

## THE ASSESSMENT OF WEED INFESTATION OF OATS-PEA MIXTURES GROWN IN ORGANIC FARM

### Summary

The field experiment with legume-cereal mixtures was carried out in the years 2011-2013, at the Advisory Agricultural Center in Szepietowo (Podlaskie voivodeship). The aim of the study was to assess the degree of weed infestation of mixtures of oats with pea grown in organic farm. The first factor was the cultivar of pea (semi-leafless Milva cultivar and with bipinnate leaves Klif cultivar), while the second factor was the percentage of pea in the weight of sown seeds (40, 60 and 80%). Qualitative and quantitative analyses of weed infestation of the mixtures were carried out with the use of the square-frame method from the surface of 0,5 m<sup>2</sup>. The studies have shown that the mixtures with 40% share of legumes had the smallest weed infestation measured by the dry matter of weeds. The mixtures with semi-leafless pea cultivar Milva were somewhat more competitive against the matter of weeds, but such dependency was not recorded in relation to the numbers and composition of the segetal flora. Species diversity of weeds was similar in all mixtures. The most common species, regardless of the percentage of the components and the cultivar of peas were: *Stellaria media*, *Chenopodium album*, *Galinsoga parviflora* and *Erigeron canadensis*.

**Słowa kluczowe:** mixtures, oat, peas, organic farming, weeds

## OCENA ZACHWASZCZENIA MIESZANEK OWSA Z GROCHEM UPRAWIANYCH W WARUNKACH GOSPODARSTWA EKOLOGICZNEGO

### Streszczenie

W latach 2011-2013 przeprowadzono badania, których celem było ocena stopnia zachwaszczenia mieszanek owsa z grochem uprawianych ekologicznie, w zależności od odmiany grochu i jego udziału w mieszance. Badania wykonano w Podlaskim Ośrodku Doradztwa Rolniczego w Szepietowie. Czynnikiem pierwszego rzędu była odmiana grochu (samokończąca Milva i o tradycyjnym ulistnieniu Klif), zaś drugiego rzędu – udział grochu w masie wysiewanych nasion (40, 60 i 80%). Przeprowadzono jakościowo-ilościowe analizy zachwaszczenia mieszanek, metodą ramkową z powierzchni 0,5 m<sup>2</sup>. Badania wykazały, że najmniejszym zachwaszczeniem mierzonym suchą masą chwastów charakteryzowały się mieszanki z 40% udziałem rośliny strączkowej. Mieszanki z wąsolistną odmianą grochu Milva były nieco bardziej konkurencyjne w stosunku do masy chwastów, natomiast nie zanotowano takiej zależności w stosunku do liczebności i składu gatunkowego flory segetalnej. Różnorodność gatunkowa chwastów była podobna w uprawie wszystkich mieszanek. Najliczniej występującymi gatunkami, niezależnie od udziału komponentów i odmiany grochu były: *Stellaria media*, *Chenopodium album*, *Galinsoga parviflora* and *Erigeron canadensis*.

**Słowa kluczowe:** mieszanka, owiec, groch, rolnictwo ekologiczne, chwasty

### 1. Introduction

Mixtures of spring cereals with legumes are considered good agricultural practice in organic and low-input farming system [1, 2]. Cultivation of mixtures contributes to the complementary use of habitat resources and compensatory growth of individual plant species, causing an increased productivity and greater stability of yield [3, 4]. Moreover, the risk of lodging of legumes is significantly reduced. Mixtures limited the negative effects of excessive share of cereals in crop rotation and they are a good forecrop for the succeeding crops. They have a positive effect on the soil fertility, enriching it with nitrogen through a symbiosis of legumes with nodule bacteria and in organic matter due to the huge amount of crop residue left behind [5]. They are treated with lower doses of nitrogen fertilizer in comparison to a sole cereal, which is advantageous from an economic point of view. Yielding of mixtures and crop quality largely depends on the selection of components and their participation. Oats is considered a species which competes well with weeds due to the dynamics of the growth of its above-

ground and underground part of plants, longer stems and rich foliage which shades the soil [6]. According to Idziak and Michalski [7], the cultivation of oats in the mixture is a better option than pure sowing, because the intraspecific competition for this species is stronger than interspecific one. The research conducted by Buczek et al. [8] showed that the legume-cereal mixtures with oats are more competitive against the weeds than the mixtures with wheat and barley. This is also confirmed by the previous studies of these authors [9]. According to many authors increasing the share of legume seeds in the sowing norm increases their share in the yield, but the yield of grain cereals and the total yield of mixtures generally decrease [10, 11, 12, 13, 14]. Control of weed infestation in organic and low-input farming involves the use of direct methods, involving interventions into the stand and indirect methods of preventive character, such as proper crop rotation, choice of cultivars with greater competitiveness against weeds, proper agronomical practices and the use of undersown crops and mixed sowings [15, 16, 17]. Mixtures of legumes with cereals strongly compete with weeds than sole crops, but it is

also dependent on the composition of the mixture, the share of components, as well as weather and habitat conditions [18]. The aim of the study was to assess the weed infestation of oats-pea mixtures, grown in organic farm, depending on the cultivar of pea and its share in the weight of seeds sown.

## 2. Material and methods

The field experiment with oats-pea mixtures was carried out in the years 2011-2013, at the Advisory Agricultural Center in Szepietowo (Podlaskie voivodeship), in split-plot system, with four replication. The first factor was the cultivar of *Pisum sativum* (L.): Milva (semi-leafless cultivar) and Klif (with bipinnate leaves). The second factor concerned the percentage of *P. sativum* in mixture with *Avena sativa* (L.): 40, 60 and 80%. The density of plants in pure sowing, used as the base to calculate their density in the mixtures, was as follows: *P. sativum* 80 units·m<sup>-2</sup>, *A. sativa* 500 units·m<sup>-2</sup>. The area of a plot was 30,0 m<sup>2</sup>. The experiment was conducted on a soil belonging to a good rye complex, class IV b. The contents of available nutrients were (mg·kg<sup>-1</sup> soil): phosphorus 68, potassium 79 and magnesium 49. Soil pH, as determined in 1 N KCl, was 5,3. Seeds were sown at the first (2011 and 2012) and third (2013) decade of April. The plots were harrowed twice to control weeds in the mixtures.

Plants were harvested at the full maturity stage of mixture components at the second decade of August. Weed infestation of the mixtures was analyzed a couple days before

harvesting plants, on the surface of 0,5 m<sup>2</sup>, with four replication. The study included an evaluation of weed species composition, number of individual species and the designation of fresh and dry matter of weeds. Assessing the significance of the impact of the considered factors on the features under investigation was based on the variance analysis, indicating Tukey's confidence half-intervals at a significance level of 0,05.

## 3. Results

The degree of weed infestation of legume-cereal mixture largely depends on the weather conditions (tab. 1). In 2011, the sum of precipitation during the growing period was significantly higher than the average amount from the multi-year period, which was mainly caused by heavy rainfall in July. Favorable weather conditions, both in terms of the amount and distribution of rainfall and temperature were recorded in 2012, while significant moisture deficits occurred in July of 2013.

The percentage of pea in the mixture differentiated the dry matter of weeds (tab. 2). In all years of the research, the lowest weed infestation was recorded for the mixture with 40% of pea in the sowing, while the mixtures with 60% of pea were the least competitive against weeds in 2011 and 2012, while in 2013 – the mixtures with 80% of legume. The differences, however, were not statistically proven. The comparison of pea cultivars showed that, in general, the mixtures with semi-leafless pea cultivar Milva were more competitive against the weight of weeds.

Table 1. Meteorological conditions during the growing seasons in 2011-2013

Tab. 1. Warunki meteorologiczne podczas sezonu wegetacyjnego w latach 2011-2013

Months	Mean monthly of temperature (°C)				Sum of monthly precipitation (mm)			
	2011	2012	2013	Average from multi-year period	2011	2012	2013	Average from multi-year period
III	0,4	3,2	-4,2	1,6	18,0	19,5	18,5	30,0
IV	9,2	8,5	10,8	7,7	43,0	44,6	45,8	39,0
V	13,4	14,1	14,0	13,4	67,0	61,0	82,0	57,0
VI	18,5	15,6	18,4	16,7	57,0	105,5	82,9	71,0
VII	18,2	19,7	19,0	18,3	219,0	101,1	21,0	84,0
VIII	18,2	17,3	15,1	17,3	62,0	67,8	67,6	75,0
Mean temperature	<b>13,0</b>	<b>13,0</b>	<b>12,1</b>	<b>12,5</b>				
Sum of precipitation (III-VIII)					<b>466,0</b>	<b>399,5</b>	<b>317,8</b>	<b>356,0</b>

Table 2. Dry matter of weeds depending on the variety of pea and its percentage in mixtures

Tab. 2. Sucha masa chwastów w zależności od odmiany grochu i jego udziału w mieszance (g·m<sup>-2</sup>)

Pea percentage (%)	Year						Mean	
	2011		2012		2013			
	cultivar of pea							
	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif
40	56,0	52,4	23,1	27,3	8,4	23,5	29,2	34,4
60	64,5	108,5	36,1	19,1	10,7	41,0	37,1	56,2
80	44,0	83,4	26,8	18,3	32,4	44,6	34,4	48,8
	Mean for cultivar							
Mean	54,8	81,7	28,7	21,6	17,1	36,4	33,6	46,5
NIR	n.s.		n.s.		n.s.		n.s.	
	Mean for pea percentage							
40	54,2		25,2		15,9		31,8	
60	86,5		27,6		25,9		46,7	
80	63,7		22,6		38,5		41,6	
NIR	n.s.		n.s.		n.s.		n.s.	

Source: Own work / Źródło: opracowanie własne

In all the years of the research, the mixtures with 40% of pea were characterized by a slightly higher amount of weeds per area unit (average for cultivars and years, 82,3 plants per 1 m<sup>2</sup>), whereas with the increasing percentage of legumes plants in the weight of the sown seeds, the amount of undesirable species generally decreased (tab. 3-5). In the

mixtures with 60% of pea, there were, on average, 64,9 and from 80% - 55,5 plants per 1 m<sup>2</sup>. There was not a significant difference between the competitiveness of the mixtures in relation to the numbers of weeds per area unit depending on the variety of pea.

Table 3. Weed species composition and number of weeds (plants·m<sup>-2</sup>) in pea-oats mixtures depending on the cultivar of pea and its percentage in mixture in 2011

Tab. 3. Skład gatunkowy i liczebność chwastów (szt.·m<sup>2</sup>) w mieszankach w zależności od odmiany grochu i jego udziału w mieszance w 2011 roku

Weed species	Percentage of pea (%)					
	40		60		80	
	Milwa	Klif	Milwa	Klif	Milwa	Klif
<i>Echinochloa crus-galli</i>	-	-	0,5	0,5	-	-
<i>Elymus repens</i>	1,5	1,0	1,0	0,5	2,5	0,5
<i>Plantago lanceolata</i>	-	-	0,5	-	0,5	-
<i>Plantago major</i>	2,0	1,5	1,5	-	1,0	1,0
<i>Centaurea cyanus</i>	-	0,5	1,5	1,0	-	-
<i>Viola arvensis</i>	3,0	1,5	-	0,5	0,5	1,0
<i>Stellaria media</i>	19,0	17,0	19,5	13,5	21,5	8,5
<i>Lamium amplexicaule</i>	-	-	-	-	0,5	-
<i>Chenopodium album</i>	3,5	8,5	11,5	6,5	19,0	6,0
<i>Trifolium arvense</i>	-	0,5	-	-	-	-
<i>Sonchus asper</i>	1,0	-	-	2,0	1,0	0,5
<i>Sonchus oleraceus</i>	0,5	-	0,5	-	0,5	0
<i>Cirsium arvense</i>	7,5	14,0	6,0	10,0	3,5	13,5
<i>Veronica persica</i>	-	0,5	-	0,5	-	-
<i>Polygonum persicaria</i>	1,0	1,0	0,5	2,0	-	0,5
<i>Fallopia convolvulus</i>	4,5	1,5	1,5	3,0	2,0	-
<i>Polygonum aviculare</i>	4,5	4,0	0,5	1,5	1,0	2,5
<i>Anthemis arvensis</i>	1,5	1,5	4,5	4,5	0,5	1,0
<i>Eguisetum arvense</i>	-	-	5,0	-	1,0	-
<b>Sum</b>	<b>49,5</b>	<b>53,0</b>	<b>54,5</b>	<b>46,0</b>	<b>55,0</b>	<b>35,0</b>
<b>Number of species</b>	<b>12</b>	<b>13</b>	<b>15</b>	<b>13</b>	<b>14</b>	<b>10</b>

Source: Own work / Źródło: opracowanie własne

Table 4. Weed species composition and number of weeds (plants·m<sup>-2</sup>) in pea-oats mixtures depending on the cultivar of pea and its percentage in mixture in 2012

Tab. 4. Skład gatunkowy i liczebność chwastów (szt.·m<sup>2</sup>) w mieszankach w zależności od odmiany grochu i jego udziału w mieszance w 2012 roku

Weed species	Percentage of pea (%)					
	40		60		80	
	Milwa	Klif	Milwa	Klif	Milwa	Klif
<i>Echinochloa crus-galli</i>	5,5	-	5,8	4,3	4,0	6,8
<i>Elymus repens</i>	2,8	2,8	3,0	2,8	1,0	1,0
<i>Setaria pumila</i>	7,5	10,8	7,3	5,5	8,0	4,3
<i>Plantago major</i>	27,5	16,0	12,0	5,8	7,3	3,8
<i>Geranium dissectum</i>	-	-	-	0,3	0,3	-
<i>Viola arvensis</i>	4,8	3,8	13,0	3,5	7,5	3,5
<i>Sinapis arvensis</i>	-	-	-	-	-	1,0
<i>Stellaria media</i>	3,5	7,5	2,5	2,0	2,8	3,0
<i>Ranunculus repens</i>	0,3	-	-	-	-	-
<i>Chenopodium album</i>	5,8	7,0	5,3	2,0	4,3	8,3
<i>Trifolium arvense</i>	1,5	2,5	0,8	1,8	2,8	1,3
<i>Matricaria maritima</i>	2,3	4,0	0,5	-	0,5	0,5
<i>Sonchus asper</i>	0,3	0,5	-	-	1,5	0,3
<i>Sonchus oleraceus</i>	-	-	1,0	1,0	1,8	0,8
<i>Taraxacum officinale</i>	0,3	0,5	-	-	-	-
<i>Myosotis arvensis</i>	-	-	-	-	-	0,3
<i>Cirsium arvense</i>	0,3	-	-	-	0,3	1,0
<i>Convolvulus arvensis</i>	0,3	-	0,5	-	-	-
<i>Veronica persica</i>	2,5	0,8	0,8	-	-	0,8
<i>Erigeron canadensis</i>	14,3	23,5	26,3	7,8	4,8	4,3

cont. of table 4 / cd tab. 4

<i>Polygonum persicaria</i>	-	-	-	-	0,3	0,3
<i>Fallopia convolvulus</i>	6,0	0,5	4,0	-	1,3	0,5
<i>Polygonum aviculare</i>	2,3	2,0	2,0	1,0	-	2,3
<i>Cerastium arvense</i>	0,3	-	-	-	-	-
<i>Anthemis arvensis</i>	1,0	1,0	1,8	0,3	1,0	1,3
<i>Lactuca serriola</i>	7,3	4,8	3,3	-	0,5	-
<i>Spergula arvensis</i>	4,0	3,3	0,8	0,8	1,0	-
<i>Gnaphalium uliginosum</i>	8,0	1,5	5,3	3,8	0,5	3,3
<i>Rumex obtusifolius</i>	0,3	0,8	0,3	-	1,0	0,3
<i>Capsella bursa-pastoris</i>	-	0,8	1,0	0,5	0,3	0,3
<i>Vicia hirsuta</i>	-	0,3	-	-	-	-
<i>Galinsoga parviflora</i>	20,0	21,3	14,5	18,8	9,3	13,5
<i>Equisetum arvense</i>	0,5	1,0	0,8	1,3	1,3	-
<b>Sum</b>	<b>129,2</b>	<b>117,0</b>	<b>112,6</b>	<b>63,3</b>	<b>63,4</b>	<b>62,8</b>
<b>Number of species</b>	<b>26</b>	<b>23</b>	<b>23</b>	<b>18</b>	<b>24</b>	<b>24</b>

Source: Own work / Źródło: opracowanie własne

Table 5. Weed species composition and number of weeds (plants·m<sup>-2</sup>) in pea-oats mixtures depending on the cultivar of pea and its percentage in mixture in 2013

Tab. 5. Skład gatunkowy i liczebność chwastów (szt.·m<sup>2</sup>) w mieszankach w zależności od odmiany grochu i jego udziału w mieszance w 2013 roku

Weed species	Percentage of pea (%)					
	40		60		80	
	Milwa	Klif	Milwa	Klif	Milwa	Klif
<i>Echinochloa crus-galli</i>	-	0,5	0,5	-	-	1,5
<i>Elymus repens</i>	-	-	0,5	-	-	0,5
<i>Setaria pumila</i>	4,5	1,5	1,5	4,0	3,0	1,0
<i>Anthemis arvensis</i>	1,5	3,5	2,5	1,0	0,5	2,0
<i>Aphanes arvensis</i>	-	0,5	-	-	-	-
<i>Capsella bursa-pastoris</i>	-	-	1,0	-	-	-
<i>Chenopodium album</i>	15,0	12,0	20,0	21,0	20,0	23,0
<i>Cirsium arvense</i>	1,5	2,0	1,5	6,0	1,5	4,5
<i>Convolvulus arvensis</i>	0,5	1,0	-	1,5	1,0	0,5
<i>Erigeron canadensis</i>	22,0	13,5	4,5	3,5	2,0	19,5
<i>Fallopia convolvulus</i>	1,5	5,0	4,0	0,5	4,5	3,5
<i>Plantago major</i>	19,0	2,5	11,5	0,5	3,0	-
<i>Polygonum aviculare</i>	1,5	0,5	0,5	1,0	1,0	0,5
<i>Polygonum per Esicaria</i>	-	2,0	0,5	-	1,0	2,5
<i>Rumex acetosella</i>	1,0	-	-	-	-	-
<i>Senecio vulgaris</i>	4,5	8,0	3,5	1,0	2,5	1,0
<i>Sonchus asper</i>	1,5	-	0,5	-	0,5	0,5
<i>Sonchus oleraceus</i>	-	-	0,5	-	-	-
<i>Trifolium arvense</i>	1,0	-	0,5	-	0,5	0,5
<i>Veronica persica</i>	3,5	-	-	-	-	1,0
<i>Viola arvensis</i>	1,0	1,0	2,0	1,0	2,5	1,0
<i>Equisetum arvense</i>	1,0	11,0	1,5	15,0	4,0	6,5
<b>Sum</b>	<b>80,5</b>	<b>64,5</b>	<b>57,0</b>	<b>56,0</b>	<b>47,5</b>	<b>69,5</b>
<b>Number of species</b>	<b>16</b>	<b>15</b>	<b>18</b>	<b>12</b>	<b>15</b>	<b>17</b>

Source: Own work / Źródło: opracowanie własne

Species diversity of segetal flora was similar in all mixtures. The presences of 32 species of dicotyledonous and 3 species of monocotyledonous weeds were recorded. Regardless of the percentage of components and pea cultivar, *Stellaria media* and *Chenopodium album* were the most numerous species in the first year of the study, while in the second year it were *Galinsoga parviflora* and *Erigeron canadensis*, and in the third year - *Chenopodium album* and *Erigeron canadensis*. In certain years, there was also a relatively large percentage of *Cirsium arvense*, *Plantago major*, *Viola arvensis* and *Equisetum arvense* and among monocotyledonous species in the second year of the study – *Setaria glauca* and *Echinochloa crus-galli*.

#### 4. Discussion

Weed infestation of mixed sowings of cereals and legumes depends on, among others, their density and species included in the mixture. The more compact stand, the more competitive the crop is against the weeds. Our study showed that the mixtures with 40% of legumes at the sowing were the most competitive against the weeds. These results were confirmed by other authors that indicate that increasing the percentage of legume in the mixture causes an increase in weed infestation, which indicates a higher competitiveness of cereals against weeds in comparison with legumes [19, 20].

In own studies, the mixtures of oats with semi-leafless pea cultivar Milwa were more competitive against the matter of weeds. Pea varieties differ considerably in term of the stems length, leaf arrangement, susceptibility to lodging and length of the growing season. They also differ in term of their complementarity in relation to cereals. It is important to choose the cultivars which yield best under given habitat conditions. The height of the components in the mixtures and their diverse habitus determine the canopy architecture. Large differences in the height of plants lead to layered structure of the stand, which creates less favorable light conditions for the species with shorter stems. Particularly unfavorable conditions occur when legumes dominate over cereals, because it leads to the lodging of plants and, consequently, to the yield reduction [14, 21]. According to Książak and Borowiecki [22] high yielding potential was recorded for semi-leafless cultivars of pea, which are particularly useful for mixtures with spring cereals grown for seeds. Due to the large amount of tendrils, they have a lower coefficient of transpiration and are less susceptible to lodging.

There is no evidence of a significant influence of the percentage of components and pea cultivar in the mixture on the species composition of weeds, which is consistent with the findings of other authors [19]. The most numerous were dicotyledonous weed species: *Stellaria media*, *Chenopodium album*, *Galinsoga parviflora* and *Erigeron canadensis*. According to many authors, perennial species are especially bothersome types of weeds in organic farms. According to Barankiewicz and Misiewicz [23], serious problems in the cultivation of spring cereals are caused, among others, by: *Galinsoga parviflora*, *Capsella bursa-pastoris*, *Stellaria media* and *Chenopodium album*, according to Kapeluszný and Haliniarz [24] – *Sonchus arvensis*, *Chenopodium album*, *Echinochloa crus-galli* and *Equisetum arvense* and in opinion of Feledyn-Szewczyk [25] – *Chenopodium album* and *Stellaria media*. In previous studies, the authors pointed to *Chenopodium album*, *Echinochloa crus-galli*, *Stellaria media* and *Capsella bursa-pastoris* as the species which was the most bothersome and which occurred in the highest amounts in organic farms [26].

## 5. Conclusions

1. The level of weed infestation of the oats-pea mixtures was slightly dependent on the percentage of components. The lowest dry matter of weeds in the stand of the mixture was recorded for the mixture with 40% of legume as compared to the mixtures with 60 and 80% of pea.
2. A higher numbers of weeds per area unit were found for the mixtures with 40% share of pea, whereas increasing the percentage of legume seeds at the sowing, the number of unwanted species generally decreased.
3. The mixtures with semi-leafless pea cultivar Milwa were slightly more competitive against the matter of weeds than cultivar Klif with bipinnate leaves, while there was not such dependency in relation to the numbers and species composition of segetal flora.
4. Species diversity of weeds was similar in the cultivation of all mixtures. The most numerous species, regardless of the percentage of components and pea cultivar were: *Stellaria media*, *Chenopodium album*, *Galinsoga parviflora* and *Erigeron canadensis*.

## 6. References

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