AHDB HORTICULTURE

# Grower Summary

## BOF 077

Narcissus: Investigation into the effects of a range of potential biocides in hot water treatment

Annual Report 2018

## Disclaimer



The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

## Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

## Further information

If you would like a copy of the full report, please email the AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

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AHDB Horticulture is a Division of the Agriculture and Horticulture Development Board.

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| **Project title:** | Narcissus: Investigation into the effects of a range of potential biocides in hot water treatment |
| **Project number:** | BOF 077 |
| **Project leader:** | Rob Lillywhite, University of Warwick |
| **Report:** | Third annual report, December 2018 |
| **Previous report:** | Second annual report, December 2017 |
| **Key staff:** | Mr Rob Lillywhite<br>Dr John Clarkson<br>Dr Adam Baker |
| **Location of project:** | Warwick Crop Centre, University of Warwick |
| **Industry Representative:** | Mr Julian Perowne, Jack Buck (Farms) Ltd, Green Lane, Moulton Seas End, Spalding, PE12 6LT<br>Mr Andrew Richards, Carwin Farm, 16 Carwin Rise, Loggans, Hayle, TR27 5DG |
| **Date project commenced:** | 1st January 2016 |
| **Date project completed (or expected completion date):** | 31st December 2019 |

## GROWER SUMMARY

### Headline

At the end of the third year of the project, growers should be aware of the following:

- First year results of the filtration and UV sterilization experiments have demonstrated that there was no negative treatment effects on flower production
- Thermal treatment of bulbs at 60°C for up to five minutes did not have a negative effect on plant growth or flower production but longer and hotter treatments did impose significant reductions in both
- Commercial testing of a chlorine dioxide dosing system has demonstrated that it can be successfully retrofitted to hot water treatment (HWT) tanks and that it appears to be an effective biocide
- In-tank fungicide testing confirms previous HDC guidelines that active ingredients are lost in HWT

### Background

Hot water treatment (HWT) of narcissus bulbs is used to control pests and diseases, notably stem nematodes, bulb scale mites and Fusarium basal rot. This has been the standard approach for at least 70 years. For most of that time, formalin was added to HWT tanks as a general biocide i.e. to reduce inoculum in the tank water, however approval for formalin was withdrawn in 2008. Work in AHDB funded project BOF 061a (Lole, 2010) identified FAM 30 as a viable alternative and this has since become standard practice in the UK. However, FAM 30 is expensive in comparison to formalin and the result has been that growers do not always use it at the required rate and this issue is exacerbated since FAM 30 rapidly depletes in tanks under a high bioload.

Other biocide alternatives have been considered, notably chlorine dioxide which was demonstrated to be effective against spread of Fusarium (Chastagner and Riley, 2002) and is believed to be currently used by American Narcissus growers. However, in AHDB Horticulture project BOF 061a (Lole, 2010), chlorine dioxide was assessed alongside a number of alternative biocides, but was not considered further as FAM 30 was found to be more effective. The use of chlorine dioxide was further reviewed in BOF 070 (Hanks, 2010) which suggested that additional investigations were required before it could be recommended to growers.

Other biocides previously examined include peroxyacetic acid (Hanks and Linfield, 1999), hydrogen peroxide and UV (Stewart-Wade, 2011) but tank bioload was again found to reduce their efficacy so further commercial scale evaluation is required before they can be recommended. Non-chemical biocidal approaches, e.g. UV and thermal treatment, have been used in other water-based treatment systems and appear to offer a viable alternative to chemical approaches but their efficacy is known to be very dependent of water clarity, which is a problem with high bioload HWT (Pettitt, 2016). The issue of high HWT tank bioload was reported in BOF 070 (Hanks, 2010) and generating a solution to this issue is probably key in improving the efficacy of all biocides and biocidal approaches (and probably fungicides as well).

Project aim

The aim of this project is to examine a range of candidate biocides (chlorine dioxide, hydrogen peroxide and didecyl dimethyl ammonium chloride) and physical approaches (thermal and UV treatment) for their efficacy and ease of use against stem nematode and Fusarium basal rot.

The project has been divided into eight objectives:

1. Review of the literature
2. *In vitro* laboratory tests
3. Assess the feasibility and cost of retrofitting biocide delivery systems to existing HWT tanks
4. Assess impact of different treatments on infrastructure
5. Small-scale tank tests
6. Commercial scale testing
7. Field trials
8. Health and safety considerations

**Summary**

This report covers the period January 2018 to December 2018 which is the third year of the four year project to investigate new or improved biocidal approaches in the hot water treatment of daffodil bulbs. This period saw the completion of on-farm testing and continuing monitoring of field crops.

***Filtration and UV trials***

On farm trials to examine both filtration and UV sterilization were carried out in September 2017 at Carwin Farm in Cornwall. Trial methodology was described in the 2017 Annual report. The bulbs were replanted in autumn 2017 and assessed in spring 2018. Stem length was measured on the 26$^{th}$ March 2018 and the number of flowers was assessment on 17$^{th}$ April 2018. Flower production will be assessed again in Spring 2019.

These initial first-year results show that neither filtration nor UV sterilization appear to have any negative effect on flowering. It is interesting, if not unexpected, that dipping using clean water gave better results. A fuller analysis will be carried out on flowering in spring 2019 when the crop will have been down for 18 months.

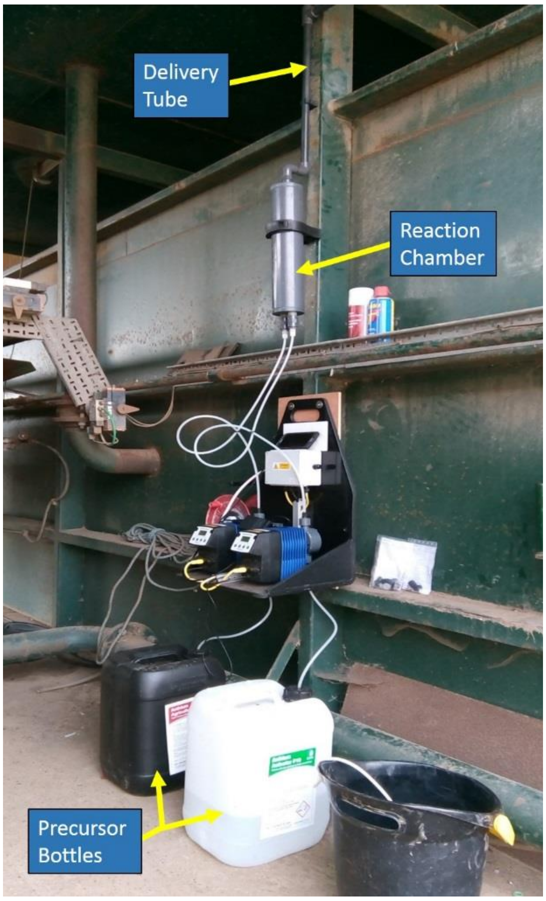
***Thermal treatment of bulbs***

Thermal treatment of bulbs was not included within the project remit but a number of growers expressed an interest in this approach. The decision was therefore made to trial it and include the results in this project. Small-scale laboratory tests were conducted at the University of Warwick and on-farm testing was carried out in Cornwall. Temperatures between 60 and 70°C degrees, and durations between 3 and 12 minutes were tested. Assessment was a mixture of observation and disease incidence

Although there was some inconsistency in the approach and results, taken together the trials do provide some positive results. Short dips in the range 60-65°C of around five minutes did reduce the incidence of rots with few negative effects. The temperature is likely hot enough to provide control of surface pathogens and short enough to avoid physiological damage, however dips at 70°C or at 60-65°C for more than five minutes had a negative impact on bulbs. Given the logistical difficulty of handling large volumes of bulbs on farm it is unclear at this stage whether, with such small tolerances and the potential for significant losses, this method of sterilisation is practical.

***Chlorine dioxide testing***

Chlorine dioxide was demonstrated to be effective against spread of *Fusarium* (Chastagner and Riley, 2002) and is believed to be currently used by American Narcissus growers. However, in AHDB Horticulture projects BOF 061 and 061a, $ClO_2$ was assessed alongside a number of alternative biocides, but was not considered further as FAM 30 was more effective. The use of $ClO_2$ was further reviewed in BOF 070 with the recommendation that further investigations were required before it could be recommended to growers. This project continues that work, and in 2018 undertook full on-farm testing of a commercial chlorine dioxide dosing system.




Scotmas Ltd undertook trials on Jack Buck Farms in Lincolnshire in July and August 2018. An automated dosing system, using precursor chemicals, was installed on one of the HWT tanks (pictured opposite). This uses a concentration monitoring system to achieve a set residual chlorine dioxide value which indicates that all pathogens have been destroyed. Trials were conducted over a period of two weeks until a steady residual level of $ClO_2$ could be maintained (in this case 1.6ppm).

Laboratory analysis of tank water confirmed that the system controlled 99% of all pathogens which is considered a successful outcome.

***Analysis of fungicide concentrations in HWT***

In 2018, AHDB commissioned some additional work to examine the degradation of fungicides within HWT of bulbs. That work is reported here for convenience. In spring 2018, five growers agreed to take part in fungicide concentration monitoring trials. Gowers were sent pre-numbered collection tubes and a protocol for sampling. Sampling began on the first day of dipping and continued at regular intervals for the next week. The aim was to track how fungicides concentrations varied over time using the grower's normal starting and refill quantities of fungicides. The samples were returned to Warwick Crop Centre and levels of chlorothalonil (Bravo 500) and thiabendazole (Storite or Tezate) were analyzed, using HPLC with UV detection. Standards of known concentration were run alongside the samples to allow standardization of the results. The recommended rate for chlorothalonil is 500ppm (equivalent to 1l Bravo 500 per 1000l water) although half-rate is sometimes used. Thiabendazole is normally used (in the presence of an acidifier) at 275ppm (1.25l Storite per 1000l water). Following collation of the samples and data, two sets of observations were excluded as not being sufficiently robust or complete.

The three growers all used chlorothalonil as their main fungicide although one also used thiabendazole as well. The key outcome was that no grower, after two days, had a measurable level of chlorothalonil that was greater than 35% of the dosed rate. At the end of the second day of dipping, growers 1, 2 and 3 had 68ppm (27%), 176ppm (35%) and 97ppm (19%) of their target values, respectively. These results support the findings of the HDC Factsheet 10/13 that states that a stable concentration of about 25% of the target concentration is achieved after two days.
Concentrations for Grower 3 did vary over the course of dipping which might be due to the use of thiabendazole as well or another the use of top-loading tanks which might result in accumulation of more sediment than front loading tanks.
Grower 2 had the highest levels measured and these were maintained well into the season and it may be relevant that the samples from Grower 2 were also consistently the clearest in terms of visual appearance/sediment level. Earlier work in BOF 061c also showed relatively low levels of chlorothalonil compared to dosed rate and it was suggested that this was in part due to the sedimentation of the chemical and this is certainly backed up by the very high levels of chlorothalonil detected in the end of year tank sediment.
Thiabendazole (used only by Grower 3) showed a similar pattern to chlorothalonil with an initial value of approximately 50% of dosed rate which then stabilized at a lower level after the first two days of dipping.

Overall, the results support the findings published in the HDC Factsheet 10/13 that active ingredients are 'lost' from the circulating dip during HWT. To some extent this is as expected, as fungicides will only provide protective control of pathogens if they are adsorbed by the bulb or adhere to the bulb surface. However, loss of active ingredients also occurs through heat and chemical degradation and through sequestration into tank sediments. The ratio across these different losses is unknown although it may be possible to reduce any negative impact through improved understanding of the chemical interactions between different fungicides, biocides and acidifiers. However, this is difficult as the continuing loss of active ingredients, and the different rates used, make this a never-ending task. Minimising tank sediments and bioload through improved bulb cleaning is easier to achieve.

**Financial Benefits**

At this stage of the project, it is possible to provide an initial assessment of the financial benefits arising from the research. Based on the approach and costs incurred during the chloride dioxide trials undertaken in Lincolnshire, we estimate that the cost of using FAM 30 and chloride dioxide are £4.45 and £7.00 per treated tonne of bulbs, respectively. The use of FAM 30 requires no set up costs while that for the chloride dioxide system were between £5 and £10k based on the system used.

**Action Points**

Growers should continue to ensure that any bulbs destined for HWT are as clean as possible. This will reduced both tank bioload and sediment and improve the efficacy of all chemical ingredients.

Growers should consider the use of automated chlorine dioxide dosing systems as on-farm trials have shown them to be successful. Early indications suggest no downsides although two years of monitoring will be undertaken before a final recommendation is provided.

Growers should be cautious of using manual chlorine dioxide dosing during HWT of daffodils as the on-farm trials have demonstrated that automated dosing is require to achieve control of pathogens.