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THE IMPACT OF WINTER WHEAT CULTIVATION INTENSITY ON WEED SEED CONTENT IN SOIL

JAROSŁAW SŁAWIŃSKI, ELŻBIETA GOŁĄBEK,
BEATA GOŁUCHOWSKA

Department of Land Protection, University of Opole,
Oleska St. 22, 45-052 Opole, Poland; e-mail: jarek19@uni.opole.pl,
Elzbieta.Golabek@uni.opole.pl, beska@uni.opole.pl

ABSTRACT: During one vegetation season by means of cultivation it can be eliminated 30-60% of seeds found in the soil bank. Fallowing and mineral fertilization applied before sowing, can accelerate this process contributing to a significant reduction of seed quantity in arable layer of soil. In order to identify the relationships mentioned above, in the pot experiments conducted in the years 2002-2007, the structure of the distribution, size and diversity of the soil seed bank were identified and compared in soil samples collected from fields in the village of Przyłęk. In the tested fields potatoes and wheat were grown in crop rotation as well as wheat in monoculture using different farming systems. As a result of experiments conducted on the soil taken from extensively cultivated field the number of germinated weeds per square meter of the field surface was 1461, and in the case of intensively cultivated field 3332. In extensive cultivation 9 species of weeds were noted, among which *Chenopodium album*, *Apera spica venti*, and *Anthemide spp* dominated, and in samples collected from the field of intensive cultivation method 12 species of weeds, of which *Chenopodium album*, *Galinsoga parviflora*, *Anthemide spp* and *Apera spica-venti* were present in the greatest intensity. The application of fallowing in the experiments, lasting 72 days, increased the germination of plants, depending on the tested samples, by 20.1% to 29.9%. The results show that plant growing technology significantly affect the amount and variety of seeds of weed species occurring in the arable layer of soil.

KEY WORDS: soil weed seed bank, mechanical tillage, weed seed germination, ecological weeding

Introduction

The most important component of field weed growth are segetal weeds adapted to the conditions of the growth of crop plants, and ruderal weeds inhabiting in the areas not used for agriculture. Number of seeds, produced by individual weed species, depends - inter alia - on the length of the growing season, the content of available nutrients in the soil, climatic

conditions and agrotechnology, as well as the soil structure, soil moisture, landform and the methods of farming (Lavorel 1994).

Simplifications in the tillage generally contribute to the increase in the growth of weeds, especially in the initial period of their growth (Kordas 2004). A large number of weeds resulting from the disruption in the natural mechanisms of self-regulation of plant groups can significantly limit obtaining an appropriate level of yields, causing them to fall by 50 to 70%, and up to 90% when they occur on a mass scale (Gąsiorowska and Makarewicz 2009; Lauringson et al. 2000).

Great significance in weed control has the application of surface tillages in winter wheat cultivation, limiting the weed growth by 51% compared to the traditional technology (Małecka et al. 2006). Similar importance has direct sowing in stubble field (Blecharczyk et al. 2007). Cereal competitiveness against weeds can be increased by using appropriate fertilization, especially nitric (Wojciechowski 2009).

Materials and Methods

The object of the study was soil containing weed seeds existing in crop plant habitat, collected from two fields in Przyłęk village located in Lower Silesia Voivodeship, in the district of Ząbkowice, the municipality of Bardo. Soil samples for laboratory analyses were collected in two terms from fields differing in the method of farming: extensive (on 26th October 2002) and intensive (on 13th November 2002). The samples were taken from each soil cultivation system, at five points randomly selected on the field surface, at a depth of 0-10 cm in the case of each point. After bringing to the laboratory, the collected soil samples were placed in 10 cm tall pots. Five replicate analyses on each soil sample were carried out and the total number of replications was fifty.

Germination and growth of the plants was observed over a number of periods (cycles), each lasting about six weeks. After each period the analysis of weed intensity was performed by the determination of species spectrum, as well as the number of sprouts, and their development phase. Weed species have been recognized with the appropriate key for the determination of plant species (Rutkowski 2006). In order to speed up the germination, the soil in pots was mixed after each analysis.

After the fifth analysis the soil lay follow for 72 days. The study was carried out in the conditions of optimal photoperiod and relative humidity (Sławiński 2008). The following determinations were performed in soil samples: pH by potentiometric method, humus content by modified Tiurin's method, as well as the content of macro- and micronutrients by atomic absorption spectroscopy (AAS) method.

Results

In the field where extensive cultivation method was applied, potatoes and wheat were grown alternately. During the crop growing the following fertilizers were applied: ammonium nitrate in a dose of 60 kg/ha, before wheat sowing, and manure in the amount of 2.6 tonnes/ha in the case of potatoes. In the field of intensive cultivation method the winter wheat was grown for 20 years, separated every 3 - 4 years by phacelia growing. The polifoska fertilizer was applied in a dose of 170 kg/ha and top dressing urea in the amount of 200 kg/ha. In both fields weeds were fought with the following preparations: Aminopielik D, Chwastox D and - additionally - Arelon 75 WP, Dicuran forte 80 WP and Lentagran 45 WP in the case of the intensive cultivation.

Table 1. The results of the analyses of soil samples

Farming system	pH (in 1N KCl solution)	Humus [%]	P_2O_5	K_2O	Mg	B	Mn	Cu	Zn	Fe	Cd	Cr	Ni	Pb
			mg/kg of soil											
Extensive	3.6	1.64	129	233	73	0.93	108	2.0	17.7	510	0.47	23.2	3.0	16.3
Intensive	3.2	1.5	70	150	40	0.96	93	1.7	12.5	467	0.52	22.5	4.5	13.0

On the grounds of a comparison with literature data (Turski, Aries 1995) it should be stated that both soil cultivated extensively and intensively are characterized by very acidic pH level and low content of humus (Table 1). The content of phosphates was medium in extensively cultivated soil, and low when the cultivation was intensive. On the other hand, the content of potassium compounds was very high in the extensively cultivated soil and high in soil with intensive cultivation. The level of magnesium in both cases was intermediate, boron and zinc - very high, and iron and copper – low.

Under experimental conditions, on the extensively cultivated soil, the amount of germinated weeds was more than twice less (2.3 times), than on the soil of intensive method of cultivation (Table 2). Among the plants dominating in extensive cultivation, the species of *Dicotyledones* were noted, comprising 75% of the total emergence, of which *Chenopodium album* L., *Galium aparine* L. and *Anthemide spp* occured in the greatest intensity. The species of *Monocotyledones* were represented only by *Apera spica-venti* L.

On intensively cultivated soil *Dicotyledones* accounted for 81% of the registered emergence and the strongest dominance was observed in the case of *Chenopodium album* L., *Galinsoga parviflra* Cav. and *Anthemide spp*. *Monocotyledones* were represented by *Apera spica-venti* L. and *Poa annua* L.

Table 2. The total number of sprouts in tested soil samples per unit of field surface (sprouts/m^2).

Plant species	Farming system	
	extensive	intensive
Apera spica venti	365	442
Poa annua	-	182
Chenopodium album	929	1135
Galinsoga parviflora	18	683
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

A large number of sprouts in the soil collected from intensive cultivated field probably resulted from the type and form of cultivation carried out on this field. Wheat growing in monoculture sown without the ploughing limited the range of species and caused the accumulation of a large number of weed seeds in topsoil. Application of a wide programme of chemical weed control reduced the soil seed bank only in the upper soil layers, but did not affect the seeds placed deeper. An example of this can be the number of seeds of *Apera spica-venti* and *Chenopodium album* in the tested soil samples.

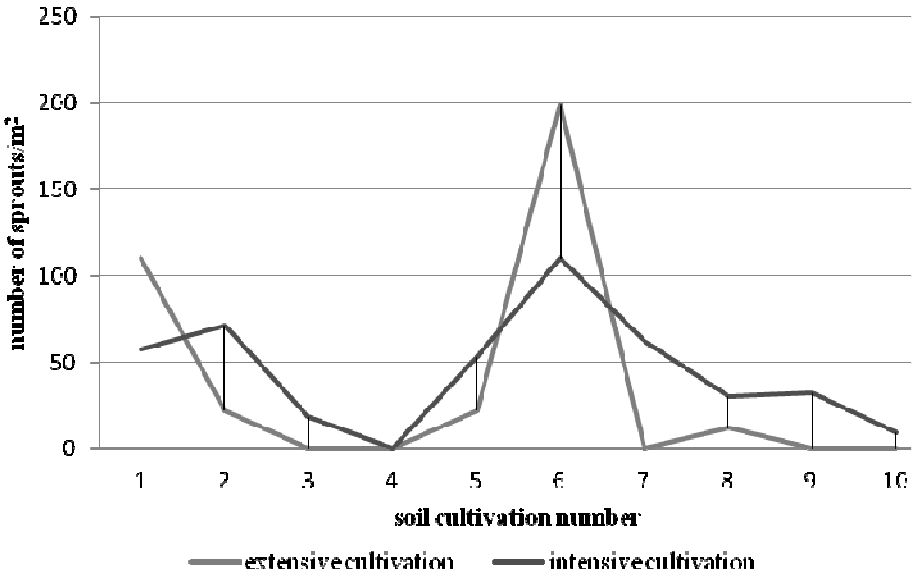

Fig.1. Sprouting dynamics of *Apera spica-venti* (04.11.2002 – 06.12.2007).

Loose wind bent-grass (*Apera spica-venti*) on soil taken from extensive cultivation was germinated in 24.9% and from intensive cultivation in 13.2% in relation to the total germination (Fig. 1). As a result of the application in the research several number of soil mixing procedures, the reserve of live seeds in the samples taken from both extensive and intensive cultivation was exhausted after tenth soil mixing.

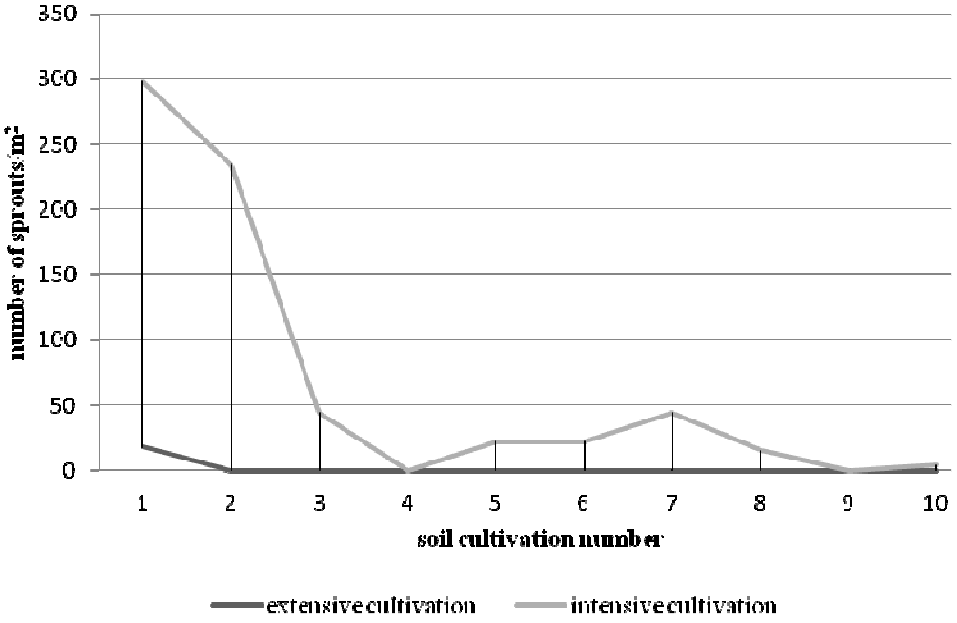

Fig.2. Sprouting dynamics of *Galinsoga parviflora* (04.11.2002 – 06.12.2007).

The germination of smallflower (*Galinsoga parviflora*) equaled to 1.2% in the case of soil coming from extensive cultivation and to 20.5% from intensive cultivation in relation to the total germination (Fig. 2). As a result of application in the research several number of soil mixing procedures, the supply of live seeds in the samples collected from extensive cultivation was exhausted after first mixing and from intensive after tenth mixing of soil.

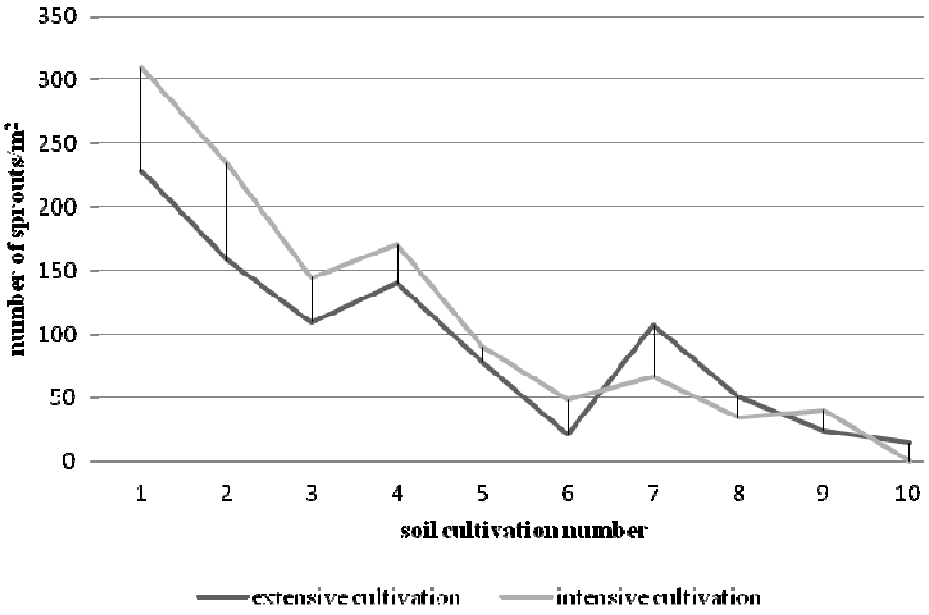

Fig.3. Sprouting dynamics of *Chenopodium album* (04.11.2002 – 06.12.2007).

The germination of lamb's quarters (*Chenopodium album*) on the soil taken from extensively cultivated field equaled to 63.5%, and intensively 34.0% in relation to the total germination (Fig. 3). In the result of the application of several numbers of soil mixing operations in the research, the supply of live seeds in the samples collected from extensive and intensive cultivation was exhausted after tenth mixing of soil.

Soil fallowing for 72 days in the course of the experiments, increased the germination of plants, depending on the tested samples, by 20.1% to 29.9% (Table 3). On the extensive soil, after finishing the break in cultivation, the number of germinated plants was 437/m^2, which accounted for 29.9% of the total number of observed weeds. Only two species of weeds responded positively to the fallowing: *Apera spica-venti* and *Chenopodium album*, of which the most numerous was the germination of *Apera spica*-venti (56.5%).

Table 3. The effect of fallowing on dominant weed species sprouting in examined soil samples (sprouts/m^2).

Plant species	**Farming system**	
	extensive	**intensive**
Apera spica venti	186	270
Poa annua	-	-
Chenopodium album	251	317
Galinsoga parviflora	-	85
Anthemide spp	-	-
Galium aparine	-	-

Fallowing the field where intensive cultivation was conducted, has contributed to the increase in the overall weed germination by 20.2%. Three weed species: *Apera spica-venti*, *Chenopodium album* and *Galium aparine* responded to the treatments carried out after fallow period in the experiment, of which *Apera spica-venti* germinated in the highest intensity, i.e. 61.1%.

General comments and summary

Over the course of the laboratory experiments (in the years 2002 - 2007) on soil samples collected from extensively and intensively cultivated fields the following number of weeds germinated: 1461 pcs\$m^2$ and 3332 pcs\$m^2$. Soil fallowing for 72 days and subsequent tillage contributed to the increase in the total germination of the plants by 20.1% - 29.9%. *Apera spica-venti* was the weed species most strongly stimulated by the soil treatment performed after fallowing, regardless of the type of soil.

The results obtained in the research indicate that species composition and abundance of seeds in the soil seed bank depends on many factors, of which the most important is the type of cultivation and grown crop. Application of extensive cultivation supports common occurrence of weeds, which however can be limited by properly selected rotation and weed controlling programme. In the intensive cultivation, particularly in the conditions of sowing without the ploughing and monoculture of the crop, weed seeds contained in the soil have no suitable conditions for germination, especially in deeper soil layers, because of the limited

number of mechanical tillage operations, and it is difficult to develop an effective programme to control their number as a result.

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