# Adaptation and Management of Forage Legumes – Strategies for Improved Reliability in Mixed Swards

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# Is clover cyst-nematode a problem for organic dairy farms?

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## ABSTRACT

Forty-eight grass/clover plots, on eight organic dairy farms on sandy soil, were sampled for *Heterodera trifolii* (clover cyst-nematode)(Expt. 1). On three of the eight farms no *H. trifolii* cysts were found. On the remaining five farms, infestation with *H. trifolii* was classified as medium to high on 56% of the plots. Screening the available information for factors affecting clover cyst-nematodes, a relationship was found with year of sowing and nitrogen mineralisation potential. No relationship could be found between the development of the clover cover in the years 2001 and 2003 and densities of *H. trifolii*. In general it appeared that clover cyst-nematode infestation on organic dairy farms caused few problems in the vegetative, spreading phase of clover growth but could form a problem in the establishment phase. In a crop rotation experiment, both the treatments involving a rotation of 3 years grass/clover with silage maize had a low to medium infestation with *H. trifolii* (Expt. 2). An increase in infestation was noticed in the grass/clover phase and a decrease in the arable phase. Apparently the 3 years grass/clover in rotation with 3 years silage maize kept the densities of *H. trifolii* in equilibrium. Crop rotation can help to reduce a clover-cyst infestation to an such extent that problems with clover cyst-nematodes in the vegetative and establishment phases of clover growth can be overcome.

Keywords: *Heterodera trifolii*, grass/clover, organic dairy production

## INTRODUCTION

For their nitrogen supply, organic dairy farms mainly depend on biological nitrogen fixation by clover. Reduction of clover growth by pests can therefore have an important impact on the functioning of the farm as a whole. Ennik (1982) concluded that clover cyst-nematodes (*Heterodera trifolii*) can cause a substantial reduction in white clover growth. Baars (2002) found an increase in the percentage of experimental grass/clover plots infected with *H. trifolii* from less than 3% at the start of the experiment to 100% after 6 years, and there was a

negative trend between the dry matter production of white clover and the number of *H. trifolii* cysts in plots not receiving nitrogen fertiliser. *H. trifolii* can inversely affect the development of white clover in the sward in two distinct phases: during the establishment phase and the phase of vegetative spreading through the production of stolons (Plowright, 1985), while a substantial period of fallow (>6 months) can result in a rapid decrease of *H. trifolii* densities, down to levels that do not harm clover. The aim of this study was to assess the prevalence of the clover cyst-nematode on organic dairy farms in the Netherlands and to investigate the effect of crop rotation on the encountered infestations in Belgium.

## MATERIALS AND METHODS

Eight organic dairy farms on sandy soil in the project BIOVEEM were selected to assess the prevalence of clover cyst-nematode (Expt. 1). In total, 48 grass/clover plots on these farms were sampled for *H. trifolii* in the soil layer 0-10 cm, in October 2003. To investigate the effect of crop rotation on *H. trifolii,* the development of a clover cyst-nematode infestation was sampled over two years (October 2002 and October 2003) in a crop rotation experiment on a sandy-loam in Belgium (University of Gent, Expt. 2). The treatments sampled in this experiment were: permanent grass/clover (since 1966), 3 years grass/clover in a crop rotation with 3 years silage maize, 3 years silage maize in a crop rotation with 3 years grass/clover and permanent arable cropping (since 1966). In the soil samples, total cysts, cysts with a live content and larvae/eggs in living cysts of *H. trifolii* were determined. Soil samples were also analysed for chemical parameters. Data on crop history, year of sowing, clover cover and fertilisation of the different parcels were collected. Factors or variables possibly affecting clover cyst-nematodes were screened using multiple linear regression.

## RESULTS

On three of the eight farms the densities of *H. trifolii* cysts were negligible (Table 1). On the remaining five farms, the average infestation on the measured grass/clover plots was, according to Dutch standards, low or medium. The clover history of the farm or date of conversion were unrelated to the densities of *H. trifolii*. According to Dutch standards, damage to clover can occur from a medium or greater infestation. On the five farms, 56% of the plots were within this range. Multiple linear regression on factors and variables possibly

affecting the abundance of clover cyst-nematodes resulted in few suitable models, with models accounting for a maximum of 40% of the total variance. The best model showed significant contributions of the year of sowing and the potential nitrogen mineralisation of the soil. Clover cover had only a weak relationship with total clover cysts. No relationship could be found between the development of clover cover between the years 2001 and 2003 and densities of *H. trifolii*.

Table 1. Average (with standard deviation) densities (100 $g^{-1}$ soil) of *H. trifolii* on eight organic dairy farms

| Farm | Number of plots | Total cysts | Live cysts | Larvae/eggs in live cysts | Infestation classification |
|---|---|---|---|---|---|
| 1 | 3 | 0 (1) | 0 (1) | 17 (30) | none |
| 2 | 9 | 41 (44) | 14 (15) | 844 (949) | medium |
| 3 | 3 | 4 (4) | 2 (2) | 130 (147) | low |
| 4 | 9 | 0 (1) | 0 (0) | 4 (13) | none |
| 5 | 3 | 54 (27) | 17 (12) | 823 (665) | medium |
| 6 | 9 | 0 (1) | 0 (0) | 2 (4) | none |
| 7 | 9 | 31 (26) | 12 (11) | 781 (856) | medium |
| 8 | 3 | 43 (22) | 14 (15) | 817 (720) | medium |

Infestation classification: none=only empty cysts, low=1-300 larvae/eggs, medium=301-900 larvae/eggs, fairly high=901-2100 larvae/eggs, high>2100 larvae/eggs.

Table 2. Average densities (100 $g^{-1}$ soil ) of *H. trifolii* in different cropping systems

| | 2002 | | | | 2003 | | | |
|---|---|---|---|---|---|---|---|---|
| | Total cysts | Live cysts | Larvae/ eggs in live cysts | Infestation classification | Total cysts | Live cysts | Larvae/ eggs in live cysts | Infestation classification |
| Permanent G/C | $3^{b}$ | $1^{b}$ | $20^{b}$ | low | $1^{bc}$ | $1^{b}$ | $35^{b}$ | low |
| G/C after 3 years maize silage | $3^{b}$ | $2^{b}$ | $55^{b}$ | low | $14^{b}$ | $7^{a}$ | $413^{a}$ | medium |
| Maize silage after 3 years G/C | $41^{a}$ | $12^{a}$ | $355^{a}$ | medium | $24^{a}$ | $6^{a}$ | $185^{b}$ | low |
| Permanent arable cropping | $0^{b}$ | $0^{b}$ | $0^{b}$ | none | $0^{c}$ | $0^{b}$ | $0^{b}$ | none |

Infestation classification: none=only empty cysts, low=1-300 larvae/eggs, medium=301-900 larvae/eggs, fairly high=901-2100 larvae/eggs, high>2100 larvae/eggs.
Values followed by the same character within each column do not differ significantly ($P<0,05$).

As anticipated, no *H. trifolii* cysts were found in the permanent arable cropping treatment (Table 2). In the permanent grass/clover, the infestation of larvae/eggs was low for both years. In the two treatments with a crop rotation of 3 years grass/clover with silage maize, the infestation was higher than in permanent grass/clover. The permanent- and temporary grass/clover had, in 2003, an average clover percentage of 5% and 31%, respectively, on a dry matter basis. In the treatments with the crop rotation, an increase in infestation was noticed in the grass/clover phase and a decrease in the arable phase. In the temporary grass/clover the increase in larvae in 2003 was higher than the augmentation of total cysts and live cysts.

## DISCUSSION AND CONCLUSION

Fifty-six % of the grass/clover plots had a medium to high infestation (Expt. 1) and could thus suffer from damage from *H. trifolii,* according to the Dutch standards. Plowright (1985) states that damage to white clover seedlings occurs at levels above 2000 larvae/eggs 100 $g^{-1}$ soil and that densities above 4000 larvae/eggs 100 $g^{-1}$ soil may result in seedling death. Such high densities only occurred in a few plots. Ennik (1982) reported a case in which a total of 70 total clover cysts was recorded in a grass/clover sward and where a rapid decline in clover content was observed. However, in this study no relation could be found between the development of clover cover between 2001 and 2003 and densities of *H. trifolii.* The infestation with *H. trifolii* in the crop rotation experiment was considered low to medium (Expt. 2), which suggests that 3 years of grass/clover in rotation with 3 years of silage maize keeps the densities of *H. trifolii* in equilibrium. However, the increase in the number of larvae/eggs in the grass/clover phase was more rapid than was the decrease in larvae/eggs in the arable phase. It is still an open question if this can create problems, since the arable phase can halve the densities of larvae/eggs in just one year. The present data suggest that damage of *H. trifolii* on organic dairy farms on sandy soils is negligible in the vegetative phase of clover growth and can cause problems in the establishment phase of clover on a limited numbers of plots. However, crop rotation can help to reduce a clover-cyst infestation to an extent that problems with clover cyst-nematodes in the establishment phase of clover growth can be overcome.

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