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Weeds emergence from soil seed bank in vegetable – winter wheat crop rotation

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Abstract: In pot experiments (1994-2000), the weed emergence on the soil taken from a field of the Opole province on which vegetables (cucumber, cabbage and bean) and each second year wheat grew, were studied. The vegetables were weeded by means of herbicides: trifluralina, propachlor and metachlor and wheat with mixtures of 2.4-D + mekoprop + dikamba or MCPA + dikamba.

In general 3991 weeds/m^2 emerged, of which 61 % from 0-10 cm and 39 % from 10-20 cm of soil layer. In the depth of 0-10 cm resumed growth more by 30 % *Capsella bursa-pastoris*, *Fallopia convolvulus*, 32 % *Chenopodium album*, 52 % *Echinochloa crus galli* and 100 % *Fumaria officinalis*, *Viola arvensis*, than at the 10-20 cm soil layer. In the deeper layer compared with shallower, in bigger amount emerged: *Galinsoga parvoflora* and *Amaranthus retroflexus* by 18 % and 26 % respectively and by 100 %: *Stellaria media*, *Anthemide spp*., *Lamium purpureum*, *Thlaspi arvense* and *Veronica persica*.

The experiments lasted over 5-23 periods, each period of 6 weeks. During investigation mixing, reversing and different time of fallowing were applied. Soil mixing as more effective then was reversing, for *Chenopodium album* (3.5-4), *Galinsoga parvoflora* (1.4-2.5) and for *Echinochloa crus galli* (3-13 times).

It has been shown, that tillage together with appropriate period of fallowing accelerates the time of weeds growth resumption. This method of tillage can be helpful in ecological weeding program in vegetable-agricultural crop rotation.

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

Introduction

In each year the weeding source of cultivated plants is supplemented by of seeds stored in the soil, according to Harper's "seed bank" (Harper 1957). The size of seed bank depends, among others, on technology of crop production, species composition of weeds and characteristic and nutrient included in the soil. The vertical distribution of seeds in

the soil bank is heterogeneous. The biggest number of seeds is in 30 cm uppermost layer of soil, below this value is the reduction of seed number as well as seeds composition shrinks (Holub 1994; Desaint et al. 1991). The aim of the research is the recognition of reservoir and the length of soil seed bank life by measuring rate of plants growth resumption in laboratory condition.

Methods

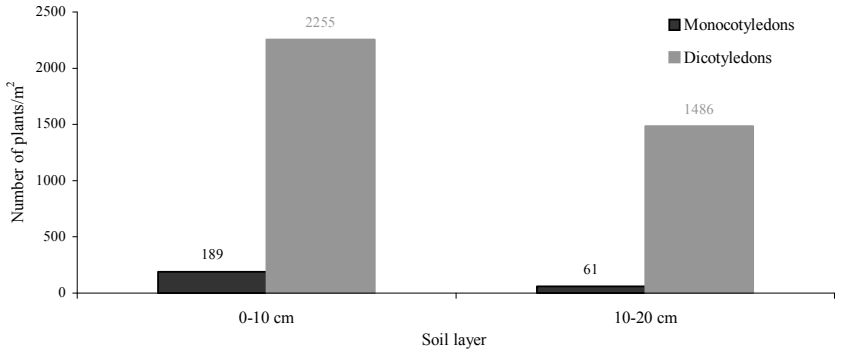
In pot experiments (04 Mar. 1994 – 28 Apr. 2000) weed emergence in the soil taken from winter wheat field in Opole-Półwieś province, Poland, were investigated. Before sampling, in the field vegetables (cucumber, cabbage, bean) rotated with winter wheat were cultivated. The vegetables with trifluralin, propachlor or metolachlor and wheat with mixtures of 2,4-D + mekoprop + dikamba or MCPA + dikamba were weeded.
The investigations lasted 5 – 27 periods of time, each period of 6 weeks.

In order to hasten plants emergence, mechanical treatments (mixing and reversing of the soil) were used, between which fallowing occurred (break in experiments conducting, when maintained temperature of 24 – 26 °C, relative humidity 70 – 80 % and no water has been given).

Results

During experiment 3991 weeds/m^2 (Fig. 1), including 61 % from 0 – 10 cm and 39 % from 10 – 20 cm of the soil layer, were emerged. In the soil from 0-10 cm, by 30 % *Capsella bursa-pastoris*, *Fallopia convolvulus*, 32 % *Chenopodium album*, 52 % *Echinochloa crus-gall* and 100 % of *Fumaria officinalis* and *Viola arvensis* more pieces of resumed growth than in the dipper part of soil (Fig. 2).

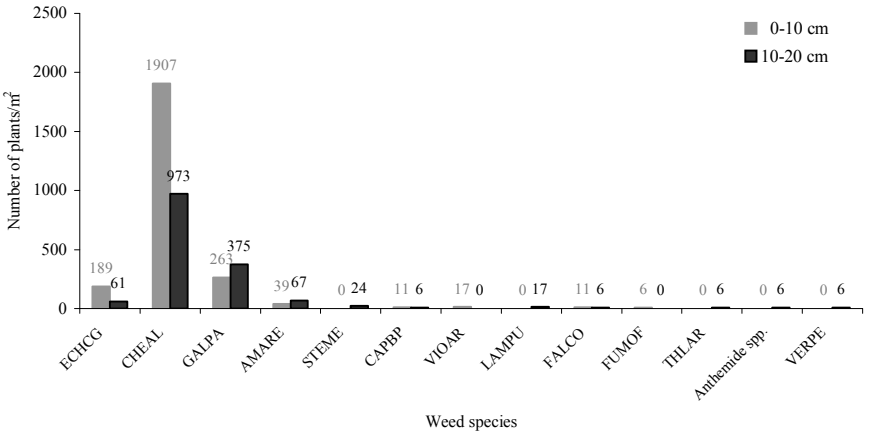
Fig. 1 Effect of tillage on emergence in 04 Mar.1994 to 28 Apr.2000



In 10-20 cm of the soil layer, in bigger amount than in shallower part, emerged: *Galinsoga parviflora* 18 %, *Amaranthus retroflexus* 26 %, *Stellaria media*, *Anthemide spp*., *Lamium purpureum*, *Thlaspi arvense* and *Veronica persica* 100 % (Fig. 2).

The species: *Chenopodium album*, *Galinsoga parviflora* and *Echinochloa crus galli* resumed the growth, in relation to the general number of emerged weeds, in amount of 94 % but *Amaranthus retroflexus*, *Stellaria media*, *Capsella bursa-pastoris*, *Viola arvensis*, *Lamium purpureum*, *Fallopia convolvulus*, *Fumaria officinalis*, *Thlaspi arvense*, *Anthemide spp.* and *Veronica persica* emerged only in 6 %.

Fig. 2 Emergence and species of weeds Opole - Półwieś
(04 Mar.1994 - 28 Apr.2000)



The course emergence density of *Chenopodium album* (Table 1) in both soil layers had a 3 periods of biological tillages activity. The first one included the treatments of 1+1a+2 (126 days + 174 days of fallowing) by which 51 % (0-10 cm) and 51 % (10-20 cm) of emergence were received, by second one 2a+3+4 (336 days + 404 days of fallowing), this values were 20 % (0-10 cm) and 16 % (10-20 cm) and by the third, the tillages 4a – 8a (672 days + 287 days of fallowing) resulted in emergence of 0 – 7 %. The end of living seeds in both soil layers were reached by 27 tillages.

Table 1. Tillage effect on of *Chenopodium album*, *Galinsoga parviflora*, *Echinochloa crus galli* emergence (04 Mar.1994 – 28 Apr.2000)

Tillages*	Weed species					
	Chenopodium album		*Galinsoga parviflora*		*Echinochloa crus galli*	
	Soil layer [cm]					
	0-10	10-20	0-10	10-20	0-10	10-20
	Number of plants/m^2					
1	459	288	50	127	11	0
1a	149	50	28	28	17	11
2	371	155	28	39	99	33
2a	161	61	39	22	6	0
3	155	66	0	0	44	17
3a	22	39	11	6	0	-
3b	77	28	11	28	0	-
3c	77	44	6	39	0	-
3d	72	82	11	17	0	-
3e	16	11	0	6	0	-
4	67	33	17	17	6	-
4a	72	6	0	6	0	-
4b	17	6	11	17	0	-
4c	50	6	11	11	0	-
5	0	11	0	0	0	-
6	6	11	0	0	0	-
6a	17	18	11	0	6	-
6b	28	6	17	6	-	-
6c	33	0	6	0	-	-
6d	11	6	0	0	-	-
7	6	13	6	0	-	-
7a	6	0	-	0	-	-
7b	22	6	-	6	-	-
7c	0	20	-	-	-	-
7d	6	0	-	-	-	-
7e	0	0	-	-	-	-
8	7	7	-	-	-	-
total	**1907**	**973**	**263**	**375**	**189**	**61**

*1 – mixing in the day of soil sampling;
2, 3, 4, 5, ,7, 8 – mixing after next time of fallowing;
a, b, c, d, e, (e.g.: 1a, 1b, 6a, 6b, 6c, 6d) – soil reversing

In the case of *Galinsoga parviflora* (Table 1), the most biological effective tillages were 1+1a+2+2a (168 days + 174 days of fallowing), after which the emergence of 55 % in the shallower and 58 % in the 10-20 cm soil layer were obtained. The emergence after 21 (0-10 cm) and 23 (10-20 cm) tillages have been finished.

In both soil layers, the growth resumption of *Echinochloa crus galli* were the most effective after 1+1a+2 (126 days + 174 days of fallowing) tillages by which 67 % (0-10 cm) and 72 % (10-20 cm) emergence have been reached. The growth resumption after 5 (10-20 cm) and 17 tillages have been finished.

The presented findings shows, that about 50 % of emergence after periods of: 300 – *Chenopodium album*, 342 – *Galinsoga parviflora* and 300 – *Echinochloa crus galli* days have been reached. By taking into account 3 times bigger efficiency in plants emergence of the soil mixing, comparing with reversing (Table 1), there is a probability, in the case of changing reversering in to mixing to short 3 times the periods mentioned above by *Chenopodium album* and *Echinochloa crus galli*. The thesis is confirmed by other investigations (Sławiński et al. 1996; Sławiński 1997).

The weeds in bean (forecrop of winter wheat) represented by 2 – 3 *Chenopodium album* + *Echinochloa crus galli* + *Galinsoga parviflora* plants/100 m^2 produced seeds, which were dominant in the investigated soil layers.

On the field of winter wheat, where the soil samples were taken, 12 species – *Stellaria media, Viola arvensis, Galium apparine, Senecio vulgaris, Lamium purpureum, Fumaria officinalis, Fallopia convolculus, Capsella bursa-pastoris, Thlaspi arvense, Circum arvense, Papaver rhoas* and *Veronica hederifolia* on 01 June 1994 have been recorded. In laboratory conditions: *Galium aparine, Senecio vulgaris, Circum arvense, Papaver rhoas* and *Veronica hederifolia* did not emergence. The reason for it seems to be 3 – days break between time of soil sampling (Mar. 1st) and the beginning of laboratory experiment (Mar. 4th) in the time of which the germination process has began and the one of stages stopped (Aldrich 1984) which resulted in destroying of propagules.

The reason of bigger amount of weed emergence (Table 1): 2359 (0-10) and 1409 (10-20 cm) were caused with 0-tillages by winter wheat sowing, after which emerged dominant seed escaped from bean.

The conducted experiments shows, that mechanical treatment of the soil (mixing, reversing) influenced the time of seeds disappearing. The lowering numbers of propagule were not depended on numbers but on kind of mechanical treatments, though influence on the parameter had although the fallowing.

The presented method of weed seeds emergence hastening can be useful during the vegetation time, as well as during the winter time to ecological weeding in vegetable – agricultural crop rotation.

Conclusions

1. In laboratory conditions 3391 weeds/m^2 emerged, including 61 % in 0-10 cm and 39 % in 10-20 cm soil layer.
2. In 0-10 cm 8 weed species and in 10-20 cm soil layer 11 of them were emerged
3. Soil mixing were more effective than reversing, for *Chenopodium album* (3.5 – 4), *Galinsoga parviflora* (1.4 – 2.5) and for *Echinochloa crus galli* (3 – 13 times)
4. Results of conducted experiments have shown that weed prevention and control can play important roles in ecological weeding of cultivated plants.

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