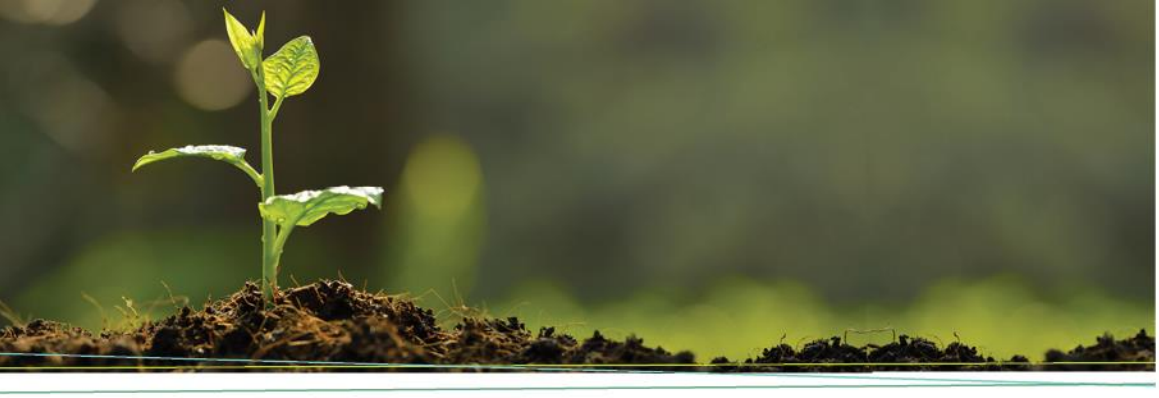

Focus Group SOIL-BORNE DISEASES

Mini-paper - *Inundation in the cultivation of flower bulbs*

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Introduction

In the cultivation of flower bulbs in the Netherlands, production in open fields is threatened by different soil borne diseases. The main problems are caused by fungi and plant parasitic nematodes. Chemical control of the problem has become increasingly insufficient resulting in a high input of pesticides. Also the admission of certain pesticides has expired.

Inundation, flooding a lot for an extended period of time, is used as a method of irrigating rice (surface watering), for water supply (basin irrigation), and for leaching of salt lands in arid regions. Inundation can control a number of soil-related diseases, pests, weeds and residues and is used more frequently in the cultivation of bulbs as a sustainable method for control of nematodes and some fungi.

The method was first discovered in the Netherlands by a bulb grower more than fifty years ago. After the Wieringermeer area was flooded in 1944, the growers in that area had little to no problem with soil borne diseases for a few years. As the grower had some problems with diseases and nematodes in the soil he decided to flood his land and discovered that this method helped control the diseases and nematodes infestation.

Since then, different diagnostic studies have proven the positive effect of inundation on disease control especially in nematodes and the method has been registered by the nVWA (consumer food and product safety authority) as an official control measure for Potato Cyst Nematode (PCN): *Globodera pallida an G. rostochiensis* in the Netherlands.

Implementation

Inundation is executed in a minimum of 10 weeks prior to planting in summertime. To start inundation, a small dike of approximately 30 centimetres high is created around a lot after levelling. To prevent breaches in the dike, an overflow with a large diameter is formed on the North Eastern side of the lot. The lot is continuously flooded with approximately 5 centimetre of water with pumps keeping drainage closed and air free.

To reach the maximum potential of the inundation, soil temperature should be around 17 degrees Centigrade or higher. Sufficient duration of the flooding, and therefor duration of the anaerobic condition in the soil, also needs to be taken into account. In summer this will last 6 to 8 weeks or even 10 weeks in the presence of the nematode *Ditylenchus dipsaci.* With colder soil temperatures a

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longer period of flooding is needed to reach the same potential as the needed anaerobic conditions are reached more slowly in cold conditions. The soil structure also influences the time needed to reach anaerobic conditions; in sandy homogenous soils this can already be reached in a few days.

After the inundation period, water is slowly drained so that normal water levels in the soil are restored. Studies have shown that soil properties such as texture, organic carbon, total nitrogen, pH, extractable phosphorus, potassium and clay content in periodically short-term (3-5 weeks) flooded soils do not decline. Long term flooding has proven to affect the macrofauna distribution in the soil and soil structure, as several species preferred periodically or episodically flooded locations. The effect on macrofauna has not been found in short-term inundation, however experience soil quality has never found to be improved after inundation.

With inundation, nematodes are well or moderate disputed depending on the species (see table 1). Also, inundation fights of fungi, weeds and residuals (see table 2 and 3).

Table 1: Controlling activity of inundation in Nematodes

Nematodes	**Control by inundation**		
	Well	**Moderate**	**Unknown***
Pratylenchus penetrans	X		
Globodera pallida, G. rostochiensis	X		
Ditylenchus dipsaci	X		
Aphelenchoides subtennis	X		
Rotylenchus	X		
Ditylenchus destructor		X	
Trichodorus spp.		X	
Paratrichodorus spp.		X	
Meloidogyne chitwoodi			X *
Meloidogyne fallax			X *

*nr of individuals not sufficient in control to make a reliable conclusion on the control by inundation.

Table 2: Controlling activity of inundation on fungi

Fungi	**Control by inundation**		
	Well	**Moderate**	**Unknown**
Sclerotinia bulborum	X		
Sclerotinia sclerotiorum	X		
Botrytis	X		
Rhizoctonia tuliparum	X		
Stromatinia gladioli		X	
Phytium sp.		X	
Rhizoctonia solani		X	
Sclerotium cepivorum		X	
Fusarium sp.		X	
Olpidium brassicae		X	

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Table 3: Controlling efficiency of inundation on residual bulbs and weeds

	Control by inundation		
	Well	**Moderate**	**Unknown**
Residuals	Tulip, narcissus, hyacinth, sparaxis, potato, anemone, brodicacea	Iridaceae, Allium moly, Scilla, Ornithogalum	
weeds	creeping thistle, coltsfoot	Akkerkers	seed weeds, horsetail, yellow nutsedge *

*nr of plants not sufficient in control to make a reliable conclusion on the control by inundation.

Challenges

It should be taken into account that the biological equilibrium of the soil will be disrupted. Crops sensitive to *Pythium, Rhizoconia solani* or *Olpidium brassicae* should not be cultivated in the first year after inundation. After the first year, the soil ecosystem is recovered sufficiently for growing these sensitive crops again. Also soil quality will be affected by inundation. In the Netherlands there are very limited official control measures and inundation has become a necessity for control of nematodes.

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