Anna SZAFIROWSKA
Instytut Ogrodnictwa, Skierniewice, Poland
e-mail: anna.szafirowska@inhort.pl

DIFFERENCES BETWEEN SNAP BEAN CULTIVARS IN SEED PRODUCTIVITY AND QUALITY IN ORGANIC CULTIVATION

Summary

The aim of studies was to select the most suitable cultivars of snap bean for seed production under organic conditions. Seed cultivation in organic farms is rather troublesome because of the scarcity of efficient disease and pest control agents. On the other hand the legumes species are very much wanted in this kind of farms. The research was conducted on organic experimental field in the Institute of Horticulture at Skierniewice during 2012-2013. Ten open pollinated cultivars were examined as fallows: five yellow pod ones Furora Polana, Galopka, Korona, Tampa and Tara and five green pod Delfina, Eliza, Paulinera, Sandra and Syrenka. In general the yellow pod cultivars yielded better in both years of studies. Among them the highest yield was obtained from cv. Furora Polana and Tampa, but the lowest from cv. Tara. In the group of green pods cv. Syrenka yielded the best while the worst Eliza and Sandra. Seed parameters such as germination percentage, seedling and seed health differed between cultivars. Two of them distinguished themselves in the highest quality parameters. There were cv. Tampa with germination in average 89,4% and cv. Tara 83.3%. Seeds of some cultivars germinated below standards for this species. The seeds of three cultivars Sandra, Syrenka and Paulinera never reached the required minimum of germination.
***Key words**: snap bean cultivars, bean seed production, organic seed cultivation*

ZRÓŻNICOWANIE ODMIAN FASOLI SZPARAGOWEJ POD WZGLĘDEM PLONU I JAKOŚCI NASION W UPRAWIE EKOLOGICZNEJ

Streszczenie

Celem prowadzonych badań było wytypowanie odmian fasoli szparagowej najbardziej przydatnych do produkcji nasion w uprawie ekologicznej. Produkcja nasion w systemie ekologicznym jest obarczona trudnościami związanymi z niedostatkiem skutecznych środków ochrony roślin. Z drugiej strony rośliny motylkowate są zalecane do uprawy w gospodarstwach ekologicznych. Badania prowadzono na ekologicznym polu doświadczalnym Instytutu Ogrodnictwa w Skierniewicach w latach 2012-2013. Do badań wzięto dziesięć odmian ustalonych fasoli, pięć żółtostrąkowych: Furora Polana, Galopka, Korona, Tampa i Tara oraz pięć zielonostrąkowych: Delfina, Eliza, Paulinera, Sandra i Syrenka. W obu latach badań żółtostrąkowe odmiany plonowały lepiej niż zielonostrąkowe. Wśród tych pierwszych najlepiej plonującymi w obu latach badań były Furora Polana i Tampa, a najgorzej plonowała Tara. W grupie odmian zielonostrąkowych najwyższy plon dała Syrenka, a najniższy Eliza i Sandra. Parametry jakości nasion, takie jak energia i zdolność kiełkowania, udział siewek i nasion chorych, były zróżnicowane w zależności od odmiany. Dwie odmiany wyróżniały się najwyższymi parametrami kiełkowania: Tampa – ze średnią zdolnością kiełkowania 89,4% i Tara – 83.3%. Nasiona niektórych odmian kiełkowały poniżej wymaganej normy dla tego gatunku. Nasiona trzech odmian: Sandra, Syrenka i Paulinera w żadnym roku nie osiągnęły wymaganego minimum kiełkowania.
***Słowa kluczowe**: odmiany fasoli szparagowej, produkcja nasion fasoli, ekologiczna uprawa nasion*

1. Introduction

Worldwide seed production is usually located in areas of dry, arid climate with low disease - pressure which permits to produce seeds that meet seed-borne disease standards.

Fertile soils, water for irrigation, easy access to fertilizers and pest control sources as well as good selection of cultivars suitable for specific conditions make key points of good seed yield. In organic production the use of organic sowing material is required. Unfortunately the availability of organic seed is still much limited all over the world. In Wisconsin which is the biggest region of snap bean production for processing in the USA, organic snap bean production covers only one third of demands [1]. One of the reasons of such situation is limiting availability of organic seeds. In Poland in 2013 organic seeds of only three bean cultivars were available on the nation's market as compared to 83 of conventional ones [2]. The knowledge about the cultivation of organic vegetable seeds is scant. There is no recommendations for vegetable cultivars suitable for organic farmers [3]. On the other hand it has been proved that the right choice of cultivar is the key point in organic vegetable production [4, 5, 6].

The aim of studies was to select the most suitable cultivars of snap bean for seed production under organic growing conditions.

2. Materials and methods

The experiment was conducted during 2012-2013 in the Institute of Horticulture at Skierniewice on the experimental field certified for organic cultivation. Ten snap bean cultivars five of yellow pods and five of green pods were examined. The yellow pods were as follows: Furora Polana, Galopka, Korona, Tampa, Tara. The green pod cultivars were Delfina, Eliza, Paulinera, Sandra, Syrenka. All of Polish origin with fibre-free pods meant for consumption and for processing.

The experimental design was a randomized complete design with 4 replicates. Plot dimensions were 2,3 x 5 m.

Plots were seeded around 25th May at the rate of 420 000 seeds per hectare. The sowing material came from conventional production in first year, then the seeds obtained in first year were used for the experiment in the second year. In both years winter wheat as a fore crop was used and the organic compost was applied in a dose of 30 tons per hectare. During vegetation period field emergence as well as diseases and insect occurrence were observed. The plots were harvested on 27-28th September. Pulled up seeding plants were left for drying, then the pods were husked. The harvested seeds were divided into following fractions according to the seed quality: healthy seeds, diseased, injured by common bean weevil (*Bruchus obtectus)*, pitted seeds and other it is broken, wrinkled and small. For the diseased seeds recognition the method of Grzelak and Czyżewska [7], Grzelak and Szust [8] were used and for the pest recognition methods of Szwejda [9, 10]. Germination parameters were measured according to ISTA rules [11].

The results of each year of the studies were subjected to an analyses of variance. The means were separated by the Newman-Keul's test at 5% level of significance.

3. Results and discussion

In both years of studies the influence of cultivar on seed yield and share was observed (tab. 1, 2, 3). On average the higher seed productivity showed yellow pod cultivars with 2,40 and 2,67 tones of total yield per hectare respectively in first and second year of research. The green pod cultivars yielded an average 2,11 and 2,16 tons in dependence on the year. The differences in yielding between yellow and green pod cultivars were bigger in 2013 to disadvantage for the last ones. The green pod cultivars were more sensitive to unfavorable weather condition. Heavy rainfalls occurring in June damaged more young plants of green pod cultivars than yellow ones. The highest total seed yield produced cultivars Furora Polana and Tampa 3,13 and 2,96 tons per hectare on average. Likewise their marketable yield distinguished itself among others reaching 2,45 and 2,65 respectively.

Table 1. Total and marketable seed yield of examined snap bean cultivars
Tab. 1. Ogólny i handlowy plon nasion badanych odmian fasoli szparagowej

Cultivar	Total seed yield t·ha^{-1}		Mean	Marketable yield t·ha^{-1}		Mean
	2012	2013		2012	2013	
Furora Polana	3,40 a	2,85 ba	3,13	2,66a	2,24ab	2,45
Galopka	2,68 ab	3,21ab	2,95	2,20ab	2,33ab	2,26
Korona	2,15bc	2,20bc	2,18	1,38cb	1,39b	1,38
Tampa	2,42 bc	3,51 a	2,96	2,04ab	3,25 a	2,65
Tara	1,37c	1,56c	1,46	1,05c	1,07bc	1,06
Mean	2,40	2,67	2,54	1,87	2,06	1,96
Delfina	2,07	3,01ab	2,54	1,70bc	1,30b	1,50
Eliza	1,40 c	1,74cb	1,57	1,25cb	0,94cb	1,09
Paulinera	2,32 bc	1,53c	1,93	1,77bc	0,59c	1,18
Sandra	1,83 cb	1,83 cb	1,83	1,40bc	0,71cb	1,05
Syrenka	2,94 ab	2,68b	2,81	2,50ab	0,90cb	1,70
Mean	2,11	2,16	2,14	1,72	0,88	1,30

Numbers followed by the same letter or with no letter do not differ significantly / *Dane oznaczone taką samą literą lub bez oznaczenia nie różnią się istotnie*

Source: own work / Źródło: opracowanie własne

Table 2. The share of seed fractions in the total seed yield of snap bean cultivated in 2012
Tab. 2. Udział badanych frakcji nasion w plonie ogólnym fasoli uprawianej w 2012 roku

Cultivar	Marketable yield %	Diseased seeds %	Pitted seeds %	Bean weevil injured %	Others * %
Furora Polana	78,2	9,0	8,9	0,1	3,8
Galopka	82,7	8,4	5,3	0,7	2,9
Korona	64,3	24,2	3,5	0,1	7,9
Tampa	84,3	5,1	0,1	0,4	10,1
Tara	76,8	10,2	3,5	0,4	9,1
Mean	77,3	11,4	4,3	0,3	11,3
Delfina	82,3	12,9	2,0	0,8	2,0
Eliza	89,0	6,8	0,3	0,0	3,9
Paulinera	76,3	14,4	5,0	0,3	4,0
Sandra	76,5	15,4	0,0	2,9	5,2
Syrenka	85,0	12,0	1,8	0,0	1,2
Mean	81,8	12,3	1,8	1,3	3,3
Mean for all cv.	79,6	11,9	3,1	0,8	7,3

* broken, wrinkled, small seeds / * *nasiona połamane, pomarszczone, małe*
Numbers followed by the same letter or with no letter do not differ significantly / *Dane oznaczone taką samą literą lub bez oznaczenia nie różnią się istotnie*

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Table 3. The share of seed fractions in the total seed yield of snap bean cultivated in 2013
Tab. 3. Udział badanych frakcji nasion w plonie ogólnym fasoli uprawianej w 2013 roku

Cultivar	Marketable yield %	Diseased seeds %	Pitted seeds %	Bean weevil injured %	Others * %
Furora Polana	78,7	4,6	9,3	4,7	2,7
Galopka	72,7	9,1	8,4	6,4	3,4
Korona	62,8	13,2	10,6	10,1	3,3
Tampa	92,6	2,1	0,4	0,8	4,1
Tara	69,1	18,7	4,7	2,3	5,2
Mean	75,2 a	9,5b	6,7	4,9	3,7
Delfina	43,1	49,4	3,3	0,1	4,1
Eliza	43,0	35,5	3,0	0,1	19,3
Paulinera	38,7	53,5	2,7	0,4	4,7
Sandra	39,0	49,0	5,6	1,0	5,4
Syrenka	30,3	59,3	4,9	0,5	5,0
Mean	38,8 b	49,3 a	3,9	0,3	7,7
Mean for all cv.	57,0	29,4	5,3	2,6	5,7

* broken, wrinkled, small seeds / * *nasiona połamane, pomarszczone, małe*
Numbers followed by the same letter or with no letter do not differ significantly / *Dane oznaczone taką samą literą lub bez oznaczenia nie różnią się istotnie*

Source: own work / Źródło: opracowanie własne

The best yielding cultivars among green pods were Syrenka and Delfina with 2,81 and 2,54 tons of total yield and 1,50 and 1,70 tons per hectare of marketable yield respectively. The differences within cultivars were statistically proved. The lowest seed productivity showed cv. Tara, Eliza and Sandra. Data concerning the yield structure in tables 2 and 3 showed the influence of weather conditions on examined seed characters. The share of marketable yield in total yield was 79,6% in 2012 and 57% in 2013. The share of diseased seeds was 11,9 and 29,4% respectively. Damages caused by pest injury as well as mechanical and other characters were more or less similar in both years of studies. It is worth to notice that the presence of imago and larvae of snap bean weevil in 2012 was rear and the injuries reached at most 2,9%. Heavier infestation was found in 2013, when level of injured seeds reached 4,9% for cv. Furora Polana, 6,4% for cv. Galopka and 10,1% for cv. Korona.

The minimal germination percentage for snap bean seeds according to National Seed Standards is 75% [12]. This character describes ability to germinate in longer duration which in case of snap bean means 9 days (second counting). In 2012 average germination ability across all cultivars was 75,1% slightly above the required minimum for this species (tab. 4). Cultivars of yellow pods germinated an average 80,0% and the group of green pods made 70,2%. It is worth to note that among the second group only two cultivars Eliza and Delfina met germination standards. In 2013 average germination ability across all cultivars was 77,4% (tab. 5). All yellow pod cultivars germinated above the required minimum while in green pod group only Delfina met the germination standards. The differences between cultivars in case of germination ability and seedling infection was statistically proved.

In both years seedlings and seeds of green pod cultivars were more infected by diseases than cultivars of yellow pods. Diseased seeds were infested by typical pathogens for bean species. Most frequent isolates were fungi of *Alternaria*, *Fusarium*, *Botrytis* and *Stemphylium* spp – data not shown.

Table 4. Germination percentage and healthiness of snap bean seeds cultivated in 2012
Tab. 4. Kiełkowanie oraz zdrowotność nasion fasoli z uprawy w 2012 r.

Cultivar	Germination %		Diseased %		abnormal seedlings %	Others ** %
	First counting *	Second counting	seed-lings	seeds		
Furora Polana	44,9	78,4	14,9	3,5	2,4	0,8
Galopka	39,5	73,8	19,8	2,9	2,9	0,6
Korona	45,3	75,3	20,4	2,0	2,2	0,0
Tampa	52,9	89,4	6,1	3,2	1,3	0,0
Tara	32,0	83,4	8,1	4,8	3,1	0,6
Mean	42,9	80,0	14,0	3,3	2,4	0,4
Delfina	49,3	75,0	16,4	2,9	5,0	0,7
Eliza	53,6	79,8	13,3	1,6	5,3	0,0
Paulinera	45,1	73,3	14,6	5,8	6,3	0,0
Sandra	39,8	56,4	28,9	9,7	5,0	0,0
Syrenka	41,8	66,7	20,5	6,3	6,5	0,0
Mean	45,9	70,2	18,7	5,3	5,6	0,1
Mean for all cultivars	44,4	75,1	16,4	4,3	4,0	0,3

* first counting after 5 days, second counting after 9 days of sowing / * *pierwsze liczenie po 5 dniach, drugie po 9 dniach od wysiewu*
** others – hard and fresh seeds / ** *nasiona twarde i świeże*
Numbers followed by the same letter or with no letter do not differ significantly / *Dane oznaczone taką samą literą lub bez oznaczenia nie różnią się istotnie*

Source: own work / Źródło: opracowanie własne

Table 5. Germination percentage and healthiness of snap bean seeds cultivated in 2013
Tab. 5. Kiełkowanie i zdrowotność nasion fasoli z uprawy w 2013 r.

Cultivar	Germination %		Diseased %		abnormal seedlings %
	First counting *	Second counting	seed-lings	seeds	
Furora Polana	48,0	83,0 ab	11,2 bc	0,9	4,9
Galopka	50,9	79,8 ab	14,4 b	3,1	2,7
Korona	62,4	90,9 a	6,2 cb	0,5	2,4
Tampa	57,8	86,9 ab	4,2 c	0,0	8,9
Tara	60,4	83,3 ab	9,1 bc	5,8	1,8
Mean	55,9	84,8	9,0	2,1	4,1
Delfina	49,6	78,0 ba	12,9 bc	2,7	6,4
Eliza	55,1	74,2 b	17,8 ab	5,3	2,7
Paulinera	35,8	59,3 c	21,3 a	12,1	7,3
Sandra	50,9	73,6 bc	12,7 bc	8,7	5,0
Syrenka	46,7	64,2cb	19,1ab	13,8	2,9
Mean	47,6	69,9	16,8	8,5	4,9
Mean for all cultivars	51,8	77,4	12,9	5,3	4,5

* first counting after 5 days, second counting after 9 days of sowing / * *pierwsze liczenie po 5 dniach, drugie po 9 dniach od wysiewu*
** others – hard and fresh seeds / ** *nasiona twarde i świeże*
Numbers followed by the same letter or with no letter do not differ significantly / *Dane oznaczone taką samą literą lub bez oznaczenia nie różnią się istotnie*

Source: own work / Źródło: opracowanie własne

4. Discussion

Snap bean seeds must be planted early enough to mature prior to fall mists and rains, but late enough to avoid bean maggot attacks. In the area of central part of Poland the proper sowing time is the last decade of May [13]. The experiment was conducted on the field organically managed for 10 years. Applying an organic compost, a long term crop rotation and drip irrigation promoted vigorous plant growth with no need for using plant control agents. According to American scientists a long term crop rotation including grain deprives disease causing organisms of a host and contributes to a healthy soil structure [14]. Perhaps the grain fore crop used in the experiment as well as location on the 10 years organically managed field protected snap bean plants against serious disease invasion. The results obtained in the studies agree with the opinion of other scientists that early maturity and rapid grow is critical to snap bean cultivars to outcompete weeds and produce enough green matter to feed pods and seeds [14, 15]. It is clear that not all cultivars are suitable for organic snap bean production for seeds. In general cultivars with yellow pods developed faster thus showing better resistance to unfavorable weather conditions. The green pods cultivars were more sensitive to environmental conditions. All tested cultivars had a genetic resistance to common snap bean diseases, and such a character is preferable in organic cultivation [16]. The results proved that combination of genetic characters as well as fallowing organic cultivation standards promotes to obtain a good yield of snap bean seeds.

5. Conclusions

A two year studies concerning suitability of snap bean cultivars for organic seed production allow to create following conclusions:
1. The differences between snap bean cultivars to react against environmental stresses were found.
2. Yellow pod cultivars showed better tolerance to unfavourable weather conditions and a higher yield potential than the green pod cultivars.
3. The quality of seeds depended on the cultivar and growing conditions. In general yellow pod cultivars produced better quality seeds.
4. There were at least three cultivars among ten examined which produced seeds below national standards for this species.

6. References

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This work was performed in the frame of the Multiannual Programme "Development of sustainable methods of horticultural production to ensure the horticultural products high biological and nutritional quality, and to preserve the biodiversity of the environment while protecting its resources" financed by the Polish Ministry of Agriculture and Rural Development; Task 4.6 , IO 2008-2014.

Praca została wykonana w ramach programu wieloletniego „Rozwój zrównoważonych metod produkcji ogrodniczej w celu zapewnienia wysokiej jakości biologicznej i odżywczej produktów ogrodniczych oraz zachowania bioróżnorodności środowiska i ochrony jego zasobów" finansowanego przez Ministerstwo Rolnictwa i Rozwoju Wsi, zadanie 4.6. IO 2008-2014.