

Controlling *Aphelenchoides subtenuis* Nematodes with a Hot Water Treatment in *Crocus* and *Allium*

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Abstract

Several bulbous crops like *Crocus*, *Allium* and some species of *Tulipa* and *Narcissus* can be infected with the nematode *Aphelenchoides subtenuis*. The nematodes cause retarded growth, poor or no flowering and eventually death of the bulbs and corms. A hot water treatment after lifting the bulbs has proved to be effective in controlling the nematodes. Due to a high incidence of infected stocks of bulbs a study was conducted to establish if the efficacy of the treatment could be improved by altering the timing and the temperature of the hot water treatment and the storage temperature of the bulbs prior to the hot water treatment.

Bulbs and corms of *Allium* and *Crocus* were given a hot water treatment of four hours at 43.5 or 45°C. Between lifting and the hot water treatment the bulbs were stored at 25 or 30°C. Prior to the hot water treatment some of the bulbs were immersed in water for 24 hours. The hot water treatment was performed at 7, 10, 12 or 14 days after lifting the bulbs or corms.

Controlling *Aphelenchoides subtenuis* was only effective when the hot water treatment of four hours at 45°C was applied within 10 to 14 days after lifting the bulbs. When *Crocus* was stored at 30°C a hot water treatment was only effective until 10 days after lifting. When stored at 25°C a treatment was effective until 14 days after lifting. The hot water treatment became more effective when the bulbs were immersed in water for 24 hours prior to the hot water treatment.

INTRODUCTION

The nematode *Aphelenchoides subtenuis* can infect several bulbous crops such as *Crocus*, *Allium* and some species of *Tulipa* and *Narcissus*. The nematodes cause retarded growth, poor or no flowering and eventually death of the bulbs and corms. Symptoms on the bulbs and corms only become visible during storage, sometimes just before planting. A hot water treatment of the bulbs after lifting has proved to be effective in controlling the nematodes (Slootweg, 1961). Until this research it was advised to give a hot water treatment of four hours at 43.5°C within 14 days after lifting. When the treatment was delayed to two or more weeks after lifting the treatment was not effective.

A high incidence of infected stocks of bulbs and corms of *Allium* and *Crocus* made it necessary to investigate if the efficacy of the hot water treatment could be improved by altering the timing and temperature of the treatment, by changing the storage temperature prior to treatment and by immersing the bulbs in water prior to the hot water treatment.

MATERIALS AND METHODS

Three experiments were performed with bulbs and corms that were naturally infected with *Aphelenchoides subtenuis*. One of the experiments was performed twice in a period of two years. All the bulbs and corms were lifted at the normal time, i.e., when the leaves had just died back. After the hot water treatment the bulbs and corms were stored at 23°C until planting and then grown in the field for one season. After lifting in June the corms were stored at 23°C until September, at which point the bulbs were then inspected. After the storage period symptoms became more visible. Where there was uncertainty a

microscope was used to confirm the presence or absence of the nematodes. Every treatment consisted of four replicates with 150 corms (*Crocus*) or 50 bulbs (*Allium*) each.

Experiment 1

This experiment was performed with *Crocus vernus* 'Flower Record'. After lifting in June the corms were immediately stored at 25 or 30°C for 7, 10, 12 or 14 days. After storage the corms were immersed in tap water for 24h at 18 to 20°C prior to the hot water treatment of 4 h at 43.5°C.

Experiment 2

This experiment was performed twice with *Crocus vernus* 'Flower Record', over a period of two years. Each year new corms from an infected stock were used. Between lifting and the hot water treatment corms were stored for 7 days at 30°C. Prior to the hot water treatment some of the corms were immersed in tap water for 24 h at 18 to 20°C. The corms then received a hot water treatment of 4 h at 43.5 or 45°C.

Experiment 3

This experiment was performed with *Allium aflatunense* 'Purple Sensation'. After lifting in June the bulbs were stored for 7, 10 or 14 days at 30°C. After this storage period and prior to the hot water treatment some of the bulbs were immersed in tap water for 24 h at 18 to 20°C. Finally the bulbs received a hot water treatment of 4h at 43.5 or 45°C.

RESULTS

Experiment 1

In the control treatment (no hot water treatment) 54.9% of the harvested corms were infected with nematodes. The stock used for this experiment can be characterized as heavily infested. A hot water treatment of 4 h at 43.5°C was not effective to eliminate the nematodes (Table 1). There was no influence of the duration of the storage at 25°C on the percentage of infected corms. When the corms were stored at 30°C for 12 days the percentage of infected corms increased when compared to storage for 7 or 10 days. The percentage infected corms increased even more when the hot water treatment was given at 14 days after lifting compared to after 12 days.

Experiment 2

In the control treatment (no hot water treatment) 54.9% of the corms harvested in the first year and 85.6% of the corms in the second year were infected with nematodes. Both stocks were heavily infested with nematodes. Until this research the standard hot water treatment consisted of a 24-h immersion in water followed by a treatment of 4h at 43.5°C which resulted in 1.5% infected corms in year 1 and 0.0% infected corms in year 2 (Table 2). The hot water treatment of 4 h at 45°C without immersing in tap water resulted in 1.0 and 1.03% infested corms in year 1 and year 2 respectively. When the corms were immersed in tap water prior to the treatment of four hours at 45°C all the nematodes were eliminated. Although the results from these treatments do not differ significantly, the treatment with 24 h immersion in water followed by 4 h at 45°C is considered to be the best because no living nematodes were found in any of the replicates.

Experiment 3

In the control treatment (no hot water treatment) 69.6% of the harvested bulbs were infected with nematodes. In several treatments a hot water treatment at 45°C was more effective in eliminating the nematodes than a treatment at 43.5°C (Table 3). Immersing the bulbs in water prior to the hot water treatment resulted very often in lower percentages of infected bulbs compared to no immersion. When the hot water treatment was given 14 days after lifting of the bulbs, the result was a high percentage of infected bulbs.

DISCUSSION

In several experiments on *Allium* and *Crocus* the nematode *Aphelenchoides subtenuis* was not eliminated completely by a hot water treatment of 4 h at 43.5°C with a pretreatment of 24 h immersion in tap water. This old advice therefore needs adjustment. A hot water treatment of 4h at 45°C resulted in more healthy bulbs and corms than a treatment at 43.5°C. Although the stock was heavily infested, barely any infected corms could be found after one year, therefore the treatment can be considered to be very effective. Comparing hot water treatments with or without 24 h immersion in tap water, we found a higher percentage of eliminated nematodes when bulbs were immersed. That is the same response to immersion in tap water prior to a hot water treatment as found with the stem nematode (*Ditylenchus dipsaci*, Vreeburg, 2006). The storage temperature between lifting and the hot water treatment of the bulbs had a significant effect on the number of surviving nematodes. Storage at 30°C made the nematodes less susceptible to a hot water treatment compared to storing at 25°C. However storage at 30°C is more efficient to prevent damage of a hot water treatment at higher temperatures compared to 25°C (unpublished). This research clearly showed that this nematode becomes less susceptible to a hot water treatment the longer the bulbs and corms are stored after lifting. When the hot water treatment was given 14 days after lifting the percentage of surviving nematodes increased, this indicates that the efficacy of the hot water treatment is reduced when the procedure is not carried out within a certain time after lifting

Literature Cited

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Tables

Table 1. Effect of storage temperature prior to the hot water treatment and number of days between lifting the corms and the hot water treatment on the average percentage of infected corms. Untreated control 54.9% infected. $LSD_{(0.05)}=1.989$, $P<0.01$.

Storage temperature	Number of days between lifting and hot water treatment			
	7	10	12	14
25°C	0.06	0.11	0.0	0.87
30°C	1.27	0.72	4.3	8.13

Table 2. Effect of immersion in water and temperature of hot water treatment on percentage of infected corms. Untreated control 54.9% (year 1) and 85.6% infected.

Immersing	Temperature (°C)	Experiment	
		Year 1	Year 2
24 hours	43.5	1.49	0.00
24 hours	45	0.00	0.00
No	45	0.98	1.03
LSD		3.96	8.28
<i>P-value</i>		<0.01	<0.01

Table 3. Effect of immersion in water and number of days after lifting until hot water treatment on percentage of infected bulbs. Untreated control 69.6% infected. $LSD_{(0.05)}=10.4$, $P<0.01$.

Immersing	Days	Temperature	
		43.5°C	45°C
24 hours	7	3.5	0.8
24 hours	10	4.9	0.7
24 hours	14	24.4	11.5
No	7	10.1	3.0
No	10	32.3	22.2
No	14	63.1	51.2
LSD		10.37	
<i>P-value</i>		<0.05	