that inside.
No records are available of May 21st , May 27-28th and May 31st in view of discharge operations during these days.

5. Scientific and expert knowledge about *Aspergillus niger* on onions

The fungus *Aspergillus niger* is worldwide considered to be one of the most important pathogens of stored onions (black mould). Symptoms of its presence are the black spores of the organism that are formed on and between the outer papery scales. The incidence may vary from a few clusters typically aligned along the veins of the bulb to a large part of the bulb being covered with conidia, giving the bulb a sooty appearance. The fungus may also advance into the storage scales below the papery scales. Such invasions may be accompanied by introduction and development of secondary soft rot bacteria (6, 8).

While the presence of *Aspergillus niger* becomes evident in the postharvest phase during storage or transport, infection of the bulbs already takes place in the preharvest phase. According to Machacek (1927; cited in 5), mycelial growth of *Aspergillus niger* progesses from the neck of the onion to the bulb where it may further develop during storage. This hypothesis was confirmed by Hayden et al. (5) who demonstrated a clear relationship between the incidence of *A. niger* on onion leaves and the incidence of *Aspergillus niger* in stored bulbs. No great differences in sensitivity for black mould have been observed for red, purple and white skinned onions (1).

Several sources have been identified for the introduction of *Aspergillus niger* on onion plants and bulbs. These include seed, air, soil, and insects.

- Screening of onion seed samples showed that *Aspergillus niger* was present on samples collected from a wide range of geographical locations (2). Particularly high incidences were found on seeds produced in hot climates. Transmission of *Aspergillus niger* from contaminated seeds to seedlings was demonstrated to occur (2).
- Studies with surface-sterilized seeds have shown that other sources must exist including the soil and the air. A comparative study has showed that in warm climates like Sudan, the incidence of *Aspergillus niger* spores in soil around onion plants and in the air was higher than in temperate climates like in the UK (2). In Sudan, the number of *Aspergillus niger* spores increased strongly especially around harvest.
- Finally, spores of *Aspergillus niger* may also be introduced to the bulbs by mites and termites during storage (7), Venkatarayan and Delvi 1951, cited in (6).

Development of *Aspergillus niger* on onion bulbs is dependent on storage temperature and relative humidity during storage.

- A study by Hayden (1990, cited in (2, 4)) on the effect of temperature on the growth of *Aspergillus niger* has shown that the optimal temperature for growth is between 30°C and 35°C. Growth does not occur below 15°C and is very slow between 15 and 20°C. The upper limit for mycelial growth and sporulation are 45°C and 40°C, respectively. Since *Aspergillus niger* thrives only at higher temperatures, its occurrence on onions is especially associated with tropical zones.
- No data have been found on the effect of the relative humidity on the growth rate of *Aspergillus niger.* It is known however that invasion of wounded tissue by *Aspergillus niger* is favoured at relative humidities higher than 80% (Hayden 1990, cited in 4).

In conclusion, the incidence of *Aspergillus niger* on onion bulbs and the severity of the disease is a function of both preharvest factors (including climate, seed origin, crop rotation, and crop protection) and postharvest factors (including handling of the bulbs, and temperature and relative humidity during storage) (3).

6. Discussion and conclusions

Aims of this study were to answer the following questions.
1. Could the *Aspergillus* explosion have been caused by the 8 days delay of the vessel?
2. Would there have been an *Aspergillus* explosion 'now' if the vessel had not had any delay?

Could the *Aspergillus* explosion have been caused by the 8 days delay of the vessel?
During the delay, the temperature was around 30°C. This is in the range of or close to the optimal growth temperature of *Aspergillus niger*. The duration of the delay was 8 days, which is long enough to give Aspergillus niger the opportunity to significantly further develop and spread.

Conclusion: Yes, the *Aspergillus* explosion could be caused by the 8 days delay o f the vessel.

The second question asked in the introduction, **"Would there have been an *Aspergillus* explosion 'now' if the vessel had not had any delay?"** cannot be answered. The reason is that nothing is known about the state of infection of the onions at the start of the voyage. In addition, no model is available that is able to predict the development of *Aspergillus niger* even if the degree of infection and the storage conditions are given.

Our impression is that if the vessel had not had any delay, the damage caused by *Aspergillus niger* on these specific onion lots would have been less at arrival in Vlissingen. We cannot prove this, though.
In general, onion lots from New Zealand could show an *Aspergillus* explosion at arrival in Vlissingen even without delay of the vessel. In that case, the initial quality of the onions and the circumstances during the journey must be sufficiently favourable.
In general , further development of *Aspergillus* after arrival depends on the initial grade of infection at arrival and on handling, temperature and relative humidity from then on. When the circumstances are favourable (see chapter 5), it is possible to get an *Aspergillus* explosion after arrival.

7. Research proposal

An experiment in which the storage conditions (i.e. temperature and relative humidity) as experienced by the onions during transport are simulated and in which the effect of the additional storage time of 8 days on development of *Aspergillus niger* is investigated, cannot answer the question either with a yes or a no, simply because the onions that would be used are not the same as the onions that were transported on the vessel. However, as long as this limitation is appreciated and provided that a sufficiently large part of the bulbs used is infected with *Aspergillus niger*, such an experiment may give a good impression of the contribution of the 8 days delay to the development of *Aspergillus niger* during transport. Also, such an experiment could confirm our answer to the first question.

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