

The Development of Strategies to Regulate the Infestation of Wireworms (*Agriotes* spp. L.) in Organic Potato Farming

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Problem/Goals:

The potato is the most important root crop in organic farming. It is very good for direct marketing and obtains high market values, but only if the digged potatoes are not damaged. Wireworms, the larvae of click beetles, bore their way into potato tubers which leaves the whole harvest unmarketable. The infestation can be seen by the 2 mm holes in the tubers. The destructive worms are orange in colour, about three centimetres long and they are clearly segmented. The most unusual characteristic of the click beetle's larva is the fact that it remains a larva for several years (up to 6 years) instead of undergoing a complete metamorphosis at least once a year. During this time they only feed on organic material. There are twelve different species of plant damaging click beetles in Germany. The genus which can be found most often is the *Agriotes* spp. L. The fully-grown beetles live around eight weeks and they are not very much known as they are seldom seen. Moreover, they cause little to no damage to the plants they feed on. Between May and July they lay up to 160 eggs in humid and humous soils covered with low vegetation. These conditions are given in clover grass which is often a preceding crop to potatoes.

More and more organic farmers dig potatoes which are damaged by wireworms. Therefore a nationwide status quo-analysis is carried out by the Agricultural Chamber Rhineland concerning the problem of wireworms in organic potato farming. The project is being financed by the Federal Ministry of Consumer Protection, Food and Agriculture ("Federal Program Organic Agriculture"). The project has started in June 2002 and will go on until December 2003. New information shall be compiled and new strategies against wireworms shall be developed for advice centres and practice. Impulses shall also be given to politics, science and research. For some years the section organic farming of the Agricultural Chamber Rhineland has been conducting observations and experiments in the Centre of Horticulture in Cologne-Auweiler regarding the problem of wireworms. The results led to the following hypotheses:

Hypotheses:

- Clover grass in the crop rotation increases the amount of wireworms in the soil. Therefore potatoes should not be cultivated in the first year after ploughing up clover grass or grassland.
- The dimension to which the harvest crop is affected by wireworms is influenced by:
 - Spring sown crop or winter sown crop in the crop rotation
 - the intensity of soil tillage
 - the point of time of soil tillage.

Methods:

A nationwide survey among organic potato growers started in October 2002. Different agricultural advice centres in Germany are involved, too. In addition, the causes for wireworm infestation are analysed in detail on at least 30 farms. There will

be registered farm-related data, the quality of harvest, the quantity of harvest damage, the amount of wireworm losses in the potato tubers and site-specific wireworm species. The wireworm damage is delimited from other pests and diseases with similar damage symptoms. New strategies will be developed for wireworm reduction.

The experiments in stockless organic farming were conducted in the experimental Centre of Horticulture in Cologne-Auweiler in block enclosures with 4 repetitions each.

Results/ Discussion:

When redacting this text in November 2002 no final results were yet available from the nationwide survey and the farm inquiries. These will be published in a presentation at the Vienna Conference.

Crop rotation:

After clearing an organic orchard with grass underseed the areas were prepared with clover grass and cereals during several years for experiments with stockless organic farming. There was a crop rotation experiment with two different crop rotations on one field:

Crop rotation 1: Winter wheat + catch crop – carrots – field beans + catch crop – white cabbage – potatoes

Crop rotation 2: Winter wheat + undersown crop – potatoes – winter rye + undersown crop – clover grass– celery.

In spite of the same preconditions for both crop rotations the infestation with wireworms in crop rotation 2 was significantly higher (57%) during a period of three years than in crop rotation 1 (8%). Apparently the wireworms had better development conditions in crop rotation 2 under clover grass and two winter cereals with undersown crop than in crop rotation 1 without clover grass and four summer crops. However it was noticed that the potato tubers in crop rotation 2 were damaged less and less by wireworms every year.

According to the usual cultivation recommendations potatoes should be planted directly in the first year after clover grass because the larvae could feed on sufficient food supply in organic material from the previous year. However in another experimental field in Cologne-Auweiler the potato infestation with wireworms also increased in the first year after clover grass so that no marketable potatoes could be digged. Presumably there lived quite a few generations of wireworms in the soil due to the preceding perennial cultivation of clover grass.

Soil tillage:

Furthermore the influence of a turning and non-turning tillage on potato infestation with wireworms was investigated. In fields with turning tillage a potato infestation with wireworms was twice as high (31%) as in fields with non-turned tillage (14%). In both experiments the rotary harrow was used in November and the harrow, hoe and curry comb were used in May. In addition, the field with turning tillage was also ploughed up in November, whereas the field with non-turning tillage was only treated with a cultivator.

In another tillage experiment the effect on the potato infestation with wireworms was checked/tested by ploughing up clover grass at three different times and in varying intensity. In the most intensive variant the soil was tilled three times: after using the cultivator in autumn it was furrowed in winter and in spring. In the medium intensive variant the soil was tilled twice. The cultivator was used in autumn after it had been furrowed in spring. In the lowest intensive variant the soil was tilled only once. It was furrowed directly before the potatoes were planted in spring. This treatment implicated the least infestation with wireworms (28%), whereas an early intensive tillage in autumn entailed significantly the highest infestation (58%).

These results contradict the current opinion that wireworms can be disrupted in their development and even reduced through more intensive tillage. It is more probable that organic material in the soil is decomposed faster through more intensive soil cultivation. Through this the larvae are deprived of their food supply. Besides an early ploughing up of the clover grass implicates a considerable nitrate leaching in winter. Using the cultivator in late summer leads to a similar high mineralization.

Neemcake:

Through a fertilization with neemcake (80 kg N/ha) with a content of 6% nitrogen, 3% phosphate and 1% potassium the potato yields could not only be increased significantly, but also the health of tubers could be improved. With a wireworm infestation of 4 % it was remarkably better than in the check (28%). It still has to be tested if this impact is due to a phytosanitary effect or due to the additional disposition of organic material.

Early Scything off the potato tops:

On an experimental field with an infestation by wireworms, which was known to be high, the potato tops were partially scythed off in the first week of July 2002. These potatoes were dugged 3 weeks later when the skin was strong enough at the end of July. The potato tops of the remaining potato plants died naturally at the beginning of August. The potatoes dugged early in September had a 28% higher infestation with wireworms than the tubers dugged earlier. No difference in yields could be proved between the two different diggings.

Conclusions:

- On fields with high wireworm density potatoes should not be cultivated.
- Strong weed infestation should be controlled.
- Perennial clover grass should not be cultivated as a preceding crop to potatoes.
- Instead of undersown crop catch crop should be cultivated.
- The crop rotation should include spring sown crops which need to be hoed.
- Stock controls should be carried out periodically. In case of wireworm infestation the potatoes should be grubbed out as quick as possible when the skin is strong enough.
- An earlier digging of the potatoes through scything off the potato tops may reduce the potato infestation with wireworms.
- A thorough tillage before cultivating and after harvest can harm critical development stages of the click beetles like egg laying, egg ~, larval and cocoon stages.

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