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EVALUATION OF YIELDING OF OATS-PEA MIXTURES CULTIVATED IN ORGANIC FARMING

Summary

In the years 2011-2013 the studies were carried out, whose aim was to assess a yielding of oat-pea mixtures grown on seeds in organic farming. The field experiment was conducted at the Agricultural Advisory Center in Szepietowo. The cultivar of Pisum sativum (L.): Milva (semi-leafless cultivar) and Klif (with bipinnate leaves) was the first factor. The second factor concerned the percentage of P. sativum in mixture with Avena sativa (L.): 40, 60 and 80%. The study showed that the mixtures yield was significantly influenced by tested factors and the course of weather conditions. Increasing the percentage of legume seeds in the mixtures with semi-leafless cultivar Milwa as well as with cultivar of bipinnate leaves - Klif resulted in the decrease in their yields. In 2011 and 2013, higher yields were recorded for Milwa cultivar and, in more favorable moisture conditions, for Klif cultivar. Number of nodes with pods and the number of pods per plant in the both tested cultivars, regardless of the morphological composition, had not influence on a significant differentiation together with increasing the pea percentage in mixture with oat. Increasing of pea percentage in weight of sown seeds resulted in an increase in the number of seeds per plant in both pea cultivars only in the first year of the studies, while in the following years, it resulted in the reduction in the number of seeds. It was found that together with increase of pea percentage in mixture, the length of fruiting part and dry matter of siliques per plant were reduced. The composition of mixtures had a little effect on the height to t he first pod and height of plants.
Key words: *cereal-legumes mixtures, yielding level, pea cultivar, organic farming*

OCENA PLONOWANIA MIESZANEK GROCHU Z OWSEM UPRAWIANYCH W SYSTEMIE EKOLOGICZNYM

Streszczenie

W latach 2011-2013 przeprowadzono badania, których celem była ocena plonowania mieszanek grochu z owsem uprawianych według zasad rolnictwa ekologicznego, w zależności od odmiany grochu i jego udziału w masie wysiewanych nasion. Badania zrealizowano w Podlaskim Ośrodku Doradztwa Rolniczego w Szepietowie, w układzie podbloków losowanych (split-plot), w 4 powtórzeniach. Czynnikiem I rzędu były odmiany grochu: Milwa (wąsolistna), Klif (tradycyjna), a czynnikiem II rzędu udział grochu w mieszance: 40, 60 i 80%. Badania wykazały, że zwiększenie udziału nasion roślin bobowatej w wysiewanych mieszankach zarówno z wąsolistną odmianą grochu Milwa, jak i z odmianą o normalnym ulistnieniu Klif, powodowało zmniejszenie poziomu ich plonowania średnio o 10%. Poziom plonowania mieszanek i grochu był istotnie uzależniony od odmiany grochu. W 2011 i 2013 roku większymi plonami cechowała się odmiana Milwa, zaś w roku o korzystniejszych warunkach wilgotnościowych, odmiana Klif. Cechy morfologiczne, określające liczbę węzłów ze strąkami i liczbę strąków na roślinie, u obu ocenianych odmian niezależnie od budowy morfologicznej nie ulegały znacznemu zróżnicowaniu w miarę zwiększenia udziału grochu w mieszance z owsem. Więcej strąków i nasion na roślinie oraz strąków na węźle wytwarzała odmiana Klif. Stwierdzono że, zwiększanie udziału grochu w masie wysiewanych nasion powodowało wzrost liczby nasion na roślinie u obu odmian grochu jedynie w pierwszym roku badań, natomiast w kolejnych latach powodowało ich zmniejszenie. Stwierdzono, że wraz ze wzrostem udziału grochu w mieszance, długość części owocującej, sucha masa łodygi i masa strączyn z jednej rośliny ulegały zmniejszeniu.
Słowa kluczowe*: mieszanki zbożowo-strączkowe, poziom plonowania, odmiana grochu, rolnictwo ekologiczne*

1. Introduction

The demand for feed protein in Poland and the European Union is now covered in 23-25% by the production of legume seeds [1]. In order to meet its annual feed requirements, Poland needs approximately 1 million tonnes of protein [2]. In recent years, there has been initiated a discussion on support of legumes plants. The proponents of this issue suggest that their production should be developed due to the positive impact of these species on the environment and the possibility of their use as an additional source of protein in feed production [1]. One of the most important characteristics of this group of plants is the ability to fix atmospheric nitrogen. The studies of Szukała [3] showed that lupines, by root nodule bacteria, enrich the soil with 40-60 kg $N \cdot ha^{-1}$ of atmospheric nitrogen and field pea leaves with 40-60 kg $N \cdot ha^{-1}$ [4], thereby the introduction of legumes to crop rotation allows to limit the use of mineral fertilizers by as much as 20-25% [5].

The qualitative selection of mixture components has often been addressed in the studies concerning the assessment of the composition and yield of mixtures of cereals with peas [6; 7; 8]. A cereal crop in the mixture with pea gives a greater yielding stability of the mixture, but at the same time constitutes a strong competition to peas, which causes that the share of pea seeds in the mixture yield is often vari-

able [9]. Cereal - legume mixtures play an important role in the sustainable development of agricultural production due to the low use of non-agricultural inputs, especially of mineral fertilization [10], leaving a good position for the succeeding plants [11, 12] and phytosanitary function in the individual stages of crop rotation [13, 14].

It is worth emphasizing that the cultivation of legume-cereal mixtures was recognized as a good agricultural practice, especially under organic and integrated production systems and the need was pointed out to seek pea cultivars adapted to this type of cultivation [10, 15, 16, 17].

2. Material and methods

The field experiment with oats-pea mixtures was carried out in the years 2011-2013, at the Agricultural Advisory Center in Szepietowo [52°52′11″N 22°32′27″E], (Podlaskie province), in split-plot system, with four replications. The cultivar of *Pisum sativum* (L.): Milva (semi-leafless cultivar) and Klif (with bipinnate leaves) was the first factor. 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^{-2}, *A. sativa* 500 units·m^{-2}. The plot area was 30,0 m^2. The experiment was conducted on a soil belong to a good rye complex, class IV b. The contents of available nutrients (mg·kg^{-1} soil) were: phosphorus 68, potassium 79 and magnesium 49. Soil pH, as determined in 1 N KCl, was 5,3. In the first year, forecrop was: spelt wheat, in the second and third year – vegetables. 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 full maturity stage of mixture components at the second decade of August. The density of pea and oat, the degree of lodging of them were estimation. Moreover the height of plants, height to the first and last pod, length of fruiting part of pea, number of pods per fruiting node, number of nodes with fruiting pods per plant, number and weight of seeds, stem dry matter of one plant, dry matter of siliques, height of oat plants, weight of 1000 grains of oat, number and weight of grains on oat plant. After harvesting, the yield of mixture seeds, share of components in yield and weight of 1000 seeds were estimated by moisture 14%.

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 and discussion

The yield of mixtures depended on the course of weather conditions. In the second (2012) and third year of the study (2013), in April, total monthly rainfall remained at a similar level, whereas it was slightly lower in the first year (2011) (Tab. 1), which resulted in relatively lower level of mixtures yield. A greater diversity of total monthly rainfall among the individual years of the study was reported in June. In the second year of the study, a large precipitation in June, far exceeding average of multi-year period, resulted in a rapid growth of mixtures, resulting in a higher seeds yield of mixture and pea. Michalska [18] reports that the yield of pea seeds is largely affected by thermal conditions in April, and the largest demand for water in the development of pea occurs about two weeks before flowering. Drought stress causes the inhibition of elongation growth, weaker development of leaves and stems and the reduction of assimilation area of leaves in young, developing pea plants [19]. The result is a reduction in the number of formed flower buds and the number of pods per plant, the quantity of seeds per pod and thousand seeds weight [20]. The mixtures yield was affected by the tested factors (pea cultivar and its percentage in the weight of sown seeds). The highest seed yields, both from the mixture and pea were obtained in the second year of the study (2012), which was characterized by favorable moisture conditions, in both varietal combinations. The seeds yield of the mixture and pea significantly depended on the pea cultivar used in the mixtures. In 2011 and 2013, higher seeds yield of both mixture and pea were achieved due to the use of traditional pea cultivar, Milwa, while in 2012, Klif cultivar. The importance of the selection of legume cultivar as a component of mixture with spring cereals was confirmed by the studies of Rudnicki and Wenda-Piesik [21].

Table 1. Meteorological conditions in the periods of vegetation in 2011-2013

Tab. 1. Meteorological conditions in the periods of vegetation in 2011-2013

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

Source: Own work / Źródło: opracowanie własne

In all years of the research, the increase in percentage of pea seeds in mixtures with semi-leafless cultivar - Milwa as well as with bipinnate leaves cultivar - Klif caused a decrease in the level of their yields (Tab. 2). An increase in the percentage of pea seeds in the sown mixture up to 80% caused a reduction in their productivity by respectively: 12% in 2011, 14% in 2012 and 4% in 2013, compared with the yield obtained at the lowest percentage of legume plants. Such a dependency was observed by a number of authors for the cereal-pea mixtures [7; 22; 23; 24; 25; 26; 27; 28; 29], as well as for the mixtures of cereal with yellow and blue lupine [30]. Other studies on the density of sowing and the composition of mixtures indicate that the percentage of legumes can range from 30 to 50% [7; 31; 32], whereas - due to the possibility of a stronger lodging – pea percentage of about 30% is better for mixtures with high-stem cultivars. Similar conclusions can be drawn from the results of the studies by Borowiecki and Księżak [15]

Table 2. Seeds yield of mixture and pea in researched years
Tab. 2. Plon nasion mieszanki i grochu w latach badań

Pea percentage (%)	Yield of mixture seeds (t·ha^{-1})						Yield of pea seeds (t·ha^{-1})					
	2011		2012		2013		2011		2012		2013	
	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif
40	4,36	4,14	5,15	5,46	4,39	4,25	1,57	1,47	1,75	1,80	1,25	1,32
60	4,32	4,03	4,69	4,89	4,57	4,32	2,38	2,10	2,63	2,69	2,46	2,25
80	3,95	3,62	4,63	4,44	4,32	3,96	2,80	2,53	3,38	3,33	3,14	2,89
Mean for cultivar												
	4,21a	3,93b	4,82a	4,93a	4,43a	4,18b	2,25a	2,03b	2,59a	2,61a	2,28a	2,15b
Mean for pea percentage												
40	4,25a		5,31a		4,32a		1,52a		1,78a		1,29a	
60	4,18a		4,79a		4,45a		2,24a		2,66a		2,36a	
80	3,79a		4,54a		4,14a		2,67a		3,36a		3,02a	

** numbers in columns followed by the same letters do not differ significantly / * liczby w kolumnach oznaczone tymi samymi literami nie różnią się istotnie* *Source: Own work / Źródło: opracowanie własne*

Table 3. Pea percentage in mixture yields and thousand seeds weight of pea
Tab. 3. Udział grochu w plonie mieszanki oraz masa tysiąca nasion grochu

Pea percentage (%)	Pea percentage in yields (%)						Thousand seeds weight					
	2011		2012		2013		2011		2012		2013	
	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif
40	36,0	34,0	34,0	33,0	28,0	31,0	225,0	209,0	215,6	224,5	172,0	179,0
60	55,0	52,0	56,0	55,0	53,0	52,0	219,0	201,0	214,4	219,8	177,0	184,0
80	71,0	70,0	73,0	75,0	70,0	71,0	211,0	199,0	196,3	221,3	175,0	184,0
Mean for cultivar												
	54,0	52,0	54,0	54,0	50,0	51,0	218,0a	203,0b	208,8a	221,9b	172,0a	182,0b
Mean for pea percentage												
40	35,0		33,5		29,5		217,0a		220,0a		175,5a	
60	53,5		55,5		52,5		210,0b		217,1a		180,5b	
80	70,5		74,0		70,5		205,0c		208,8a		179,5c	

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and Siuta et al. [33], where the increase in the percentage of pea in the mixture with a simultaneous reduction of sowing density of spring cereal reduced the mixtures yield. In other studies of Księżak [34] concerning yielding of pea-wheat mixtures grown conventionally, the yield of seeds was not affected by an increasing pea percentage in the sowing.

Pea percentage in mixtures yield was by 7-10% lower than at the sowing, regardless of pea cultivar. Increasing pea percentage of seeds in sowing weight of seeds, regardless of the foliage type, resulted in an increase in the yield of pea seeds (Tab. 2) and its percentage in the mixture yield (Tab. 3). Increasing the percentage of pea seeds in the sown mixture up to 80% caused the increase in productivity of peas in the individual years by respectively: 76, 88 and 134% in comparison with the yields obtained at the lowest percentage of legumes. Also, according to other authors, increasing the percentage of legume seeds in the mixed sowings causes an increase in the share of their seeds in the mixture yields [27; 35; 36;]. According to Księżak and Magnuszewska [37], in the south-eastern region of Poland, oat is more competitive species for peas than wheat and barley, due to which the percentage of its seeds in the mixture yield is lower, while in north-eastern and the south-western regions, the percentage of pea seeds in the mixture yields is similar. However, according to Szczukowski [26] and Kotecki [24], the main reason for low pea yield in mixtures with spring cereals is a small number of pods formed by its plants. Increasing the percentage of legumes up to 80% in the number of sown seeds resulted in almost two-fold increase in the pea percentage in the yield. This dependency was the same for the mixtures with Milwa and Klif cultivars. The seeds of semi-leafless cultivar Milwa had a slightly larger percentage in the mixture yield compared to bipinnate leaves cultivar - Klif (Tab. 3).

The percentage of pea seeds in the mixture yield did not show a large variation in years. The overall tendency was that the lower proportion of the percentage of pea seeds in the yield, the higher cereal yield in the mixture. This dependency was confirmed by the studies of Rudnicki and Wenda Piesik [38], according to which, the correlation coefficients of these dependencies amounted to r =-0.96. The percentage of pea seeds in the mixture yields depended on the meteorological conditions in the years of research, which was also confirmed in other studies [9; 21; 27].

There was a slight decrease in the thousand seeds weight in the both tested pea cultivars under the influence of increasing the percentage of its seeds in the composition of sown mixture. In the first year of study, a larger thousands seeds weight was recorded for Milwa cultivar, while in the second and third year, for Klif cultivar (Tab. 3).

In the experiment, important morphological characteristics determining the pea yielding were assessed. The characteristics, which determine the number of pods per plant, considered by Święcicki [39] as a basic indicator of yielding potential of pea seeds, decreased together with an increase in pea percentage in mixture with oat only in the case of Klif cultivar. Among the many authors, there is a consistent view that together with increasing density of plants in the

stand, there is a decrease in the number of pods per plant [40; 41; 42]. The largest number of pods and nodes with pods in the both cultivars were recorded in the second year of the studies. Precipitation in June and in the first half of July of this year which improved moisture conditions enabled a good formation of pods by peas and obtaining high yields. More pods and seeds per plant and pods per node were produced by Klif cultivar (Tab. 4).

Increasing the percentage of pea seeds in weight of sown seed resulted in an increase in the number of seeds per plant in both pea cultivars only in the first year of studies, while in the following years, it caused a reduction in the number of seeds. The number and weight of seeds of Klif pea cultivar per plant was higher than for Milwa cultivar. It should be noted that in the year with better weather conditions, this difference was twofold higher. According to the authors [43; 44], the increase in density of plants in the stand results in the reduction of number of seeds per pod and seeds per plant. Due to the increase in density of pea plants, the weight of seeds per plant continued to decrease (Tab. 5). These results are consistent with the results obtained by Kotecki [40]; Kotecki and Grządkowska [41].

It was found that together with the increase in pea percentage in mixture, stem dry matter and dry matter of siliques per plant were reduced (Tab. 6). In 2011 and 2013, there was no variation between pea cultivars, while in 2012, the values of both these traits were significantly higher in Klif cultivar compared to Milwa. Stem dry matter of one plant for the pea percentage of 40, 60, 80 was higher at Klif cultivar by respectively: 61, 36, 23%. The mixtures composition had only a little effect on the height to the first pod and the height of the plant (Tab. 7), while the length of fruiting part decreased together with increasing pea percentage in the sown mixture. The changes in structure of pea in mixture with oat were reported by Księżak [7]. In the studies of this author, the first pod was formed higher on the shoot and the fruiting part of the shoot was elongated.

Table 4. Number of pods per fruiting node and number of nodes with fruiting pods per plant
Tab. 4. Liczba strąków na węźle oraz liczba węzłów ze strąkami

Pea percentage (%)	Number of pods per fruiting node						Number of nodes with fruiting pods per plant					
	2011		2012		2013		2011		2012		2013	
	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif
40	2,75	3,10	3,15	5,05	2,02	2,98	1,59	1,83	2,15	3,03	1,48	2,10
60	2,84	2,89	2,95	4,70	2,28	2,80	1,64	1,80	2,13	2,80	1,60	1,95
80	2,88	2,98	3,15	4,68	2,13	2,50	1,60	1,83	2,23	3,00	1,60	1,70
Mean for cultivar												
	2,82a	2,99a	3,08a	4,81a	2,14a	2,76b	1,61a	1,82b	2,17a	2,94a	1,56a	1,92a
Mean for pea percentage												
40	2,93a		4,10a		2,50a		1,71a		2,59a		1,79a	
60	2,87a		3,83b		2,54a		1,72a		2,47a		1,78a	
80	2,93a		3,92b		2,32a		1,72a		2,62a		1,65a	

** numbers in columns followed by the same letters do not differ significantly / * liczby w kolumnach oznaczone tymi samymi literami nie różnią się istotnie* *Source: Own work / Źródło: opracowanie własne*

Table 5. Number and weight of seeds on a plant
Tab. 5. Liczba i masa nasion na roślinie grochu

Pea percentage (%)	Number of seeds						Weight of seeds					
	2011		2012		2013		2011		2012		2013	
	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif
40	11,00	11,60	10,68	21,13	7,88	10,80	2,63	2,41	2,32	4,18	1,33	1,93
60	11,40	11,90	9,70	18,40	8,65	9,73	2,43	2,50	1,86	3,90	1,53	1,81
80	12,00	12,90	9,08	17,60	8,37	7,88	2,39	2,39	1,81	3,82	1,52	1,37

Source: Own work / Źródło: opracowanie własne

Table 6. Stem dry matter of one plant and dry matter of siliques (cm)
Tab. 6. Sucha masa łodygi jednej rośliny i masa strączyn z jednej rośliny (cm)

Pea percentage (%)	Stem dry matter of one plant						Dry matter of siliques					
	2011		2012		2013		2011		2012		2013	
	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif
40	1,57	1,65	1,58	2,55	1,51	1,35	0,36	0,40	0,60	1,21	0,33	0,44
60	1,38	1,35	1,46	1,98	1,48	1,30	0,35	0,36	0,42	1,18	0,30	0,45
80	1,40	1,32	1,49	1,84	1,37	1,25	0,35	0,39	0,44	1,30	0,31	0,42

Source: Own work / Źródło: opracowanie własne

Table 7. Height to the 1st pod, height of the apex pea and length of fruiting part of pea (mean from years 2011-2013)
Tab. 7. Wysokość do pierwszego strąka, wierzchołka rośliny oraz długość części owocującej grochu (cm) (średnia z lat 2011-2013)

Pea percentage (%)	Pea variety					
	Milwa			Klif		
	height to the:		length of fruiting part of pea	height to the:		length of fruiting part of pea
	1st pod	apex pea		1st pod	apex pea	
40	54	58	3,5	60	65	5,0
60	53	58	3,9	59	65	4,8
80	53	57	3,5	59	65	4,6

Source: Own work / Źródło: opracowanie własne

Other authors [24; 26] claimed that under the increase in the cereal component, there was limited the number of pods, seeds and weight of seeds per pea plant. Księżak [7] recorded a little impact of the differentiated percentage of the components in rate of sowing for the development of such features as: number of seeds per pod, number of fruiting nodes, number of pods and seeds per fruiting node.

The tested factors had a little effect on height and thousand grains weight of oat (Tab. 8). It should however be noted that in the third year of study, the number of grains per oat plant was about twofold higher than in the first year (Tab. 9).

Table 8. Height of plants and weight of 1000 grains of oat
Tab. 8. Wysokość roślin i MTZ owsa

Pea percentage (%)	Height of plant						Weight of 1000 grains of oat					
	2011		2012		2013		2011		2012		2013	
	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif
40	72,0	75,0	89,9	85,6	83,0	83,0	37,0	37,0	32,9	32,4	24,9	25,6
60	74,0	72,0	86,8	90,3	86,0	87,0	35,0	35,0	33,2	30,7	23,9	26,0
80	72,0	68,0	92,3	92,5	88,0	92,0	35,0	34,0	35,0	33,8	24,1	25,3
Mean for cultivar												
	72,7a	71,7a	89,7a	89,5a	85,7a	87,3a	35,7a	35,3a	33,7a	32,3b	25,3a	25,6b
Mean for pea percentage												
40	73,5a		87,8a		83,0a		37,0a		32,7a		25,3a	
60	73,0a		88,6b		86,5a		35,0a		32,0b		25,0a	
80	70,0a		92,4c		90,0a		34,5a		34,4c		24,7a	

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Table 9. Number and weight of grains on oat plant
Tab. 9. Liczba i masa ziaren na roślinie owsa

Pea percentage (%)	Number of grains						Weight of grains					
	2011		2012		2013		2011		2012		2013	
	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif	Milwa	Klif
40	43,0	39,0	53,4	47,8	50,0	67,8	1,6	1,4	1,8	1,2	1,5	1,7
60	43,0	42,0	53,4	57,4	78,7	69,2	1,6	1,5	1,8	1,8	1,7	1,8
80	38,0	37,0	53,7	69,5	75,1	107,1	1,3	1,4	2,2	2,3	1,7	2,4

Source: Own work / Źródło: opracowanie własne

4. Conclusions

1. The mixtures yield was significantly influenced by tested factors and the course of weather conditions. Increasing the percentage of legume seeds in the mixtures with semi-leafless cultivar Milwa as well as with cultivar of bipinnate leaves - Klif resulted in the decrease in their yields. In 2011 and 2013, higher yields were recorded for Milwa cultivar and, in more favorable moisture conditions, for Klif cultivar.
2. Number of nodes with pods and the number of pods per plant in the both tested cultivars, regardless of the morphological composition, had not influence on a significant differentiation together with increasing the pea percentage in mixture with oat. A higher number of pods and seeds per plant and pods per node were produced by Klif cultivar.
3. Increasing the pea percentage in weight of sown seeds resulted in an increase in the number of seeds per plant in both pea cultivars only in the first year of the studies, while in the following years, it resulted in the reduction in the number of seeds.
4. It was found that together with the increase in pea percentage in mixture, the length of fruiting part and dry matter of siliques per plant were reduced. The composition of mixtures had a little effect on the height to the first pod and height of plants.

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