How important are long-term effects for weed control according to economic thresholds in cereals - an example for Apera spica-venti

B. Gerowitt
Institut für Pflanzenpathologie und Pflanzenschutz der Georg-August-Universität Göttingen, Grisebachstr. 6, D-3400 Göttingen, F.R. Germany

Summary
Since German farmers are advised to control the annual gras weed Apera spica-venti in cereals according to a pragmatic economic threshold of 20 plants/m^2, an experiment was set up in 1981 to investigate the long-term development of the weed population in a field study. Data of the population development in five different weed control strategies and of population dynamic variables from nine years are now available. The population development in the economic threshold treatment shows a severe increase neither in actual plant densities in spring nor in the weed seed bank. The development of the system and the measured population dynamic parameters indicate, that seed production of A. spica-venti in winter wheat is more efficient for the population than in barley.

Introduction

Arable production in Germany is characterized by a percentage of 50 to 75 % winter cereals in the crop rotations, an intensive soil cultivation, a high level of N-fertilization and high cereal yields up to 100 dt/ha. Economic thresholds for annual weeds in cereals can help to maintain or increase the profitability of control. Intensive grown cereals, as competitive crops are most favourable for shifting from 'clean' weed-free fields to integrated managed fields, in which a low weed infestation is welcome.

Apera spica-venti (APESV) is an annual gras weed, emerging mainly in autumn and early spring. It is therefore adapted to autumn grown cereals, where it represents the most important annual gras weed on sandy soils and primary or secondary carbonate-free soils of mid-Europe. The fruit-stand is a panicle - in cereal crops the weed usually unfolds its panicles above the crop in June 4 - 8 weeks before harvest. Literature information about seed production varies from 500 - 10000 seeds/plants (2).

Although economic thresholds are variable values influenced by agronomy and economy, for applied demands in agricultural weed control, guide values have been published for weed densities which can be endured in winter cereals (4). The range for A. spica-venti is 20 - 30 plants/m^2. While the annual profitability of weed control according to economic thresholds in cereals is proofen in several investigations (4), some farmers are worried about long-term effects of a less intensive weed control, which allows some weeds to mature in the crop.

Material and Methods

A field experiment was set up in 1981 to investigate the long-term effects of weed control according to economic thresholds in cere-

als. The crop rotation is winter barley, winter wheat, sugar beet. Five treatments will be regarded in this paper (*abbreviation*): intensive control in cereals (*BW*), no control in cereals (--), intensive control in winter barley, no control in wheat (*B-*), viceversa (*-W*) and controlling in both cereals according to thresholds (*ET*). A. spica-venti is one of the dominating species at the site. It is controlled post-emergence with Isoproturone (1250 g/ha a.i.). In the first nine years in the treatment *ET* control of A. spica-venti was skipped three times in winter barley and four times in winter wheat, since it did not exceed the fixed margin of 20 plants/m^2. When the first weed wave after sowing was counted in the beet crop, all weeds were controlled by herbicides or removed.

Data of the following variables of the population development are collected in the experiment: seed bank (25 cm depth) in the soil, emerged plants/m^2 on the stubble between crops, emerged plants/m^2 in spring, matured plants/m^2 in summer, seed production per plant, seed export at harvest. In 1989 the germination of the produced seeds was tested.

Results

Figure 1 gives information about the weed population based on the emerged plants in spring, while Figure 2 is based on the development of the seed bank in the soil. Both rely on mean values over the fields, respectively crops of the rotation. Figure 1 indicates

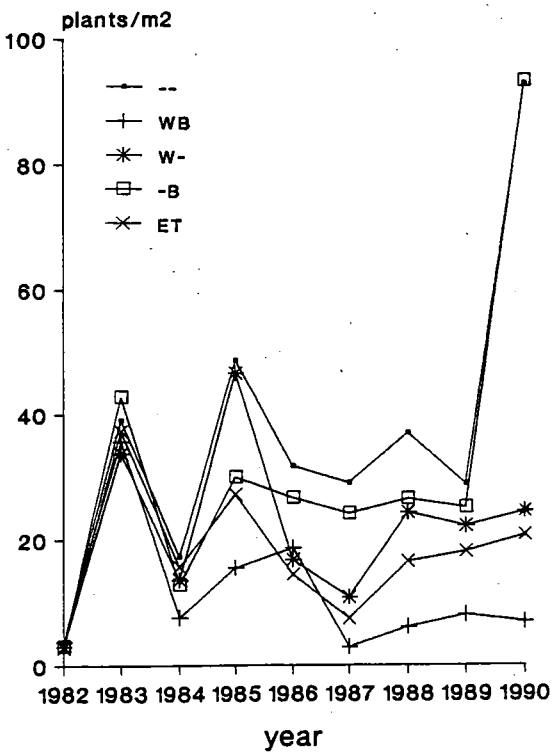

Figure 1. Densities of APESV in spring in the treatments

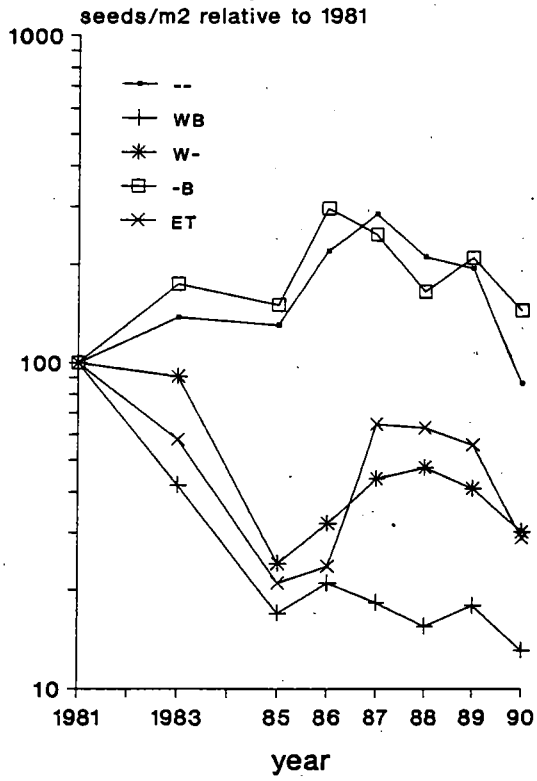

Figure 2. Development of the seed bank of APESV in the treatments

that the actual population has started to react after three years of different treatments. In treatment *ET* the actual population is rather stabilized. The plotted mean values of the actual population are influenced by the usually very low emergence of A. spica-venti in the beet crop. Seed production in wheat seems to be more effective than in barley. This is also indicated in Fig. 2, in which relative changes of the soil seed bank are plotted on a logarithmic scale. The development of the treatments *B-* and *W-* indicates, that an increasing level of seeds in the soil is almost completely relying on seed production in wheat. With the initially observed parameters of the population dynamic (values for wheat($_W$) and barley($_B$)): percent of emergence (1.93_W to 0.85_B), percent of not maturing plants (9.8_W to 20.9_B), seed production per plant (1537_W to 1309_B) and percent of seed export at harvest (0.11_W to 5.37_B) this development could not be explained sufficiently, since 'unknown losses (in %)' (86.34_W and 93.81_B) where left in the balance. Investigating the viability (in %) of the produced seeds in 1989 (26.0_W to 3.0_B) helps to further reduce the 'unknown losses'.

Discussion

Evaluating long-term effects on weed infestations, even for applied reasons, means to deal with the population dynamic of a species (1). Although most of the parameters of the population dynamic could have been examined in annual experiments, investigating them in a long-term experiment ensures that they are always influenced and compared with the ongoing development of the system. In the actual case, the viability of the seeds in the crops seems to be the most important reason for different development. Almost independent from the plants emerging in spring, seed production in barley cannot maintain the seed bank in the soil. The observed data was used for simulating the long-term development of weed populations (4). So far these nummerical simulations are not qualified for detailed predictions of e.g. annual infestations. However, they show that the apprehension, controlling A. spica-venti according to economic thresholds in cereals generally increases weed populations and can thereby cause more problems and costs of control in future, is not justified.

References

1. Fernandez-Quintanilla, C. (1988) Studying the population dynamics of weeds. Weed Research 28, 443-447.
2. Franz, K., Kaiser, F. and B. Gerowitt (1990) Einfluss unterschiedlich hoher Stickstoffdüngung auf die phänologische Entwicklung und die Samenbildung ausgewählter Unkrautarten im Winterweizen. Zeitschrift Pflanzenkrankheiten und Pflanzenschutz, Sh. XII, 127-135.
3. Gerowitt, B. and R. Heitefuss (1990) Weed economic thresholds in the F. R. Germany. Crop Protection 9, 323-331.
4. Heitefuss, R.; H. Bodendörfer and B. Gerowitt and F. Kaiser (1990): Langfristige Entwicklung und Siumlation einer Unkrautpopulation in der Fruchtfolge Rüben-Weizen-Gerste bei unterschiedlicher Häufigkeit der Bekämpfung. Proceedings EWRS-Symposium, 153-161.