

## Changes in weed community infesting common bean crop

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### ABSTRACT

In three-year field experiment common bean (*Phaseolus vulgaris* L.) 'Bona' was cultivated for harvest of green pods and dry seeds. Weed species, their growth stages, number and fresh weight were determined every two weeks starting from the third week after sowing till harvest of beans. 38 weed species, mainly annual dicotyledonous were found and *Amaranthus retroflexus*, *Chenopodium album*, *Echinochloa crus-galli* and *Galinsoga parviflora* dominated in the experiment. Majority of weeds emerged during the first three weeks after sowing, some of them germinated in two following weeks and then their number decreased gradually. Fresh weight of weeds increased rapidly from the third till fifth – seventh week and then much slower during the next few weeks and finally it decreased as

a result of decaying of some weed species. All annual weeds attained fruiting stage and some species finished their vegetation till time of harvest of bean seeds.

## INTRODUCTION

Cultivated plants are associated with weed communities and detailed knowledge of them is the base of integrated weed management (Naylor and Drummond 2002). Weed community is a dynamically changing population composed of several specific to the crop weed species. The changes are related to biology of growth and development of individual weeds and to competition between them in weed community. Main parameters characterizing weed community and its competitiveness to cultivated plants are floristic composition as well as density and fresh weight of weeds (Aldrich 1997). In Poland, studies on weeds and their control in common and runner beans were carried out by Dobrzański et al. (1979), Borowy (1996, 2003), Chmielowiec and Borowy (1998) and Adamczewska– Sowińska and Kołota (1999, 2000), however until now there has been no information on changes taking place in weed community associated with common bean crop during whole vegetation period. Dynamics of weed communities in cereals, fiber flax, potatoes and red clover were studied by Pawłowski et al. (1991), Jędruszczak (1993), and Heller (1998).

The aim of this study was to determine the course of growth and development of weeds infesting common bean crop in Lublin region in relation to their number and fresh weight.

## MATERIAL AND METHODS

The experiment was carried out in Felin experimental farm on loess-like soil containing 1.6% of organic matter and of 5.8 pH in the years 1996 – 1998. Experimental field was utilized for many years for cultivation of different vegetable crops. It was ploughed in the autumn of the year proceeding common bean cultivation and then fertilized with 30 kg N ha<sup>-1</sup>, 26 kg P ha<sup>-1</sup>, and 100 kg K ha<sup>-1</sup> in the spring. On 12-13 May it was rototilled and on the next day snap bean (*Phaseolus vulgaris* L.) 'Bona' seeds were seeded by hand on 4.95 m<sup>2</sup> plots consisting of 6 rows 3.3 m long, 0.5 m apart. Two seeds were placed every 10 cm in the row and 3 cm deep in the soil. After germination bean seedlings were thinned leaving one seedling in one point, which gave a density of 40 plants per m<sup>2</sup>. Beans grown in the first 3 rows were cultivated for green pods while plants in the remaining 3 rows were cultivated for dry seeds. Green pods were harvested by

hand three times in the second half of July and then the plants were left on plots till the end of the vegetation period. Plants destined for seed harvest were uprooted in the first days of September.

Beginning from the 3<sup>rd</sup> week after sowing, fresh weight of weeds, their growth stage and number by species were determined every two weeks till the end of August. Weeds were counted in four 25 × 40 cm frames placed randomly in interrow space. The experiment was laid out in a randomized block design with four replications. Number and fresh weight of weeds were studied by analysis of variance and significance of differences was determined using Tukey's test at 0.05 significance level.

## RESULTS AND DISCUSSION

During 3-years' study 38 weed species were found in the experiment, the majority of them being considered by Dobrzański (1999) as main weeds infesting bean crops in Poland. Annual dicotyledonous weeds predominated, while monocotyledonous ones were represented by three species only. Perennials made one third of total weed species number, however frequency of their occurrence was little. Experimental field abutted on barren land from which perennial weeds could get into bean crop easily. Every year the most numerous species was *Echinochloa crus-galli* making 42% of total weed population. It was followed by *Chenopodium album* – 26%, *Amaranthus retroflexus* – 10% and *Galinsoga parviflora* – 7%. The share of *Galinsoga ciliata*, *Urtica urens* and *Polygonum persicaria* was about 3% for each species on average. *Amaranthus retroflexus*, *Echinochloa crus-galli* and both *Galinsoga* species are sensitive to frost like bean plants and in Poland they start to germinate at the time of bean sowing in the middle of May. Other annual weeds were found sporadically. Every year the greatest diversity of weed species was observed in 7<sup>th</sup> week after seed sowing.

Dominant weed species grew on plots at every time of observation and therefore complete data illustrating their growth and development stages are presented in Table 1, while they are fragmentary in the case of sporadically occurring weeds. Three weeks after seed sowing majority of weeds developed 4 to 6 true leaves, *Anthemis arvensis*, *Gnaphalium uliginosum* and *Senecio vulgaris* formed branches on main stem and annual grasses were in tillering stage. Two weeks later majority of weeds flowered and *Capsella bursa-pastoris* and *Urtica urens* begun fruiting. Most of annual weeds flowered or fruited 7 weeks after sowing of beans. At that time *Galinsoga parviflora* and *Galinsoga ciliata* attained full blooming and *Capsella bursa-pastoris*, *Senecio vulgaris*, *Stellaria media* and *Urtica urens* – full fruiting stage. Two weeks later flowering plants of both *Galinsoga* species begun fruiting and remained in this stage till the end of

experiment. At the same time *Echinochloa crus-galli* attained full blooming stage and *Gnaphalium uliginosum*, *Lamium amplexicaule* and *Solanum nigrum* begun fruiting. The course of growth and development of weeds grown in the experiment was very similar to that observed by Borowy (2003) in semi-climbing runner beans cultivated in the same natural conditions. In the period from 11<sup>th</sup> to 13<sup>th</sup> week after sowing of beans, majority of weeds were still in blooming and fruiting stage and plants of *Capsella bursa-pastoris*, *Senecio vulgaris* and *Urtica urens* began to decay. In 13<sup>th</sup> week the fruits of *Echinochloa crus-galli* and *Poa annua* began to drop and two weeks later this process was observed also on plants of *Amaranthus retroflexus*, *Chenopodium album* and *Matricaria maritima* subsp. *inodora* while plants of *Polygonum persicaria* were still at the beginning of fruiting stage. Following perennial weed species were found in the experiment: *Artemisia vulgaris* L., *Cichorium intybus* L., *Cirsium arvense* (L.) Scop., *Convolvulus arvensis* L., *Elymus repens* (L.) Gould., *Plantago lanceolata* L., *Plantago major* L., *Rorippa sylvestris* (L.) Besser, *Sonchus oleraceus* L., *Tanacetum vulgare* L., *Trifolium pratense* L., and *Tussilago farfara* L. Their growth and development was slightly slower and less regular and this could be related to different size of vegetative organs and different depth of their placement in the soil.

Number and fresh weight of weeds changed significantly during vegetation period (Table 2) and this agrees with the results obtained by Jędruszczak (1993), Borowy (1996) and Heller (1998). Majority of weeds emerged in the first three weeks after sowing of beans. In the years 1996 – 1997 the emergence of weeds continued in the next two weeks and then their number decreased slightly till last observation. After emergence considerable part of seedlings decayed as a result of competition in plant community and usually the earliest germinating seedlings survive (Symonides 1977, Leguizamon and Roberts 1982, Jędruszczak 1993). Weeds characterized by a short vegetation period, e.g. *Capsella bursa-pastoris*, *Gnaphalium uliginosum*, *Senecio vulgaris* and *Urtica urens* decayed in August (Table 1). In 1998 the number of weeds increased in the last weeks of observation as a result of the germination of *Galinsoga parviflora* and *Galinsoga ciliata* seeds produced by first generation of these weeds which was favoured by rainfalls occurring in this period. Heller (1998) observed an increase of *Galinsoga parviflora* plants number in fiber flax crop at harvest time.

Fresh weight of weeds increased rapidly in the period from 3<sup>rd</sup> till 5-7<sup>th</sup> week of bean cultivation and this was the time of intensive vegetative growth of weeds. Then the increase was much slower at flowering and fruiting stage. Fresh weight of weeds attained the highest value in 11-13<sup>th</sup> week ( $71.5 \text{ t ha}^{-1}$  –  $132.8 \text{ t ha}^{-1}$ ), when number of weeds decreased considerably but vegetative growth of dominant weeds reached its maximum. In the last 2-4 weeks fresh weight of weeds decreased as a result of decaying of some weed species (Tables 1 and 2).

Table 1. Annual weed species, their growth stages and participation in total weed community infesting common bean crop from 3<sup>rd</sup> to 15<sup>th</sup> week after seed sowing (average for the years 1996 – 1998)

Weed species	Participation %	Weeks after seed sowing						
		3	5	7	9	11	13	15
1. <i>Amaranthus retroflexus</i> L.	10	c	g-h	i	j-k	k-l	l	m
2. <i>Anthemis arvensis</i> L.	++	d	h-i	i-j	j	j	k	l
3. <i>Capsella bursa-pastoris</i> (L.) Med.	++	d	j	k-l	l-m	n	n	n
4. <i>Chenopodium album</i> L.	26	c	g-h	i	j	j-k	l	m
5. <i>Chenopodium glaucum</i> L.	+	-	b	g	-	-	-	-
6. <i>Conyza canadensis</i> (L.) Cronquist	+	-	-	-	c	-	-	-
7. <i>Echinochloa crus-galli</i> (L.) P.B.	42	e	f	h	h-j	j-k	l-m	m
8. <i>Fagopyrum tataricum</i> Gaertn.	+	-	j	j	-	-	-	-
9. <i>Fallopia convolvulus</i> (L.) A'. Löve	+	b	g-h	i	j	-	-	-
10. <i>Galinsoga ciliata</i> (Raf.) S.F. Blake	3	c	g-h	i	j	j-k	j-k	j-k
11. <i>Galinsoga parviflora</i> Cav.	7	c	g-h	i	j	j-k	j-k	j-k
11. <i>Gnaphalium uliginosum</i> L.	++	b-g	i	j	k	l-m	m-n	n
12. <i>Gypsophila muralis</i> L.	+	-	-	j	-	j	-	-
13. <i>Lamium amplexicaule</i> L.	++	b	g-h	i-j	j-k	l-m	-	-
14. <i>Matricaria maritima</i> subsp. <i>inodora</i> (L.) Dostál	++	c	d	g	j	j-k	l	l-m
15. <i>Melandrium album</i> (Mill.) Garcke	+	-	-	-	-	-	-	l
16. <i>Poa annua</i> L.	+	e	h	i-j	j-k	l	m	-
18. <i>Polygonum aviculare</i> L.	++	c	g-h	i-j	j	j	k	-
19. <i>Polygonum persicaria</i> L.	3	b-c	g-h	i	j	j-k	k	k
20. <i>Senecio vulgaris</i> L.	++	g	i-j	j-k	m	n	-	-
21. <i>Sinapis arvensis</i> L.	+	b-c	g-h	j	-	-	-	-
22. <i>Solanum nigrum</i> L.	+	c	g	j	j-k	l	-	-
23. <i>Stellaria media</i> Vill.	++	c	g-j	j	k	k-l	l-m	-
24. <i>Veronica persica</i> Poir.	+	c	g	-	-	-	-	-
25. <i>Viola arvensis</i> Murr.	+	b-c	-	-	-	l	-	-
26. <i>Urtica urens</i> L.	3	c	i-k	j-l	k-l	l	m-n	n

## Explanations:

++ weed occurring sporadically in every year of the study

+ weed occurring sporadically in one or two study years

- weed not found

a, b, c – 2, 4, 6 true leaves

d – rosette

e – tillering

f – shooting

g – branching of stem

h – developing of flower buds

i – beginning of flowering

j – full blooming

k – beginning of fruiting

l – full fruiting

m – fruit and seed drop

n – decaying

Such weed infestation may reduce the seed yield of common and runner beans by about 95% and 85%, respectively (Borowy 1996, Chmielowiec and Borowy 1998). Majority of weeds grown in the experiment formed fruits and seeds which started to drop before harvest of beans increasing in this way the bank of weed seeds in soil. This process was observed also by Pawłowski et al. (1991), Jędruszczak (1993), and Borowy (2003) in several other crops.

Table 2. Number and fresh weight of weeds in the period from 3<sup>rd</sup> to 15<sup>th</sup> week after sowing of beans in the years 1996 – 1998

Week after sowing	Number of weeds per m <sup>2</sup>				Fresh weight of weeds (g m <sup>-2</sup> )			
	1996	1997	1998	Mean	1996	1997	1998	Mean
3	272	937	803	671	210	111	106	142
5	343	1152	536	677	2298	628	2838	1921
7	279	985	448	571	5188	3594	5294	4692
9	326	821	396	515	5595	12500	9738	9277
11	299	528	368	398	7145	12750	10375	10090
13	225	459	508	397	7938	13281	9469	10229
15	216	433	519	389	6042	11531	9406	8993
Mean	280	759	511	517	4916	7771	6746	6478
LSD 0.05	Year			158	Year			795
	Week			272	Week			1539
	Year × week			n.s.	Year × week			3241

## CONCLUSIONS

1. In the experiment 38 weed species, mainly broad-leaf annuals infested common bean crop on loess-like soil in Lublin region and following species dominated: *Amaranthus retroflexus*, *Chenopodium album*, *Echinochloa crus-galli*, and *Galinsoga parviflora*.
2. Weed species differed greatly in the course of their growth and development. All annual weeds attained fruiting stage and *Capsella bursa-pastoris*, *Senecio vulgaris* and *Urtica urens* finished their vegetation till time of harvest of bean seeds.
3. Majority of weeds emerged during the first three weeks after sowing of beans, some weeds germinated also in the next two weeks and then their number decreased gradually till harvest of beans.
4. Fresh weight of weeds increased rapidly in the time of intensive vegetative growth from 3<sup>rd</sup> to 5-7<sup>th</sup> week after sowing of beans, then much slower at flowering and fruiting stage and finally it decreased as a result of decaying of some weed species.

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#### ZMIANY W ZBIOROWISKU CHWASTÓW WYSTĘPUJĄCYCH W UPRAWIE FASOLI

Streszczenie: W trzyletnim doświadczeniu polowym uprawiano fasolę zwykłą (*Phaseolus vulgaris* L.) 'Bona' na zbiór zielonych strąków oraz suchych nasion jako materiału siewnego. Począwszy od trzeciego tygodnia po siewie aż do zbioru, co 2 tygodnie oznaczano rosnące w doświadczeniu gatunki chwastów, a także ich fazę wzrostu, liczbę i świeżą masę. W doświadczeniu wystąpiło 38 gatunków, głównie rocznych dwuliściennych. Dominującymi były: chwastnica jednostronna, komosa biała, szarłat szorstki oraz żóltlica drobnokwiatowa. Większość chwastów wschodziła podczas trzech pierwszych tygodni uprawy, niektóre podczas kolejnych dwóch tygodni i następnie ich liczba stopniowo malała. Świeża masa chwastów wzrastała szybko w okresie od trzeciego do piątego – siódmego tygodnia po siewie, znacznie wolniej w kolejnych tygodniach i następnie stopniowo malała wskutek zamierania niektórych chwastów. Wszystkie chwasty roczne osiągnęły fazę owocowania, a niektóre gatunki zakończyły wegetację do czasu zbioru nasion fasoli.

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