Danish Research Service for Plant and Soil Science
Research Centre for Plant Protection
Institute of Plant Pathology
Zoological Department
DK-2800 Lyngby

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Occurrence of soil-borne pests in Danish sugar beet fields

Forekomst af jordboende skadedyr i danske bederoemarker

Lars Monrad Hansen

Summary

Soil-borne pests in sugar beet (*Beta vulgaris*) have become more relevant during the last 15 years because the methods of cultivation have changed in such a way that there is no longer any alternative plant material in the fields. Insecticide treatment of the seeds is insufficient at high occurrences of soil-borne pests. Here only granulated insecticides are effective.

Over the period 1981 to 1984 sugar beet fields all over Denmark were examined for soil-borne pests. Collembola (*Onychiurus sp.*) were found in all the examined fields, and it was found that on average pest control measures were necessary in about 4% of the fields. Millipedes (*Blaniulus sp.*) and symphylids (*Scutigerella sp.*) were found in varying percentages of the fields, but not in densities which caused problems. Pygmy beetles (*Atomaria linearis*) were found in many fields both in 1983 and 1984, but only in 1984 were the infestations so widespread that control treatments were necessary. The pygmy beetle stay above ground during certain weather conditions, during which attacks may be ascertained and controlled by spraying.

No significant correlation was found between method of cultivation, soil structure, content of nutrients and the occurrence of soil-borne pests. Nor has it been possible to find any definite connection between the occurrence of pygmy beetles and the meteorological conditions.

Key words: Soil-borne pests, sugar beet, collembola, millipedes, symphylids, pygmy beetles.

Resumé

Jordboende skadedyr i bederoer (*Beta vulgaris*) har fået større betydning i de sidste 15 år på grund af den ændrede dyrkningspraksis, som bevirker, at alternative fødekilder i marken stort set ikke mere er til stede. Insekticidbejdsning af frøene er utilstrækkelig ved høje forekomster af jordboende skadedyr, hvor kun granulerede insekticider er effektive.

I perioden 1981–1984 er bederoemarker beliggende over hele landet blevet undersøgt for forekomst af jordboende skadedyr. Collemboler (*Onychiurus sp.*) blev fundet i samtlige undersøgte marker, og ca. 4% af markerne vil gennemsnitlig have behov for bekæmpelse. Tusindben (*Blaniulus sp.*) og symfyler (*Scutigerella sp.*) blev fundet i en varierende procentdel af markerne, men ikke i antal, som kan formodes at give problemer. Runkelroebiller (*Atomaria linearis*) blev fundet i en del marker både i 1983 og 1984, men kun i 1984 var forekomsten så stor, at der var behov for bekæmpelse. Da runkelroebillen i visse perioder bevæger sig over jordoverfladen, kan angreb konstateres og bekæmpes ved sprøjtning.

Det har ikke været muligt at finde signifikante sammenhænge mellem dyrkningspraksis, jordens struktur samt indhold af næringsstoffer og forekomsten af de jordboende skadedyr. Det har heller ikke været muligt at finde sikre sammenhænge mellem forekomst af runkelroebiller og meteorologiske forhold de enkelte år.

Nøgleord: Jordboende skadedyr, bederoer, collemboler, tusindben, symfyler, runkelroebiller.

Introduction

Soil-borne pests in sugar beet (*Beta vulgaris*) are of economic importance in most European countries (7). In recent years the field damage has increased. This may, to some extent, be ascribed to the great changes in cultivation methods during the last 15 years (8). Nearly all farmers now practice 'drilling to a stand', and weed control by application of soil herbicides. This means that weeds as alternative food for soil-borne pests are no longer present. Thus the pests concentrate on sugar beet seedlings (5).

Nearly all seeds in Denmark are treated with a dressing of pesticides (thiram, mercaptodimethur), but the control is only satisfactory when the number of soil-borne pests present is small (10). Consequently, many growers use insecticides as a safety precaution.

Recently attention has been focused on the 'soil pest complex'. This complex includes collembola (*Onychiurus sp.*), symphylids (*Scutigerella immaculeata*), millipedes (principally *Blaniulus guttulatus*) and pygmy beetles (*Atomaria linearis*). Damage by this complex presents more control problems than other seedling pests because the predisposing factors are not understood. The location and activity of pests in the soil is assumed to be affected by several factors such as predators, texture, organic matter, temperature, humidity and etc. (6).

In some cases the soil-borne pests actually kill the plants but usually secondary fungal or bacterial attacks are the direct cause. Plants are very sensitive to attacks at the seedling stage but they are fairly resistant when they have 4 permanent leaves (6).

The pests move from deeper soil layers to the seed bed when the soil humidity is sufficiently high and the soil temperature has reached 5°C. Then propagation starts (4, 9, 12). Thus soil sampled when the plants have 2 couples of permanent leaves will usually contain the maximum number of collembola, millipedes and symphylids present during the sensitive period of the plant.

Over the period 1981–84, sugar beet fields all over Denmark were examined to investigate the presence of the various soil-borne pests and to estimate the damage caused by soil-borne pests.

Material and methods

The examined sugar beet fields are divided into 2 groups, of which the larger group consists of fields which have not been treated with granulated insecticides. The smaller group comprises the untreated plots which are part of field experiments with granulated insecticides.

Samples were collected about the stage with 2 couples of permanent leaves. 25 soil cores were collected from each field or plot. The samples were taken with a conical bore (upper diameter: 6 cm, lower diameter 5.5 cm) around beet plants at a depth of about 8 cm. The samples were taken in the fields, along a line running diagonally through a square of about 1 ha. In the experiments they were evenly distributed in the untreated replicates.

The samples were put into separate plastic bags and taken to the laboratory, where they were stored at max. 5°C. Within 20 days they were examined for soil-borne pests by a simplified flotation method (11, 14).

20 of the samples were examined for occurrence of collembola with reference to the *Onychiurus* group (1), millipedes (*Blaniulus sp.*), symphylids (*Scutigerella sp.*) and pygmy beetles (*Atomaria linearis*). The remaining 5 samples were pooled and analysed for content of organic

matter, reaction figures (pH), phosphoric acid (Ft) and potassium content (Kt).

Finally, information was obtained about crop rotation in the preceding 4 years, use of organic manure and any possible ploughing in, removal or burning of straw. Data concerning precipitation and temperature was obtained from the Danish National Meteorological Office.

For the statistical analyses a one-way anova test was used (13).

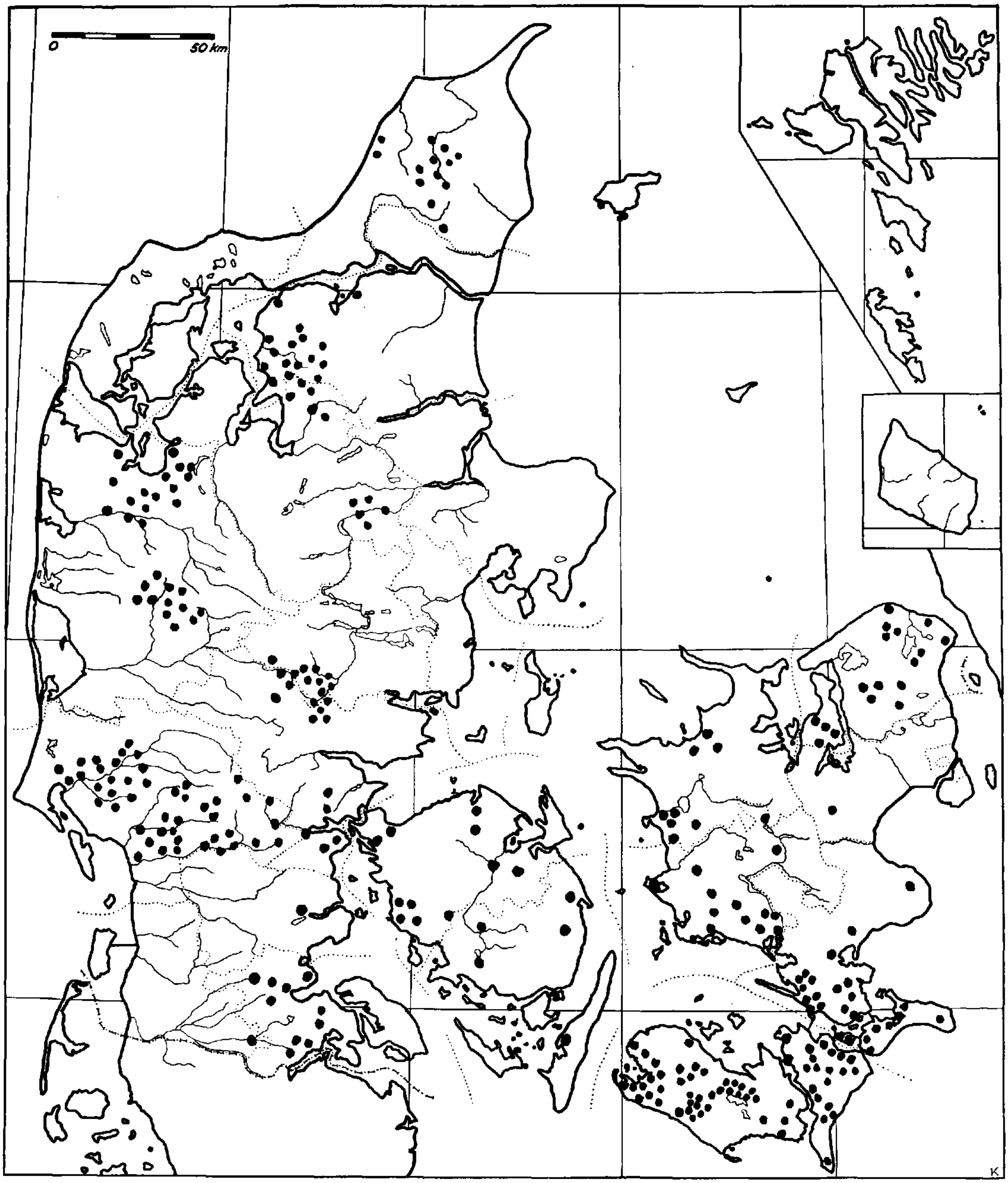

Fig. 1. Location of fields examined in 1982.
Beliggenhed af marker undersøgt i 1982.

Results

Over the period 1981–1984, 374 fields distributed all over Denmark were examined for occurrence of soil-borne pests. Fig. 1 shows the location of the fields investigated in 1982.

Collembola were found in all fields, while the other soil-borne pests were found in varying percentages in the fields over the 4 years (Table 1). After collembola the pygmy beetle was found most frequently.

Table 1. Percentages of fields with soil-borne pests
Procent marker med jordboende skadedyr.

	1981	1982	1983	1984
No of fields *Antal marker*	32	253	51	38
Collembola *Collemboler*	100	100	100	100
Diplopodes *Tusindben*	3	2	12	16
Symphylids *Symfyler*	9	8	20	13
Pygmy beetles *Runkelroebiller*	3	4	24	66

Table 2. Average number[1)] of soil-borne pests per sample. S. E. in brackets.
Gennemsnitligt antal[1)] af jordboende skadedyr pr. prøve. S. E. i parentes.

	1981	1982	1983	1984
Collembola *Collemboler*	3.2 (1.0)	3.0 (0.2)	6.7 (0.8)	3.6 (0.2)
Diplopodes *Tusindben*	0.1 (0.0)	0.1 (0.0)	0.2 (0.1)	0.2 (0.1)
Symphylids *Symfyler*	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)
Pygmy beetles *Runkelroebiller*	0.1 (0.0)	0.2 (0.1)	1.4 (0.4)[2]	2.1 (0.2)

1) Includes only fields in which the actual pest were found.
Kun marker med det pågældende skadedyr er medtaget.

2) The high mean is caused by 2 fields with very high occurences of pygmy beetles.
Dette høje gennemsnit skyldes udelukkende 2 marker med meget store forekomster af runkelroebiller.

The average occurrence of pests (Table 2) estimated on the basis of fields in which they were found shows collembola and pygmy beetles were also found in the greatest numbers.

Table 3 shows the distribution of fields as regards occurrence of collembola at 4 different densities and Table 4 illustrates the corresponding distribution of pygmy beetles.

Results of soil analyses (organic matter, pH, Ft, Kt), and information about crop rotation, use of organic manure and ploughing in, removal or burning of straw were statistically analysed in relation to occurrence of collembola, millipedes, symphylids and pygmy beetles. No significant correlations were found to explain why some fields show greater occurrences of these pests than others.

Table 3. Examined fields divided into 4 groups according to occurrence of collembola.
De undersøgte marker opdelt i 4 grupper efter forekomst af collemboler.

Number coll./sample *Antal coll./prøve*	Per cent fields *procent marker* 1981	1982	1983[1]	1984
0	0	0	0	0
0 – 10	93	98	78	97
>10	7	2	22	3

1) Late sowing.
Sen såning.

Table 4. Examined fields divided into 4 groups according to occurrence of pygmy beetles.
De undersøgte marker opdelt i 4 grupper efter forekomst af runkelroebiller.

Number beetles/sample *Antal biller/prøve*	Per cent fields *procent marker* 1981	1982	1983	1984
0	97	96	76	34
0 – 1	3	4	21	21
1 – 2	0	0	2	9
>2	0	0	1	36

Discussion

Collembola were found in all the fields examined, with an average of 3.0–6.7 collembola/plant. A more interesting question, however, is in how many of the fields the damage threshold was passed. The threshold is supposedly passed at an average occurrence of about 10 collembola/plant in the sensitive period (10, 11). In 1981, 1982 and 1984 significant attacks occurred in 2–7% (average 4%) of the fields examined. The reason for the increased occurrence in 1983 is the considerable rainfall in the spring of 1983 and the consequent late sowing and equally late sampling. By the time of the late sowing the propagation of collembola was well established, so that the sugar beet plants were generally exposed to dense collembola populations during their sensitive period. Under normal conditions, with sowing in the first half of April, about 2–7% of the sugar beet fields will require control of collembola.

Millipedes were found in 2–16% of the fields. However, the average occurrence was not above 0.2 millipede/plant. No damage threshold has been estimated for millipedes in sugar beet, but according to *Baker* (3, 4) tests have shown that at 22°C one piece of the millipede (*B. superus*) may damage the hypocotyl of a sugar beet plant completely within 3 hours. As this experiment was made in loose soil, where millipedes have greater possibility for dispersion than in the firmer field soil, the damage in the field will probably be somewhat smaller. Based on this and the known densities of millipedes, it may be concluded that, on the whole, millipedes are not among the serious pests in Danish sugar beet fields.

The damage threshold of symphylids in sugar beet has not been described, either, but considering their small size it is assumed to be at a higher number of pests/plant than in the case of the millipedes. This in combination with the results given in Table 1 and 2 show that this pest is of practically no importance in Danish sugar beet fields.

The occurrence of pygmy beetles varied greatly. In 1981 and 1982 hardly any specimens were found, whereas in 1983 and 1984 they were found in 24% and 66% of the fields, respectively. No precise damage threshold is described, but according to the literature (2) many plants will wither and die if many pygmy beetles are present. Assuming that there must be at least 2 beetles/plant (probably more) in the field in order to exceed the damage threshold, the pygmy beetle should only have given general problems in 1984, where control measures were needed in 36% of the fields.

As opposed to the other soil-borne pests, the pygmy beetle can disperse by flying. This happens when the air temperature passes 20°C. It is difficult to explain why the pygmy beetle occurs in high densities in some years, and not in others. One specific difference between 1984 and the 3 other years in question is that precipitation in the preceding winter (November 1983–March 1984) was about 25% lower and that the soil temperature remained below 2°C until the end of March. Possible correlations need closer investigations.

Conclusion

Attacks of soil-borne pests are difficult to predict, and they can only be efficiently controlled by means of granulated insecticide. However, the granulate has to be applied at the time of sowing – at a time when the soil-borne pests normally have not gone up into the seed bed.

With respect to collembola, millipedes and symphylids, usually only collembola give rise to problems. On average 4% of the sugar beet fields will contain collembola to such an extent that control is worthwhile. It can be difficult to find these fields, but examination of soil samples collected in the autumn can give an indication of the risk of attacks. This question is being examined further.

The pygmy beetle can be controlled by spraying in case of widespread attacks. As opposed to the other pests mentioned, it moves above the ground surface at certain times. Thus there is no reason for using granulated insecticide to control this pest.

Acknowledgement

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