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INFLUENCE OF FARMING SYSTEMS ON THE NUMBER AND BIODIVERSITY OF WEED SEEDS IN A SOIL BANK

WPŁYW RODZAJU UPRAWY NA LICZEBNOŚĆ I BIORÓŻNORODNOŚĆ NASION CHWASTÓW W BANKU GLEBOWYM

Abstract: 30÷60% seeds located in a soil bank can be eliminated through farming within one vegetative period. Fallowing and mineral fertilisation applied prior to planting may accelerate this process causing considerable seed reduction in an arable soil layer. In order to identify the above-mentioned dependences, in pot experiments conducted in the years 2002-2004 arrangement structure, size and diversity of soil seed bank in soil samples from fields in Przylek were distinguished and compared. On examined samples potatoes and wheat were cultivated in a crop rotation system and wheat in monoculture using various management systems. As a result of the conducted experiments on soil from the field of an extensive farming system there germinated 1382 weed pieces/m^2, and on samples with an intensive farming germinated 3129 weed pieces/m^2. In an extensive farming system there registered 9 weed species. Dominant species were *Chenopodium album*, *Apera spica venti*, and *Anthemide* spp. and on samples from fields of an intensive farming system 12 weed species, of which in the greatest intensification appeared *Chenopodium album*, *Galinsoga parviflora*, *Anthemide* spp. and *Apera spica venti*. The fallowing process lasting for 72 days used in the experiment increased the number of plant germinations depending on examined samples by 15.5 to 24.4%. The attained results indicated that this method of plant farming substantially influences the number and diversity of seeds of weed species existing in an arable soil layer.

Keywords: soil weed seed bank, mechanical tillage, weed seed emergence, ecological weeding

The growth of weeds in a cultivated plant area is influenced by weeds occurring in vegetation period in a given year and by a constantly changing seed bank in an arable soil layer [1-4]. The most essential influence on weed growth in fields are segetal weeds which are adjusted to conditions of cultivated plants growth and ruderal weeds existing in unfarmed areas. The seed number produced by a given weed species depends among other things on the length of vegetation period, the content of available nutrients in the soil, climatic conditions and agrotechnology and on soil structure, soil moisture, surface shape and farming systems [4-6]. The use of simplifications in farming increases the number of weed species in a cultivated plant field, also increasing the contribution of dominant species. As a result of disrupted biodiversity natural mechanisms of plant self-regulation do not function (or function very poorly) in agrocenoses of an intensive farming system [7].

Methods

Soil samples for laboratory research were taken twice from fields with extensive farming (26.10.2002) and intensive farming (13.11.2002). In both cases the soil at mass of 1 kg was taken in four places, each at depth of 0÷10 cm. The soil was placed in pots at a height of 10 cm constituting two objects (extensive and intensive) divided into 4 trials + control, each in 5 repetitions.

The germination and growth of plants were observed for a few periods (cycles), each of which lasted for about six weeks. After each of the periods an analysis of the

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intensification of weeds was conducted which determined the spectrum of species, number of sprouts and development phase. In order to accelerate the germination after each analysis, the soil in pots was mixed. After the fifth analysis fallowing was applied, which lasted for 72 days. The research conducted was with optimal photoperiod and relative humidity.

In taken soil samples the pH was determined as well as the contents of humus, macroelements and microelements.

Results

In the field with extensive farming, farming of potatoes and winter wheat was conducted alternately. During the farming there applied in case of wheat ammonium nitrate prior to the sowing in the dose of 60 kg/ha and in case of potatoes manure in the amount of 2.6 Mg/ha. For 20 years on the intensive farming field farming of winter wheat was conducted, with farming of phacelia every 3-4 years. Polifoska was used as a fertiliser in the dose of 170 kg/ha and top dressing with urea fertiliser in the amount of 200 kg/ha. Weeds were fought on both objects with preparations: Aminopielik D and Chwastox D, in addition in intensive farming Arelon 75 WP, Dicuran forte 80 WP and Lentagran 45 WP were used.

Table 1

The results of the analyses of soil samples

Farming system	pH in 1 M KCl	Humus [%]	P_2O_5	K_2O	Mg	B	Mn	Cu	Zn	Fe	Cd	Cr	Ni	Pb
			[mg/100 g]			[mg/kg]								
extensive	3.6	1.64	12.9	23.3	7.3	0.93	108	2.0	17.7	510	0.47	23.2	3.0	16.3
intensive	3.2	1.5	7.0	15.0	4.0	0.96	93	1.7	12.5	467	0.52	22.5	4.5	13.0

The conducted research proved that (Table 1) both extensive and intensive soil were characterised by reaction very acid and low contents of humus. The content of phosphates in the soil of extensive farming was average, and low in the soil of intensive farming. In turn the abundance in potassium compounds was very high in extensive soil and high in intensive soil. The amounts of magnesium, however in both cases was average, boron and zinc - very high and iron and copper - low.

In conditions of conducted research in an extensive farming system soil there sprouted over twice (2.3 times) as fewer weeds than in intensive farming system soil (Table 2). Dicotyledones were dominant. They accounted for 63% of all the sprouts, of which the most numerous to appear were *Chenopodium album* L., *Galium aparine* L. and *Anthemide* spp. Monocotyledones were represented only by *Apera spica-venti* L.

On extensive farming system soil the dominant species accounted for 80% of all registered sprouts and prevailing were *Chenopodium album* L., *Galinsoga parviflora* Cav. and *Anthemide* spp. Monocotyledones were represented by *Apera spica-venti* L. and *Poa annua* L.

A considerable number of sprouts in soil taken from an intensive farming system field were caused by the system and the way of farming conducted in a given object. Wheat farmed in a monoculture, no-tillage farming system reduced species spectrum and caused accumulation of a considerable number of weed seeds in a surface soil layer.

The wider-applied programme of chemical weed control reduced the soil seed bank only in surface soil layers, however it did not influence seeds in a deeper soil layer. An example is the abundance of *Apera spica-venti* and *Chenopodium album* seeds in examined soil samples.

Table 2

General number of sprouts [piece/m^2] in examined soil samples

Plant species		**Farming system**	
		extensive	**intensive**
Monocotyledonous	*Apera spica venti*	373	332
	Poa annua	-	182
Dicotyledonous	*Chenopodium album*	842	1061
	Galinsoga parviflora	18	664
	Anthemide spp.	58	529
	Viola arvensis	13	155
	Thlaspi arvense	-	97
	Galium aparine	53	-
	Veronica hederifolia	-	35
	Stellaria media	4	25
	Capsella bursa pastoris	-	25
	Cirsum arvense	18	-
	Galeopsis tertahit	3	12
	Lamium purpureum	-	12

The fallowing applied in the course of the research that lasted for 72 days increased the sprout number depending on the examined samples by 15.5% to 24.4 % (Table 3).

Table 3

The influence of fallowing on dominant species sprouts [piece/m^2] in examined soil samples

Plant species		**Farming system**	
		extensive	**intensive**
monocotyledones	*Apera spica venti*	174	199
	Poa annua	-	-
dicotyledones	*Chenopodium album*	163	243
	Galinsoga parviflora	-	66
	Anthemide spp.	-	-
	Galium aparine	-	-

In an extensive farming system soil, after a farming break, there were noted sprouts of 337 plant pieces/m^2, which account for 24.4% of the total number of observed weeds. Only two weed species: *Apera spica-venti* and *Chenopodium album* responded positively to the fallowing, of which most numerously - in 47% - sprouted *Apera spica-venti*.

The fallowing on soil from the intensive farming field contributed to an increase in general number of sprouts by 16%. Three plant species: *Apera spica-venti*, *Chenopodium album* and *Galium aparine* responded to treatment applied after the break in experiments. The highest concentration of these sprouts, namely 60%, was *Apera spica-venti*.

The presented results point out that species composition and seed number in a soil bank depend on many factors, of which the farming type and system of cultivated plant are the most important. The use of extensive farming system favours weed abundance, which, however, can be reduced by suitably selected plant rotation and weed control programme. In an intensive farming system, especially with no-tillage sowing and monoculture, weed seeds, due to the reduced number of mechanical cultivation, do not have adequate sprout conditions, especially those from deeper layers. Therefore, an effective programme to reduce weed seed number is difficult to elaborate.

Conclusions

1. During laboratory research (2002-2004) on soil samples from extensive and intensive system fields there sprouted, respectively: 1382 pieces/m^2 and 3129 pieces/m^2 of weeds.
2. The fallowing lasted for 72 days and the following farming treatment contributed to an increase of total sprout number by 15.5÷24.4% plants.
3. *Apera spica-venti,* regardless of soil type, was most powerfully stimulated by treatment conducted after fallowing.
4. The achieved findings suggest that the farming system substantially influences the number and biodiversity of weed seeds in a soil bank.

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WPŁYW RODZAJU UPRAWY NA LICZEBNOŚĆ I BIORÓŻNORODNOŚĆ NASION CHWASTÓW W BANKU GLEBOWYM

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Abstrakt: W okresie jednego sezonu wegetacyjnego poprzez uprawę można wyeliminować 30÷60% nasion znajdujących się w glebowym banku. Ugorowanie i nawożenie mineralne stosowane przedsiewnie mogą przyspieszać ten proces, przyczyniając się do znacznej redukcji nasion w ornej warstwie gleby. W celu rozpoznania wymienionych zależności w doświadczeniach wazonowych prowadzonych w latach 2002-2004 rozpoznano i porównano strukturę rozmieszczenia, ilość oraz różnorodność glebowego banku nasion w próbkach glebowych pobranych z pól w Przyłęku. Na badanych obiektach uprawiano w zmianowaniu ziemniaki i pszenicę oraz pszenicę w monokulturze, stosując różne systemy gospodarowania. W wyniku przeprowadzonych doświadczeń na glebie pobranej z pola o uprawie ekstensywnej wzeszło 1382 szt. chwastów/m^2, a w próbkach z intensywnym sposobem gospodarowania 3129 szt. chwastów/m^2. W uprawie ekstensywnej zrejestrowano 9 gatunków chwastów, wśród których dominowały *Chenopodium album*, *Apera spica venti*, i *Anthemide* spp., a w próbkach pobranych z pola o intensywnym sposobie gospodarowania 12 gatunków chwastów, z których w największym nasileniu wystąpiły *Chenopodium album*, *Galinsoga parviflora*, *Anthemide* spp. i *Apera spica venti*. Zastosowane w trakcie doświadczeń ugorowanie, trwające 72 dni, zwiększyło liczbę wschodów roślin w zależności od badanych próbek od 15,5 do 24,4%. Uzyskane wyniki wskazują, że technologia uprawy roślin w znaczny sposób wpływa na ilość i różnorodność nasion gatunków chwastów występujących w ornej warstwie gleby.

Słowa kluczowe: glebowy bank nasion chwastów, uprawa mechaniczna gleby, nasilenie wschodów chwastów, ekologiczna walka z chwastami