Effects of organic farming on weed abundance - long-term results from a site in Northern Germany

A. Verschwele, P. Zwerger
Institute for Weed Research, BBA, Messeweg 11/12, D-38104 Braunschweig
a.verschwele@bba.de

Introduction

One of the aims of organic farming systems is to maintain or enhance the agricultural and natural biodiversity in agro-ecosystems. Weeds can contribute to biodiversity but also need to be controlled. Compared to conventional farming the weed density and diversity in organic farming is expected to be enhanced because of reduced fertilisation and low efficacy of control measures. It is also assumed that the diversity of crops, especially alternation of summer and winter crops, results in a greater range of weed species. However, relatively few data are available confirming this benefit of organic farming. Thus, continuous monitoring studies have been started in 1996 on a trial area for organic farming in northern Germany.

Materials and methods

Trials on organic farming have been conducted since 1996 on an experimental area of 10 ha certified according to EC Regulation No 2092/91. This site ('Ahlum, BBA') is located south of Braunschweig and consists of homogenous loam with a high nutrient level, an annual precipitation of 579 mm and an annual mean temperature of 9.3°C. The area is managed under an arable farming system with a crop rotation of 50% cereals and 62.5% summer crops. Legumes were grown every 4 years.

Weeds were controlled by harrowing at least once in each crop and year. The soil was regularly ploughed to a depth of 20–25 cm in autumn or spring. Stubble cultivation was mainly done with a wing share cultivator (cultivation depth 10 cm). Weeds were assessed annually in the field at 205 fixed reference points in a grid of 24 x 24 m by DGPS. The same points were also used for soil samples (to 30 cm) to determine the weed seedbank by germination tests.

Results and discussion

Since 1996 both weed density and species diversity increased markedly. Weed density assessed before direct control measures ranged between 62 and 223 plants m^{-2} throughout the observation period. The following annual species were abundant each year:

- monocotyledonous weeds: *Alopecurus myosuroides*, *Apera spica-venti* and *Poa annua*
- dicotyledonous weeds: *Galium aparine*, *Lamium* spp., *Matricaria* spp., *Sonchus oleraceus*, *Stellaria media*, *Thlaspi arvense*, *Urtica urens*, *Veronica* spp. and *Viola arvensis*

Depending on the year, these species made 63% to 80% of the entire infestation. During the nine years of organic management the number of species estimated on the field increased from 19 in 1996 to 36 in 2003 (Fig. 1). In contrast to these field estimations more weed species were found in the seedbank, but the increase was similar. Over all years 43 weed species were estimated in the field compared to 53 in the seedbank. Species like *Gnaphalium uliginosum*, *Juncus bufonius* and *Solanum nigrum* were found in the seedbank, but have never been observed by field estimations. Some other weeds appeared sporadically in the field including *Aphanes arvensis*, *Taraxacum officinale* and *Rumex* spp.. This observation has been reported by others (van Elsen, 2000) and might be due to different dormancy patterns depending on weed species and actual growth conditions (Albrecht, 2002).

Out of the 12 most frequent species mentioned above only 1 decreased, 7 increased and the others remained virtually constant. In particular numbers of monocotyledonous weeds in the soil seedbank rose to an extremely level by 2004 (Tab. 1).

Figure 1. Number of weed species on the field and in the seedbank at Ahlum, 1996-2004.

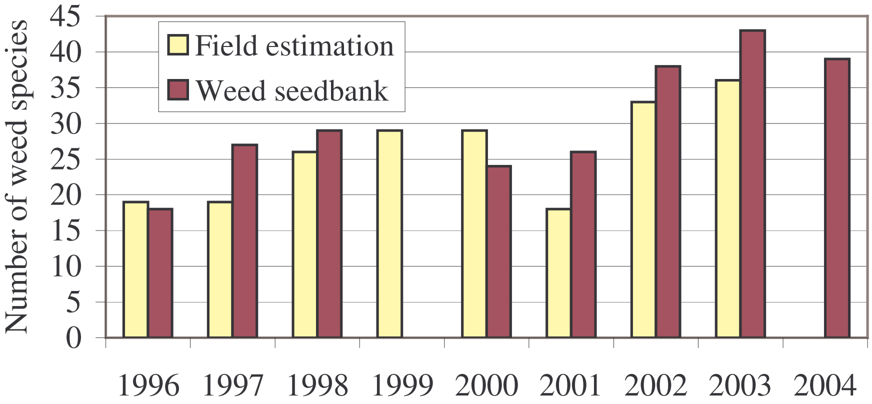

Table 1. Number of weed seeds m^{-2} to 30 cm soil depth at Ahlum, 1996-2004.

	1996	1997	1998	2000	2001	2002	2003	2004
Monocotyledonous	479	924	686	442	286	205	922	2264
Dicotyledonous	3709	6376	6171	4444	9068	6022	11537	9264
All	4188	7300	6857	4886	9354	6227	12459	11528

Despite the low fertilisation level non-nitrophilous weed species could not profit from the organic farming system. This is clearly related to the high soil fertility such that even *Galium aparine* and other nitrophilous species have not been repressed during the past nine years. The area infested with *Polygonum convolvulus* and *Cirsium arvense* has increased considerably with up to 50 and 63% respectively. Especially, *C. arvense* has become a serious problem due to less effective weed control and crop competition (Verschwele & Häusler, 2003).
Weed communities are not only affected by the production system but also by soil conditions and the diversity of the landscape (Jüttersonke & Arlt, 2002). Among other reasons this may account for the fact that weed populations have changed only little at this site: Even after nine years of organic farming the most abundant weed species were those which were highly abundant before and those recently abundant on the adjacent conventional field. Although some further weed species appeared, rare or even endangered species could not be found. Significant changes in weed communities appear difficult to achieve exclusively by organic farming. Under optimal growing conditions rare species can be suppressed by both the crop and other competitive weeds. These findings are similar to those of other investigations on organic fields (Albrecht, 2002; Hyvönen et al., 2003).
Apart from the contribution of weeds to arable biodiversity the risk of weed competition and the necessity for control measures has to be considered . If the numbers of weed species is just a function of the total number of plants (Hyvönen et al., 2003), intensive and improved control measures will reduce both weed density and, unfortunately, species diversity too. Therefore a balance is needed between the control intensity and the intended weed diversity, challenging researchers as well as farmers.

References

Albrecht, H., 2002. Proceedings of the 12th EWRS Symposium, Wageningen, 274-275.
Jüttersonke, B. & K. Arlt, 2002. Journal of Plant Diseases and Protection, S.I. 18, 305-309.
Hyvönen, T. et al., 2003. Agriculture Ecosystems & Environment 97, 131-149.
Van Elsen, T., 2000. Agriculture Ecosystems & Environment 77, 101-109.
Verschwele, A. & A. Häusler, 2003. Proceedings of the BCPC International Congress – Crop Science & Technology 2003, Glasgow, Scotland, UK, Vol. 1, 481–486.