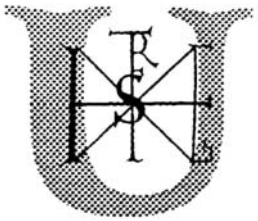

SZENT ISTVÁN EGYETEM

ANALYSIS OF WEED FLORA OF ECOLOGICAL FARMING SYSTEM AT THE ECOLOGICAL MODEL FARM OF KISHANTOS

Abstract of the thesis PhD.

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1. Antecedents and aims of work

Most part of Hungarian landscape is utilized by agriculture. More and more agricultural areas are situated on some ecologically important places, which is strongly influencing the way of farming system at the given area. Agricultural production and nature-protection have to find a long-term cooperation, since biodiversity can hardly be maintained without active contribution of the farmers.

In Hungary, initiations of ecological farming began only at the middle of 1980s, so there is little information about this system. Concerning to Hungary, there has been no comprehensive scientific study on the weed fora of ecological fields. After joining the EU, several chemicals were banned, so more and more emphasis is taken on agrotecnical methods, mechanical weed-control and combination of mechanical and chemical weed control. Methods used in ecological farming can amend the herbicides effectively, thus decreasing the use of chemicals and the burdening of environment.

The primer aim of my research was to demonstrate the weed-flora of an area which has been maintaining ecological farming for more than 10 years, and I also examined the effect of conventional and ecological farming system – which totally differ from each other conceptionally and in the manner of production as well – on the weed-flora of a given area.

Based on the results of my 4 year-long weed survey in different cultures of the 2 systems, further aims were to answer the following questions:

- Which are the typical weed species of the different cultures of ecological farming, and what is the extent of their covering,
- Does the composition of weed species and weed covering change after switching from conventional farming to ecological system,
- Is 15 years of ecological farming enough to evolve a more diverse weed flora at the given area,
- Does any interesting, rare of protected weed species turn up at the herbicide-free fields or margins,
- Can weed control without herbicides keep the weeds at an accpeteble level in different cultures,
- Which are the dangerous and important species of ecological farming system,
- Is there any difference between conventional and ecological systems regarding composition of weed flora and weed covering?

2. Material and method

My particular study was carried out at the Ecological Model Farm of Kishantos, which has been maintaining ecological farming for more than ten years, and my survey also spread through the neighbouring private field which is cultivated conventionally. From the aspect of my study it is important that on both areas with almost the same agro-ecological characteristics, following the prescribed technologies, a really up-to-par production is maintained.

On the ecological fields the structure of plants is very diverse, crop rotation plays a very important role. They mainly deal with field-grown plantd, but also deal with seed-production. Weed control is managed by agrotechnical and mechanical methods. In the conventional system only a small range of plants are grown, they mainly concentrate on winter-wheat and corn. Herbicides take up most part of the weed control. Important is that this study examines and describes the weed-situations of 2 functioning farms, so it reflects an extant status, and does not analyze an artificially installed experiment.

2.1. Method of weed survey

During my weed surveys I applied the method based on the evaluation of covering percentage, which has the advantage of being simple and quick. During the survey field-margins – which meant the area within 2m distance from the sides of the field – and the inner area were also investigated. Two repeats were done in the margins, and four in the inner area of the field, because regarding weedyness the fields were relatively homogen. On the two neighbouring fields with different farming systems I made a moer detailed survey: four trials at the margins and twelwe at the inner area. In each survey, the examination area of an 1 m^2 square was assigned randomly, and the weed-covering was determined by estimation. Covering rate of the single weed species was recorded by direct covering percentage. The weed-surveys were made between 200 and 2003, three or four times at every growing-season, so that I could obtain information about the weed species through the whole growing-season. Wherever it was possible, weed-flora of the stubbles was also investigated.

2.2. Wees-seed content of the soil

Germination-method was chosen to evaluate weed-seed content of soil. Soil samples were taken from the more detailedly examined ecological and the neighbouring conventional fields in April 2003. 12-12 samlpes were taken from the fields and 4-4 from the margins. After homogenization, samples were placed into separate flower-boxes according to the place of origin of the soil, and at the end, seedlings were determined by species, and counted.

2.3. Procession of data, assessment

I summed the weed species and their average covering rate at the field cultures at the different phases of survey in tables, and I also presented the data graphically. In the ecological farm winter wheat was present at all the four experimental year, so it was possible to make a statistical comparison of the weed species and their covering rate in the different years. Besides this, standard deviations of the samples were also calculated, and data were illustrated in Boxplot-diagrams.

For comparing ecological and conventional farming as two big groups, discriminant analysis proved to be the most adequate, for this method examines relationship between the factors by multifactorial method, and the factors taken into account together and not separately. I performed discriminant analysis to determine whether a function - including the factors: number of weed species at the margins, number of weed species in spring and in summer, weed covering in spring and in summer, and yield – can make a distinction between ecological and conventional farming. Four years' data were available for the comparison. Importance of the different factors in separating the two systems was characterized by F-value and Wilks-lambda index. Correlation of each factor with the canonical variable within the group made it possible to study the importance of the distinct factors in the discriminant function. Significant difference between group-centroids was invetigated with canonical correlation and χ^2 probe of Wilks lambda.

3. Results

Winter wheat was present on some of the ecological fields in all the four experimental years (2000-2003), so I continually examined weed-flora of this culture. Greatest difference between average number of species, and average weed-cover was found in year 2000. This year had an extremely dry weather, making the number of weed species – besides the vegetating winter wheat – also less. The average number of weed species was 4,34 in 2000. However the covering rate of these species in winter wheat was much bigger in this year than in the other three years. Year 2001 was rich in precipitation, enhancing shooting of the weeds. A 2001-es év bő csapadékot hozott és a gyomkelést erőteljesen fokozta. Average number of weed species was almost doubled, but the weed covering was only half as much as in the previous year. No difference showed up in the average weed cover between the period 2001 and 2003, and the average number of weed species showed decreasing a tendency of decreasing.

After the statistical analysis of number of weed species and weed covering values in winter wheat in the 4 experimental years, it turned out that average number of species was twice as big in the margins than in the inner areas, which means that weed flore was more diverse in the margins. Inside the field weed flora was the most diverse at spearing, but in spite of higher number of species

(7,5) the average covering was low (2,14%). Highest level of weed covering (5,23%) was found ont he stubbles, but less species (6,75) were represented in this greater covering.

Besides corn, sweet corn and hybrid corn were also grown in the ecological farm. The same weed species were present in the corn fields studied in 2000 and 2001. Among perennial species a *Convolvulus arvensis* was present during the whole vegetation, but *Sorghum halepense* turned up only at the survey in July. The other species all belonged to T_4 type, which are mostly typical of stoop-crops. Among these *Amaranthus retroflexus* gave the greatest covering (3,25%), the covering rate of the other species usually remained bellow 1%. In sweet corn *Amaranthus retroflexus* and *Chenopodium album* showed bigger covering rate during the surveys. In the hybrid culture the T_4 type of weeds were dominating, which are really characteristic of stoop-cultures. Among perennial weeds *Convolvulus arvensis* was most widespread. *Ambrosia artemisiifolia* and *Chenopodium album* were present on the whole field, with covering rates of 4-5%, and 2-3%.

In sunflower stand most of the surveyed species belonged to mono- and dicotyledonous T_4 type. Among the former mentioned *Echinocloa crus-galli,* and among the later mentioned *Amaranthus ssp., Chenopodium ssp.* and *Datura stramonium* had the most important covering *rate.* Among the late-summer weeds *Ambrosia artemisiifolia* the dangerous and hard-to-control weed of sunflower is also worth to mention. Members of T_3 type such as *Sinapis arvensis* or *Raphanus raphanistrum* were missing from the field. Among perennials belonging to G_1 type, *Sorghum halepense* is worth mentioning. In sunflower stands the number of weed species was generally low (8-10), but in year 2001 the covering of these species exceeded the critical 10 % in the surveyed field.

Spelt, spring wheat and oat proved to be more weedy than winter wheat, since the weed-suppressing ability of these species is weaker than that of winter cereals. In the different phases of survey the total weed-cover showed an ascendent tendency, which reached even 13,50 % in the stubble. In spelt field two typical cereal-weed species were represented with 0,10 % covering rate: *Anthemis austriaca* and *Consolida regalis*. The number of weed species was low (6-7) in spring wheat, most of these belonging to T_4 type. Among these, average covering of *Ambrosia artemisiifolia* was extremely high in April, reaching 12,50 %. In the oat sown in 2001, also the members of T_4 type were dominating, and their covering rate did not exceed 1,00 %. Flax surveyed in 2002 is a good example for the event that in case one of the procedures of weed controldrops out, the weed covering reaches very high level. In flax because of the great rush of work, weed harrow dropped out of the system, causing a total weed covering of 30,00 %. This great level of weedyness was not accompanied by extremely high number of weed species, since 13 species represented the total weed-range. The weed-flora of soybean was very similar to that of spring stoop cultures, weed flora mainly consisted of late-summer annual weeds, belonging to T_4 type. *Amaranthus retroflexus Chenopodium album* and *Datura stramonium* appeared in greater amount. In 2003, spring vetch

was sown into the ecological field for seed production, and also oat as supporting plant. Weed covering was low within the field, but weed cover registrated in the margins showed much higher level (14,70 %), which was partly caused by the badly sown, rare plant-stand.

Discriminant analysis was performed to compare ecological field with the neighbouring conventional one. In this analysis 8 cultures were analysed, which were – depending on the method of farming system – divided into 2 groups. One of the groups consisted of the 4 ecological (winter wheat, pea, spring wheat, flax), and the other consisted of the 4 conventional (winter wheat, pea, spring wheat, corn) cultures. Testing the equality of group means, according to F-values I could determine significant differences at P=5 % between the 2 groups (farming systems) in case of the following factors: number of weed species in spring, number of weed species in the margins, and yield. Wilks-lambda index of the distinct variables (number of weed species in summer, spring, and in the margins, weed cover in summer and in sprind, yield), in accordance with F values showed the greatest difference between the groups in the factor of yield, but also indicated differences in case of number of weed species in sprind and in the margins.

Weed-seed storages of both ecological and conventional fields consisted of low number of species, but more species were detected in the ecological soil samples. All the shot plants belonged to the range of „common" weeds.

3.1. New scientific results

1. In ecological winter wheat fields, statistical analysis of the data of 4 years, I confirm that average number of species (7,5) and also the lowest level of weed covering was found at spearing-stage (2,14 %). Highest level of weed covering (5,23 %) was found in the stubble, but this greater level of weedyness was caused by lower number of species (6,75).

2. I registrated low number of weed species in ecological cultures (5-15 species, depending on the culture), so 12 years of ecological farming did not result a moer diverse weed flora, not any rare or interesting species appeared on the surveyed area.

3. I assessed that weedyness can be kept at acceptable level without herbicides, because agrotechnical and mechanical methods can impowerish weed flora.

4. Discriminant analysis showed significant differences between ecological and conventional farming. According to F-values and Wilks-lambda, significant differences were found in case of yield (F=38,510, Wilks lambda=0,135, number of weed species in the margins (F=8,528, Wilks

lambda=0,413), number of weed species in spring (F=8,528, Wilks lambda=0,413), which are at the same time the most proper factors to divide the 2 farming systems.

5. I determined that in the weed flora and in the soil samples of both ecological and conventional fields members of T_4 life-type were dominating, among which *Ambrosia artemisiifolia* caused the greatest level of infection.

4. Conclusions and suggestions

Before covnerting into ecological farming, intensive farmnig had been carried out for at least 25 years on the area of Kishantos Ecological Model Farm, the effect of which is still visible in the weed flora of the fields. The number of weed species is still low int he ecological fields, and all of them belong to the „ common" widespread weed species. It seems that 15 years of herbicide-free period is still too short to evolve a greater level of weed-diversity, and also for the appearance of rare species.

The ecological farm is surrounded by herbicide-utilizing fields, and wattle-forests with a low number of species, which is also inhibiting the improving of diversity of weed flora, because no special or protected species are expected to settle in from those areas. It must also be taken into consideration that even in ecological farming the primer aim is improve competiting ability of cultivated plants over against weeds, so fighting off the weedyness by agrotechnical and mechanical methods. These methods also mean a permanent selection-pressure on weeds, among which some species tolerate tampering better than others, thus besides herbicide-treatment, cultivation itself can also cause desrease of weed diversity. Though herbicides must have pressed forward the disappearing of some species, cultivation itself also has an effect on it.

Data of weed surveys confirm that in case of agrotechnical and mechanical weed control only a few species can maintain their existence, and these all belong to the best-adapting species. Not even the siol contains any weed-seed storage, from which new species could emerge. This all confirm that decrease of weed diversity is caused by many factors.

Among the cultivated plants grown in the ecological fields, there are some cultures in which weeds can easily be controlled, but in some of them, weeds are really hard to control

Among the cultures of these fields, pea and flax were the most problemful species, because these stands were quite poor because of the unfavourable weather after sowing, and therefore weeds were able to gain greater area

Regarding weedyness, cereal cultures proved to be the „cleanest". Single usage of weed harrow – as a mechanical tool against weeds – had a satisfactory effect at the beginning of vegetation, and

later, weed-suppressing ability of cereals was proper enough. After statistical analysis of the data of the 4-year-long weed survey, it can be concluded that a more diverse flora formed at spearing, but weed covering remained at a low level. Less species were present on the stubbles, but total weed cover was greater.

In stoop cultures (forage and sweet corn, sunflower, soybean) weeds caused more problem, therefore more treatments were necessarry to keep weeds at acceptable level. The most problem was caused by the perennial *Cirsium arvense,* which formed big spots in some fields. On the whole, stoop cultures had higher weed-cover that cereals, but by proper use of available tools, and by supplementary manual hoeing against dangerous species (*Ambrosia artemisiifolia*, *Cirsium arvense*, *Datura stramonium*, *Sorghum halepense*) these areas could be kept in proper condition.

After some years of consequent keeping the principles of ecological farming, and professional use of available weed control methods, ecological farming system can keep weedyness at accapteble level.

Among others, the following things are necessarry for that:

- Well-planned crop rotation,
- To choose the proper tools and number of cultivation processes to improve consistence of soil, and soil-life,
- Purchase of the best tool-stores for mechanical tillage.

Ecological and conventional farming as 2 big groups were compared by discriminant analysis. The analysis revealed the importance of different factors (yield, number of weed species in the margins, number of weed species in spring and in summer, weed covering in spring and in summer) in dividing the two farming systems. According to my conclusions all the six factors had a role in differentiating the two systems, but significant differences were found only in case of yield, number of weed species in the margins, and number of weed species in spring.

5. Publications

Lectored publications:

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3. Dorner Z., Blaskó D. és Németh I. (2003): Kalászos kultúrák gyomnövényzete herbicidmentes művelés esetén. Növényvédelem. 39. 12. 607-612.
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5. Dorner Z., Németh I., Blaskó D. and Farkas A. (2004): Effect of extensive farming on weed composition in cereals in Hungary. Journal of Plant Diseases and Protection XIX. 113-117.
6. Németh I. and Dorner Z. (2004): Possibilities for biological weed control. Herbologija Vol. 5. No. 1, 95-101.
7. Németh I. és Dorner Z. (2004): A gyomflórában bekövetkezett változások valódi okai. Növénytermelés. 53. 5. 403-524.
8. Dorner Z. és Németh I. (2004): Az ökológiai és konvencionális gazdálkodású területek talajának és gyommagkészletének vizsgálata. Növényvédelem. 40. 10. 499-503.

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3. Dorner Z. és Németh I. (2004): Az ökológiai és konvencionális gazdálkodású területek talajának és gyommagkészletének vizsgálata. 50. Növényvédelmi Tudományos Napok, Összefoglaló. 117.
4. Németh I. és Dorner Z. (2004): A gyomflóraváltozások valódi okai. 50. NövényvédelmiTudományos Napok, Összefoglaló. 128.

Other publications:

1. Farkas A. and Dornerné Fejős Z. (2003): Effect of different soil tillage and fertilisation levels on soil cover of *Ambrosia artemisifolia.* 7th European Weed Research SocietyMediterranean Symposium Proceedings 21-22.
2. Dorner Z. (2000-2004): Gyomnövényeket és védett növényfajokat bemutató cikksorozat a Tápió-vidéken megjelenő közéleti lapban.