Opole Scientific Society
Nature Journal
No 41- 2008: 31–36

Restoration of growth of soil seed banks under mineral fertilisation

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Abstract: Within the period of one vegetation season, through cultivation we can eliminate 30% - 60% of seeds located in a soil seed bank. Agrotechnological factors, such as fallowing and mineral fertilising applied prior to sowing, may accelerate the exhaustion of a soil seed bank. In order to identify the above-mentioned relation, in vase experiments conducted within the years 2002-2004 the influence of various doses of N on germination of seeds of plants located in soil samples taken from the fields with various method of farming were examined. Moreover, in order to obtain a more precise observation of examined soil samples there sowed the seeds taken from plants prevalent on examined objects (*Galinsoga parviflora* Cav., *Chenopodium album* L. and *Echinochloa crus-galli* L.).

In total, in the examined soil taken from extensive farming soil 6% fewer weeds grew than in soil with intensive farming. Among the sprouts there appeared a one-year-old species, of which *dicotyledonous* species constituted 59% with the prevailing *Ch. album* (71,6%) and *G. parviflora* (19,9%) and monocotyledonous species (41%) represented by *E. crus-galli* (82,1%).

The use of NPK in several combinations (20 – 50, 110, 140 kg/ha) resulted in a reduction of the number of emerged weeds in comparison to control from 11% to 62%.

The exception was *V. arvensis*, whose germination in both extensive and intensive farming was stimulated in comparison to control, but only in terms of dose of nitrogen of 50 kg /ha.

The fallowing lasting for 72 days applied during the experiments, increased the number of plant germination by 15.5%, namely 10.611 pieces/m^2.

The produced results suggest the possibility of using prior to sowing, fertilisation and fallowing as factors that facilitate other ways of weed control of crop plants.

Key words: weed seed bank, mechanical tillage, weed seed emergence, ecological weeding, fertilize

Introduction

The nutritional requirements of the majority of seeds exceed the quantity of basic mineral components necessary for crop plants. Namely, rye needs 50 kg N/ ha, and creeping thistle needs even 138 kg N/ ha (Domańska 1997).

The improvement of nutritional conditions influences a proper growth and yield of plants (Lityński 1982; Rudnicki 1995), but also fosters the development of numerous species of weeds (Rzekanowski et al. 1999).

Therefore, it is necessary to evaluate systematically soil richness in nutrients which constitute a basic indicator of rational fertilising (Ślusarz 2000; Mengel 1983; Fotyma 1987; Fotyma 2000). Fertilising requirements do not however meet the nutritional requirements of plants. Fertilising requirements are usually much higher (Kropisz 1983).

The supply of weed seeds may decrease, but only when inflow of new portions of seed is stopped. As a result of adaptation of various treatments (agrotechnology, plant protection measures) reduction in soil seed bank may account even for more than 95% within 5 years (Dobrzański 1997).

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 vases at a height of 10 cm constituting two objects (extensive and intensive) divided into 4 trials + control, each in 5 repetitions.

After the end of vegetation, from fields (from where the soil samples were taken) three species of plants were collected (*Galinsoga parviflora* Cav., *Chenopodium album* L. and *Echinochloa crus-galli* L.), of which after drying there isolated seeds. There sowed live diaspors in the amount of 30 pieces of each species to pre-prepared containers. The examined objects were then treated with a mixture of fertilisers (urea fertiliser, polifoska, potash salt) in the amount of: 20/110/140 NPK - I trial, 30/110/140 NPK – II trial, 40/110/140 NPK – III trial, 50/110/140 NPK – IV trial.

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 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 vases 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 ton/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	pH	Humus	P_2O_5	K_2O	Mg	B	Mn	Cu	Zn	Fe	Cd	Cr	Ni	Pb
	(1 n KCL)	[%]	mg/100 g soil			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, borer and zinc – very high and iron and copper – low.

In conditions of the conducted experiments on soil of extensive farming there emerged by 6% fewer weeds than on the soil of intensive farming (table 2). Among the plants there, dominated *dicotyledonous* species which accounted for 59% of all sprouts, of which the most numerous were *Ch. album* and *G. parviflora*. However monocotyledonous species were in 82% represented by *E. crus-galli*.

Table 2 General number of sprouts (piece/m^2) in examined soil samples

	Plant species	Farming	
		extensive	intensive
	Echinochloa crus-galli	6576	7839
	Apera spica venti	469	1290
	Poa annua	30	182
	Elymus repens	-	347
Dicotyledonous	*Chenopodium album*	9473	6443
	Galinsoga parviflora	2216	2794
	Viola arvensis	129	715
	Anthemide spp	20	529
	Thlaspi arvense	-	97
	Veronica hederifolia	-	35
	Stellaria media	3	25
	Capsella bursa pastoris	4	25
	Lamium purpureum	-	12
	Galeopsis tertahit	3	12
	Cirsum arvense	129	-

Mineral fertilisers applied in several combinations caused a decrease in the number of weeds from 11% to 62%. as compared to controls. On the soil with intensive farming the biggest influence observed at *Ch. album*, which sprouts in the result of application of dose of 40 kg N/ ha, were limited by 67% as compared to controls (table 4). On the soil with extensive farming (table 3), the doses 20 and 40 kg N/ ha influenced the germination similarly, decreasing the germination by about 10%. The consequence of the application of fertilisers in doses of 30 and 50 kg N/ ha in soil of extensive farming was the comparable intensification of sprouts.

Table 3. The influence of mineral fertilisers on the germination of species prevailing (piece/m2) in extensive farming.

	Plant species	Nitrogen rate (kg/ha)				
		50	40	30	20	Control
Monocotyledonous	*Echinochloa crus-galli*	1393	1244	1293	1283	1363
	Apera spica venti	60	60	80	80	189
Dicotyledonous	*Chenopodium album*	1950	1803	1990	1753	1977
	Galinsoga parviflora	498	338	375	249	756
	Viola arvensis	60	40	30	10	40

In the case of *A. spica-venti,* each of the applied doses on the soil of extensive farming (table 3) limited the germination by more than 50%, in relation to the control, however on the soil with intensive farming (table 4) the dose 20 kg N/ ha limited the sprouts by 77,5%, and the dose 50 kg N/ ha increased the sprouts by 35%.

At *E. crus-galli* on soil with intensive farming (tab.4), each of the applied doses limited the emergencies by about 50% and on soil with extensive farming (tab.3) by about 9%, except for the dose of 50 kg N/ ha, after the application of which there noted the tendency to growth of intensification of sprouts.

Table 4. The influence of mineral fertilisers on growth of species prevailing (piece/m^2) in intensive farming

	Plant species	Nitrogen rate (kg/ha)				
		50	40	30	20	Control
Monocotyledonous	*Echinochloa crus-galli*	1318	1219	1331	1206	2765
	Apera spica venti	448	249	186	75	332
Dicotyledonous	*Chenopodium album*	1360	709	1343	908	2123
	Galinsoga parviflora	460	274	435	298	1327
	Viola arvensis	199	87	137	137	155

In the case of *G. parviflora* and *V. arvensis* the biggest reduction of germination was reported after application of dose 20 kg N\ha (table 3, 4). The dose of 50 kg N/ ha applied in the soil taken from the field of intensive farming stimulated from 30 to 50% the germination of *V. arvensis*.

Due to the decreasing number of sprouts, after the fifth treatment fallowing was applied, and after further analyses there grew additionally 10611 pieces of weed/m^2, increasing the total number of emerged plants by 24,6%.

The above-mentioned method, allowed to eliminate on average about 50% seeds in a soil surface layer, which accounts for results (40 – 60%) obtained in literature (Rzekanowski et al. 1999). In a planned system of weed control in plants, fertilisation with NPK in doses nearing the doses applied in practice may be used as a method of facilitating other ways of weed control in crop plants.

To sum up, in research that lasted for 389 days on the soil with intensive farming there reached by 6% more sprouts than on the soil with extensive farming.

The fertiliser compositions applied during the research limited emergencies: *Ch. album, G. parviflora, V. arvensis, E. crus – galli* and *A. spica venti*. The noted stimulation of germination after the application of nitrogen in the dose of 50 kg N/ha. The exception noted the example of emergencies of *Echinochloa crus – galli* on soil with extensive farming and *Apera spica venti* on the soil with intensive farming.

Conclusions

1. During the duration of laboratory research (2002 – 2004) on soil samples taken from fields of extensive and intensive farming 19082 pieces\m^2 and 20345 pieces\m^2 of weeds grew, respectively.
2. Among the applied doses of fertilisers, the most limiting on the emergencies were the doses of 20 and 40 kg N/ ha.
3. The intensification of germination of *Echinochloa crus – galli* (on the soil with extensive farming) and *Apera spica venti* (on the soil with intensive farming) was stimulated with nitrogen in the dose of 50 kg N/ ha.
4. Fallowing lasted 72 days and the following farming caused an increase in the total number of sprouts by 15.5% of plants.
5. The reached results suggest the possibility of application of prior to sowing fertilisation and fallowing as factors facilitating other ways of weed control in crop plants.

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