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Problems of abandoned fields

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Abstract. The study was based on data gathered in 1995–2002 in areas where plant cultivation was discontinued for various reasons and at various times. The objective of the study was to track changes in plant community, biomass production and soil weed seedbank in the abandoned fields.

The discontinuation of cultivation resulted in the emergence of plant communities, which were characterized for the first 1–2 years by a considerable proportion of annual species. The length of the period with annual species having a large representation in a community depended in many cases on the spread of *Elytrigia repens* in the abandoned fields. In land left idle for 5–6 years, perennial species supplanted annual species. Apart from *E. repens*, aggressive species turned out to be *Cirsium arvense* and *Artemisia vulgaris* (predominantly scattered all over the field). Weed seed density in the ploughed layer (30 cm) of abandoned fields amounted 157,000 to 666,000 seeds m^{-2}, with the upper 10-cm layer accommodating up to 51% of the total seedbank. The biomass produced by plants depended on the texture of the soil and the age of the plant community, being 32.6 t ha^{-1} at the maximum. The accumulation of organic matter on and in the soil is a positive development in abandoned fields. Abundant residue contributes to an improvement of the physical and mechanical properties of the topsoil layer, reducing soil bulk density and decelerating soil compaction. The surface residue is a favorable environment for soil fauna.

Key words: abandoned fields, weeds, organic matter, weed seedbank

INTRODUCTION

Estonian fields are becoming increasingly weed infested due to a number of factors.The main cause is a difficult economic situation resulting from the ending of large collective farms and the establishment of numerous small farms. In many cases, fields have been abandoned and become weed-infested areas (about 25% of the cultivated land).

The emergence of new plant communities in unused fields is a rapid process (Kuill et al., 1999). From abandoned fields, weeds spread to fields still cultivated, complicating weed control problems. The main objective of this study was to investigate the changes occurring in plant communities and the development of the predominant species in the communities and their effect on the soil.

The decision of whether it is practicable to resume agricultural production in abandoned areas or use other methods of management (forestation, growing shrubs for energy, etc.) has to be based on the soil fertility, the soil weed seedbank and the composition of the plant community formed in a particular field (Talgre et al., 2001).

MATERIALS AND METHODS

This study was performed in 1995–2002 and based on the data obtained from observation plots in three fields. In each field under study, a 100 x 100-m^2 observation plot was marked out. The observation plots were established on soils with three different textures sand, sandy loam and clay. In these plots, observations and plant identifications were carried out each year in the second week of July.

The species composition of a plant community was established on a 0.25-m^2 piece of land in ten replications. Plant dry matter and above-ground residues were determined (organic debris on the soil surface).

From the plot soil samples of 0.2 x 0.2 x 0.3 m were taken in 10-cm layers to 30 cm depth. From these samples, the number and viability of seeds, and the weight of rhizomes and roots were determined in the laboratory.

RESULTS AND DISCUSSION

In plant communities, both interspecific and intraspecific competition occurred. Abandoned areas were characterised by constantly changing plant communities. Year by year, some species disappeared while others became prevalent. Plant density and biomass were also subject to change.

The ratio of annual species to perennial species mainly depended on how long fields had been abandoned. The discontinuation of cultivation resulted in the emergence of plant communities, which were characterised for the first 1–2 years by a considerable proportion of annual species (0–58% of the total number of plants; Fig. 1). The total number of species in each community was relatively small, normally less than 15. Of annual species, *Tripleurospermum inodorum* proved to be the most common (21–39%), while C*henopodium album, Scleranthus annuus, Polygonum lapathifolium, Viola arvensis, Centaurea cyanus, Vicia hirsuta* and *Spergula arvensis* occurred less frequently (Lauringson & Kuill, 1997).

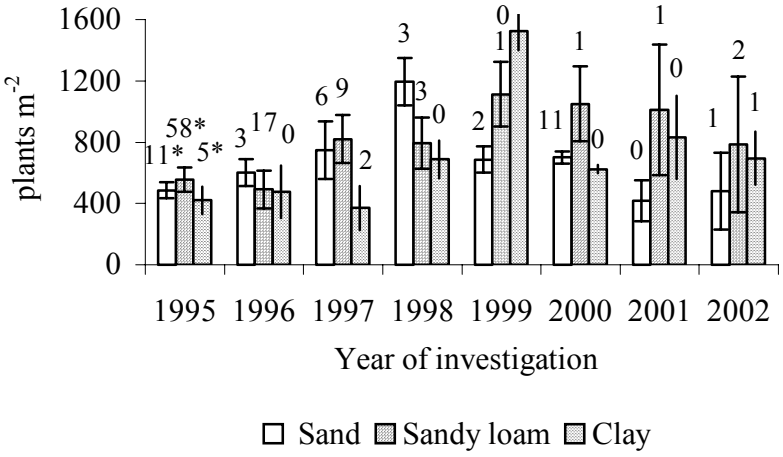

Fig. 1. Plant density (plant m^{-2}) and the proportion of annual species (%) in abandoned fields. * – annual species.

The species composition of plant communities and its dynamics in the abandoned fields depended on the following factors:

1. The competitive power of the last crop and the tillage techniques applied to it;
2. The extent of weed invasion of and the weed species composition in the last crop;
3. The quality of soil management applied to the last crop;
4. The texture and moisture regime of the soil.

Fields abandoned for a longer time often overgrew with shrubs. The process was observed to begin in the 4th to 6th year following the termination of cultivation. The main scrub-forming tree species were *Betula pendula, Alnus incana* and *Salix spp.,* that is, the species that have light seeds, which may be carried by wind to a distance of 200–400 m. The intensity of shrub overgrowth depended on the distance of a forest (scrub) from the abandoned fields – the smaller the distance to a hardwood forest or scrub, the more intensive the process of overgrowth.

The weed seedbank was often irregularly placed in the ploughed layer of abandoned fields. This variability was due to many factors, including application of manure abounding in weed seed, composts of irregular quality, variable location of weed species, the different seed-producing capacities of different species, irregular quality of soil cultivation methods. A major factor in the development of soil weed seedbank was the quality of soil management before its abandonment. Weed seed density in the ploughed layer (30 cm) of abandoned fields amounted 157,000 to 666,000 seeds m^{-2}, with the upper 10 cm layer accommodating up to 51% of the total seedbank (Lauringson et al., 2000).

In the first 3 years following the termination of cultivation, the weed seedbank increased in the topsoil layer but decreased in later years (Fig. 2). Although the vegetation in the abandoned fields is currently dominated by perennial plant species, the soil seedbank is dominated by the seeds of annual species, constituting approximately 70–75% of the total viable seedbank.

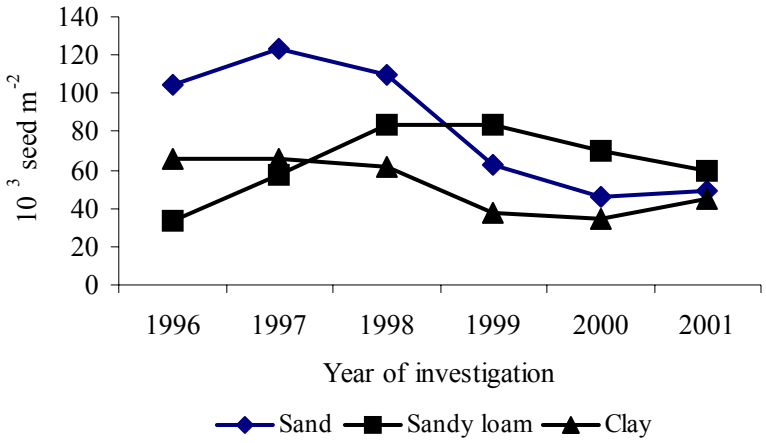

Fig. 2. Total weed seedbank (10^3 seed m^{-2}) in topsoil (10 cm) in three fields 1996–2001.

The above-ground mass of plant stalks and leaves and residues as well as the underground mass of plant roots and rhizomes was studied. The accumulation of organic matter on and in the soil is a positive development in abandoned fields. Abundant residue contributes to the improvement of the physical and mechanical properties of the topsoil layer, reducing soil bulk density and decelerating soil compaction. The surface residue is a favorable environment for soil fauna. In 1998–2002, the average rate of residue formation for all observation plots was 1.7–6.9 t ha^{-1}, or 9.6–27.8% of the total organic matter. The biomass produced by plants depended on the texture of the soil and the age of the plant community (Fig. 3 and Fig. 4), being 32.6 t ha^{-1} at the maximum. There was regularly less organic matter produced on the sandy soil. A high density in plant communities of the perennial species *C. arvense., S. arvensis*. and *A. vulgaris,* which inhabit the middle and top storeys, and the annual species *V. hirsuta* and *Galeopsis* spp. led to an increase in shoot biomass. The bulk of the biomass produced in abandoned fields was located in the ploughed layer.

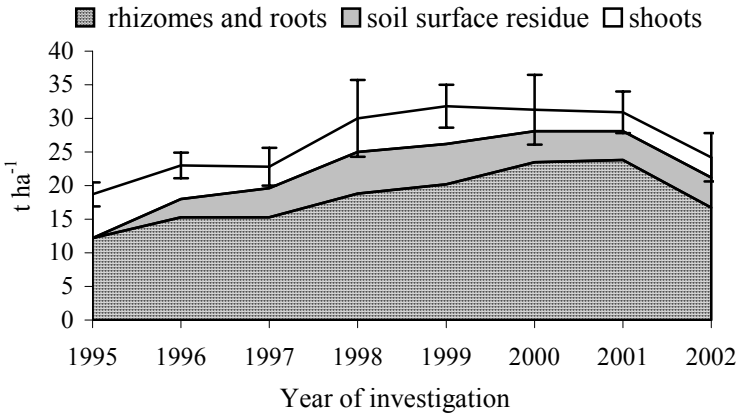

Fig. 3. Dry matter (t ha^{-1}) of organic material in abandoned field with sandy loam texture.

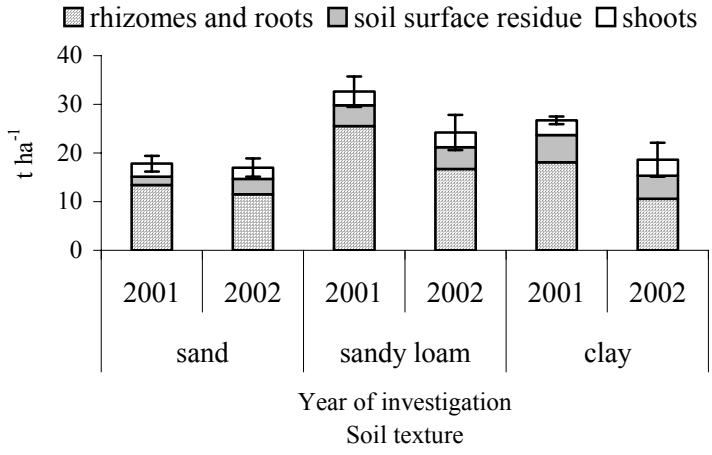

Fig. 4. Dry matter (t ha^{-1}) of organic material in abandoned fields in 2001 and 2002.

CONCLUSIONS

The termination of plant crop cultivation led to the emergence in abandoned fields of plant communities characterised by a considerable proportion of annual species in the first two years.

Four to six years after the termination of cultivation, *E. repens, C. arvense* and other perennial species become predominant in the fields.

Abandoned areas are suitable for organic farming due to their great biodiversity and non-use of chemicals.

It is possible to recultivate abandoned areas, although the process is complicated by the presence of a large number of rhizomes and roots of perennial weeds and a high weed seed density in the soil (Lauringson et al., 1999).

Fields abandoned for a longer time often overgrew with shrubs. The resumption of agricultural production in these areas would require great expenditure.

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