# Results of weed surveys for different land uses

## *Gyomfelvételezések eredményei eltérő talajhasználatnál*

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**Abstract:** Different land use patterns have a significant impact on the weed flora of agricultural land. Tillage, fertilisation and crop rotation have an important role to play in reducing weed infestation. The effects of conventional ploughing and reduced tillage (min-till) on weed control in maize fields were investigated in a maize-wheat biculture with different nitrogen application rates in a long-term Soil Tillage field Experiment set up in Keszthely, Hungary in 2023 and 2024. The results showed that either tillage or fertilizer use had an effect in minimizing weed infestation.

***Keywords****: tillage, min-till, fertilizer, maize, weed cover*

**Összefoglalás:** Az eltérő talajhasználati módok jelentősen befolyásolják a mezőgazdasági területek gyomviszonyait. A talajművelésnek, a műtrágyázásnak és a vetésváltásnak fontos szerepe van a gyomosodás visszaszorításában. A keszthelyi Talajművelési Tartamkísérletben 2023-ban és 2024-ben vizsgáltuk a kukorica területeken a hagyományos szántásos talajművelés és redukált (min-till) talajművelés gyomosodásra kifejtett hatását, bikultúrás termesztésben, eltérő nitrogén adagok kijuttatása mellett. A kapott eredmények rámutattak, hogy nem elhanyogolható a talajművelés és az okszerű műtrágya használat a gyomosodás minimalizálásának érdekében.

***Kulcsszavak****: talajművelés, min-till, műtrágya, kukorica, gyomosodás*

### 1 Introduction

Throughout the history of agriculture, the purpose of tillage has been to prevent, or at least minimise, the damage caused by weeds to the crop.Tillage can kill weeds by breaking them up, tearing them apart or pulling them out of the soil, causing them to dry out (desiccation), covering the soft tissues with soil, inhibiting photosynthesis and depleting stored nutrient reserves. It has been shown that proper soil tillage reduces the weed seedbank, as well as the number of vegetative reproductive formations in the soil. Weed seeds brought close to the soil surface by tillage can germinate and be killed by repeated tillage (Hunyadi et al., 2000).

The importance of tillage is its weed controlling effect on the area, such as ploughing or disking (Ujvárosi, 1973). The weed control effects of conventional, min-till and no-till systems have been investigated (Tuesca et al, 2001; Shrestha et al., 2002; Kismányoky, 2010). The results of several studies support the idea that conventional inversion tillage has a weed-controlling effect, whereas no tillage can be considered as weed-supportive technology (Kismányoky, 2010).

Autumn deep ploughing is of great importance for deep-rooted perennial weeds. In addition to deep ploughing in autumn, spring seedbed preparation is also important, because if deep ploughing is carried out early in autumn, several weeds, mainly of $T_1$ and even $T_2$ life forms, may emerge in autumn, but these can be controlled by spring seedbed preparation (Hunyadi et al., 2000).

It is important to note that the negative effects of weed competition for nutrients cannot be counteracted by increasing soil nutrient content alone, since weeds are very strong competitors and use available nutrients in extra quantities compared to cultivated plants (Vengris et al., 1955). The former statement is also supported by the finding that weeds often absorb nutrients faster and in larger quantities than cultivated plants. Thus, fertilization of weeds with high weed cover stimulates their development to such an extent that they outgrow and suppress the cultivated plants (Alkämper, 1976).

There are, however, cases where the optimal rate of fertilizer, or even the timing of application, helps to control weeds and reduce their harmful effects on the crop.

A study in maize showed that the increase in yield with N fertilizer was much more pronounced than the development of monocotyledonous weeds (Nieto-Staniforth, 1961). In studies in wheat, it was found that the number of weed species and their biomass was significantly reduced with increasing N fertilizer rates (Lehoczky, 1995).

Ultimately, it can be concluded that increasing nutrient supply does not control weeds, i.e. it is not a substitute for other control methods, since in most cases it only increases the high nutrient uptake by weeds and promotes their intensive growth. As described so far, the correct application of phosphorus and nitrogen can be incorporated into integrated weed management in some cases. Since most of our soils are moderately well supplied with phosphorus, its control is not really feasible, while nitrogen, which does not accumulate in the soil, is easier to control (Hunyadi et al., 2000).

## 2 Materials and Methods

The studies were carried out in the Keszthely Soil Tillage Experiment, managed by the Institute of Agronomy, Georgikon Campus, Keszthely, Hungarian University of Agricultural and Life Sciences, which was set up in 1972 to develop time and energy saving methods for different tillage methods and different nitrogen fertilizer rates. The experiment has a two-factor split-plot design with four replicates in which three different tillage variants and five different rates of nitrogen fertilizer are studied on winter wheat and maize indicator crops. The winter wheat and maize are rotated every two years (winter wheat- winter wheat- maize- maize) in a bicultural system. Three different tillage options are used in the trial: conventional deep inversion tillage in autumn, shallow disk tillage in autumn and minimum tillage system,(min-till), also disking just before drilling. The same crop protection treatment was applied to all plots in the area, and fertilizers with the active ingredients $P_2O_5$ and $K_2O$ were applied uniformly at a rate of 100-100 kg/ha.

We continued our studies in the maize crop in 2023 and 2024, Previous crop of maize was winter wheat (2023) and then (2024). For the experiment evaluation, we compared the conventional tillage and minimum tillage systems.

N Fertilizer rates:

- B1: 0 kg/ha
- B2: 120 kg/ha
- B3: 180 kg/ha
- B4: 240 kg/ha
- B5: 300 kg/ha

Weed surveys were carried out using the Balázs - Ujvárosi method at different stages of maize development. Timing of weed surveys: early summer (8-10 leaf developement stage) and flowering. In presenting the results, we would like to present the results of the maize at flowering, since at this stage we have no control of weeds and the maize absorbs most of the nutrients until the end of flowering, so these data are also important for competition.

## 3 Results

In 2023, winter wheat was the preceeding crop before maize in the Keszthely Soil Tillage long-term field experiment. Weed surveys were carried out at the time of maize flowering (Figure 1.). The results showed that the average weed cover was lower in the conventional tillage fields than in the reduced tillage fields. For both tillage systems, weed cover was highest where no nitrogen fertiliser was applied. Among the ploughed plots, the lowest average weed cover was found in treatment B3 with 180 kg nitrogen/ha, whereas in the Min-Till treatment, the lowest average weed cover was found in treatment B5 (300 kg/ha).

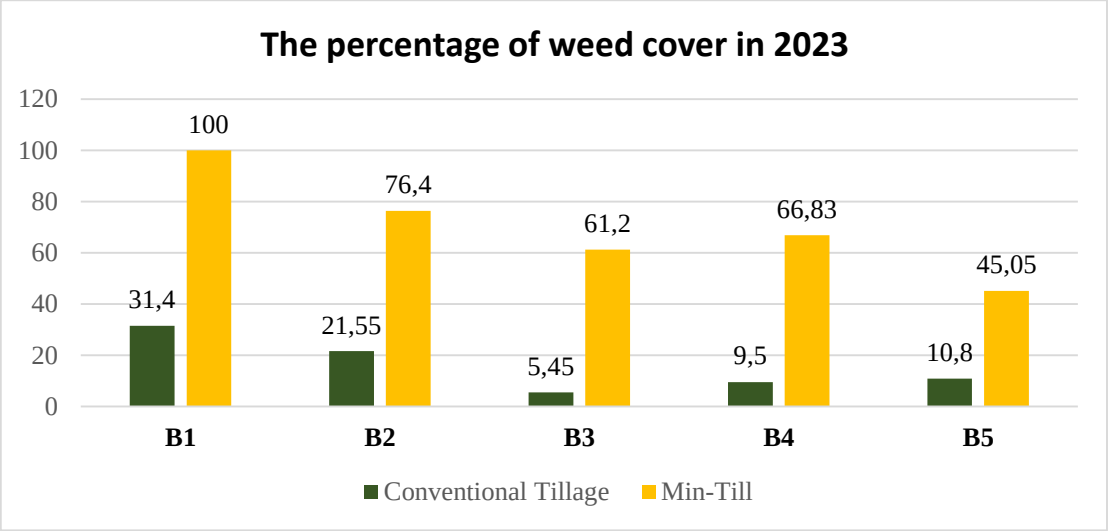


***Figure 1*** *The percentage (%) of weed cover in 2023*

In the year 2024, maize followed itself. The results of the weed surveys carried out at flowering are shown in Figure 2. The results were similar to 2023, as again the conventional inversion tillage resulted in lower weed infestation than the reduced tillage plots in all treatments. However, in contrast to 2023, the ploughed areas had the lowest weed cover at the highest applied nitrogen rates (300 kg/ha), while the highest was also where no nitrogen fertiliser was applied. In the min-till fields, similar results were obtained as in the conventional fields, as the highest weed infestation was also in the untreated fields and the lowest in the 300 kg/ha treatment.

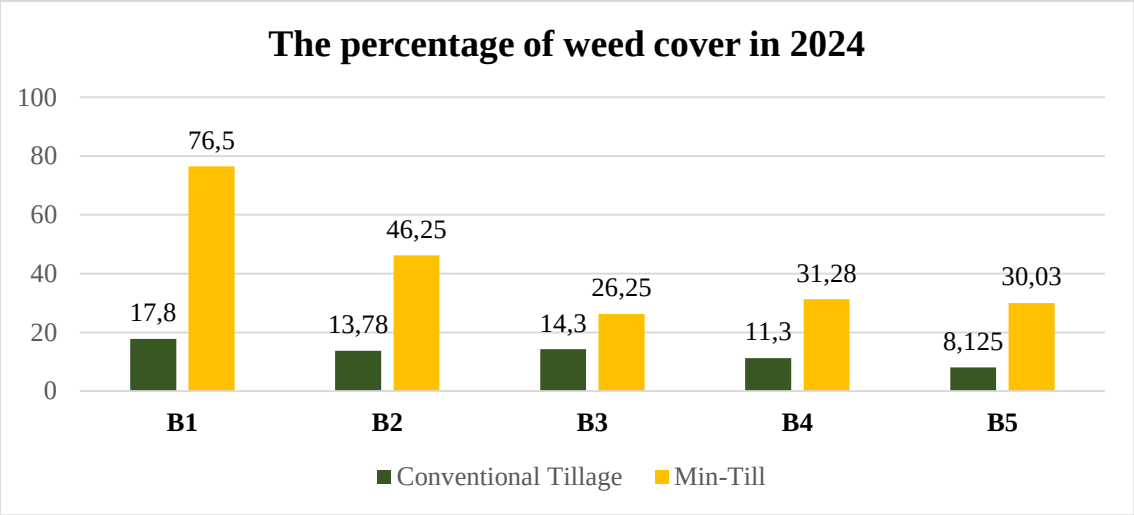


***Figure 2*** *The percentage of weed cover in 2024.*

**Table 1 Average weed cover of the main weeds in the experiment by treatment and tillage type**

| | Average weed cover (%) | | | | | | | | | | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | B1 | | B2 | | B3 | | B4 | | B5 | | |
| | Conventional tillage | Min-Till | Conventional tillage | Min-Till | Conventional tillage | Min-Till | Conventional tillage | Min-Till | Conventional tillage | Min-Till | |
| *Digitaria sanguinalis* | 10 | 4 | 2 | 5 | 0,5 | 15 | 1,05 | 8,3 | 2,55 | 4 | 2023 |
| | 3,4 | 6,5 | 3,75 | 15 | 3,5 | 2 | 3,3 | 7,5 | 2,37 | 6,67 | 2024 |
| *Echinochloa crus-galli* | - | 2 | 0,1 | 10 | 0,1 | - | 5 | - | 0,1 | 2,5 | 2023 |
| | 5 | - | 0,1 | 2 | 1 | 3 | 1 | 1 | 2 | - | 2024 |
| *Setaria pumila* | - | 10 | 5 | 6,6 | 2,5 | 5 | 1,87 | 10 | 1,86 | 10 | 2023 |
| | 7 | 15,75 | 2 | 13 | 3 | 4 | 3,5 | 7,3 | 2,025 | 6,75 | 2024 |
| *Setaria viridis* | 6,7 | 6 | 3,5 | 5 | 0,1 | 1 | - | 5 | 0,1 | 5 | 2023 |
| | 2 | 5 | 2 | 4 | 2 | 5 | - | - | 1,05 | - | 2024 |
| *Panicum miliaceum* | 15 | 3,5 | 5 | - | - | - | - | 12,5 | - | - | 2023 |
| | - | - | - | - | 0,1 | - | - | - | 1 | - | 2024 |
| *Ambrosia artemisiifolia* | 6,7 | 13,3 | 2,5 | 8,3 | 0,1 | 0,1 | - | 6,6 | - | 8,3 | 2023 |
| | - | 27,3 | - | 2 | 10 | - | 2 | - | 2 | - | 2024 |
| *Polygonum aviculare* | 6,7 | - | 8,3 | - | 1,73 | 5 | 5 | 8,3 | 8,33 | - | 2023 |
| | - | - | - | - | - | - | 0,1 | - | - | - | 2024 |
| *Convolvulus arvensis* | 6,7 | 25 | 5 | 30 | 3,37 | 28,3 | 5 | 21,6 | 3,5 | 20 | 2023 |
| | 6,5 | 9,75 | 4,75 | 10 | 10 | 18 | 3,5 | 13,3 | 4 | 8,25 | 2024 |
| *Cirsium arvense* | 5 | 18,36 | 2,55 | 13,3 | - | 13 | - | 5 | 0,1 | 13,36 | 2023 |
| | 6 | 16 | 1 | 9 | 8 | 4 | 5 | 10 | - | 9,3 | 2024 |

The first table shows the main weeds that were prominent in the fields. The table shows the average percentage cover of weeds by year and by treatment. The presence of *Digitaria sanguinalis* is outstanding, being present in the fields in all treatments in both years. In 2023, it was present in all but the B1 treatment with lower cover in ploughed fields than in min-till fields. *Setaria pumila* is also an important monocot weed, as it was present in min-till fields in all years, in all treatments, and its percent cover exceeded the results in conventional tillage fields with the same nitrogen supply. *Panicum miliaceum*, which is emerging as an increasingly important species in the weed flora of domestic maize production, was more abundant in the 2023 year of the tank trial, while in the 2024 year it was only marginally present. It is worth pointing out that *Polygonom aviculare* was present in all treatments in the year 2023, when winter wheat was the pre-sown maize in the ploughed fields, but in the min-till fields it was only present in treatments B3 (5%) and B4 (8.3%). Conversely, in 2024, it appeared only in the conventional tillage B4 treatment with an average cover of 0,1%.

Examining the data on perennial weeds, we found that *Cirsium arvense* and *Convolvulus arvensis* were the most important, but *Lathyrus tuberosus*, *Cynodon dactylon* and *Plantago major* species were also present in the areas, but their presence was more significant in the min-till areas. *Convolvulus arvensis* was present in all plots in both years, irrespective of tillage and nitrogen treatment, but it is important to highlight that it was more dominant in the min-till areas than in the ploughed areas under the different treatments. *Cirsum arvense* never exceeded an average cover percentage of 10% in conventionally tilled areas and its presence was most significant in the year 2024, when maize was followed by maize. Based on the weed survey results for the min-till cultivated areas, it can be said that *Cirsium arvense* was present in all years, in all treatments and most often had a higher percent cover than in the ploughed areas.

## 4 Discussion

Long-term field experiments are of particular importance as they provide essential information and shed light on relationships that cannot be studied in short-term experiments, or only incompletely. It is possible to study the biological and physical parameters of the soil and the results obtained can be useful not only for farmers and researchers, but also as a basis for sustainable agricultural production (Kismányoky-Jolánkai, 2009). In the long-term experiments, we investigated the maize fields of the years 2023 and 2024 from the point of view of weed infestation. The weather in the growing season of the two years was extremely different, which may have had a major impact on the development of the weed flora, which is beneficial for us because it gives a more complex picture of the factors influencing weed infestation. Summarizing the results, we can say that, independent of the effect of the year, the average weed cover was significantly higher in the reduced tillage areas than in the conventional inversion tillage areas. However, it can also be concluded that the growing season 2024 was drier, but with lower weed cover in all treatments in the min-till fields than in the previous year, but not in the conventional fields. The results of the different nitrogen treatments also show that fertilisation can have a significant effect on the development of weed flora, because, as fertilisers help plants to grow intensively, they can easily compete with weeds and then suppress them. In all cases, weed cover was higher where nitrogen fertiliser was not applied, but ploughing was also found to be better in terms of weed control in untreated areas.

In the areas studied, $T_4$ weed species typical of the domestic maize areas were common, among which it is important to highlight the monocots, which are very difficult to control by maize growers. Both *Digitaria sanguinalis* and *Setaria pumila* have higher average weed infestations with Min-Till than with conventional tillage, so it is possible that rotational tillage can help to control these species. *Cirsium arvense* and *Convolvulus arvensis* were also present in the plots studied and are important perennial weed species in maize production, which can only be effectively controlled by chemical means. The experiment showed that the application of nitrogen fertilizers and inversion tillage can help to control these weed species.

In the future, we would like to continue these studies, complemented by soil weed stock studies, and to investigate the N, P and K content of maize plants and weeds to get a more complex picture of the effects of different soil uses and to apply the knowledge gained for sustainable crop production.

## References

Alkämper, J. 1976. Influence of weed infestation on yield of fertilizer dressings. *Pflanzenschutz Nachrichten*. **29** 191–235.

Hunyadi, K., Béres, I. and Kazinczi, G. 2000. Gyomnövények, gyomirtás, gyom-biológia. Mezőgazda Kiadó, Budapest.

Kismányoky, A. 2010. Agrotechnikai tényezők hatása a kultúrnövényekre és a gyomosodásra. Doktori értekezés, Keszthely

Kismányoky, T. and Jolánkai, M. 2009. Az Országos Műtrágyázási Tartamkísérletek. (Szerk.: Debreczeni B.-né) 25–33.

Lehoczky, É. 1995. Effect of nitrogen fertilization on crop-weed competition. 9Th EWRS Symposium, Budapest, 577–583.

Nieto, J. H. and Staniforth, D. W. 1961. Corn-foxtail competitions under various pro-duction conditions. *Agron. J.* **53** (1) 1–5. https://doi.org/10.2134/agronj1961.00021962005300010001x

Shrestha, A., Knezevic, S. Z., Roy, R. C., Ball-Coelho, B. R. and Swanton, C. J. 2002. Effect of soil tillage, cover crop and crop rotation on the composition of weed flora in sandy soil. *Weed Research.* **42** (1) 76–78. https://doi.org/10.1046/j.1365-3180.2002.00264.x

Tuesca, D., Puricelli, E. and Papa, J. C. 2001. A long-term study of weed flora shifts in different tillag systems. *Weed Research.* **41** (4) 369–382. https://doi.org/10.1046/j.1365–3180.2001.00245.x

Ujvárosi, M. 1973. Gyomnövények. Mezőgazdasági Kiadó, Budapest. p. 833.

Vengris, J., Colby, W. G. and Drake, M. 1955. Plant nutrient competition between weeds and corn. *Agron. J.* **47** (5) 213–216. https://doi.org/10.2134/agronj1955.00021962004700050005x