THE ROLE OF CULTIVARS AND SOWING DATE IN CONTROL OF BROAD BEAN WEEVIL (*BRUCHUS RUFIMANUS* BOH.) IN ORGANIC CULTIVATION

Anna SZAFIROWSKA
Research Institute of Horticulture
Konstytucji 3 Maja 1/3, 96-100 Skierniewice, Poland

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Summary

During 2010-2011 the studies were conducted on the cultivation of three broad bean cultivars Windsor Biały, Makler and Bartom with organic and conventional method.

The aim of research was to determine the influence of cultivar and sowing date on the seed damage caused by broad bean weevil and on the total seed yield. Seeds were sown on April 10 and 20th. At the harvest the yield was divided into following grades: marketable, small seeds, damaged by *Bruchus rufimanus* Boh. and diseased. Plants selected on each plot were examined towards the relation between plant architecture and seed damage. The effect of applied treatments on seed yield and damage was found. The lowest percentage of injured seeds presented cv. Makler irrespectively on sowing date and growing method. The differences were proved statistically. Delay of sowing restricted the percent of damaged seeds but also decreased the yield in both growing methods. Cluster located at upper parts of a plant contained lower amount of damaged seeds.

key words: broad bean weevil, organic cultivation, seed injury

INTRODUCTION

Broad bean is recognised as one of the oldest species in cultivation, which became part of Eastern Mediterranean diet earlier than 6000 BC. Nowadays the biggest producers of broad bean seeds are China -1.9 M tones, Ethiopia - 405 thou. tones and Egypt 396 thou. tones (FAOSTAT 2010). In Poland the largest planta-

tions are located in regions of Lublin and Opole. Though the species is acknowledged as a plant easy to grow, yet the pest control is difficult especially in organic cultivation.

The dominating pest among others is *Bruchus rufimanus* Boh. (Chodulska 1985). It is an univoltine species developing in the seeds of *Vicia faba* L. The adults occurring in the most numerous during the flower-

ing time of broad bean. They become sexually mature when the first green pods appeared on the host plant and oviposit on the surface of these pods (Middlekauf 1951, Medjdoub-Bensad *et al.* 2007). The insect undergo the whole developing cycle inside the seed thus causing large losses of seed mass and reduces sowing and consumption value of the seeds (Kaniuczak 2004, 2006). In conventional production a chemical pest control is provided. Experiments with biological agents revealed reduction of pest occurrence in some cases. Mustard and nigella oils acted as oviposition deterrents and adversely influenced the fecundity of the *B. rufimanus* females (Sabbour & Abd-El-Aziz 2007). The same authors found fungi agents like *Beauveria bassiana* and *Metarhizium anisopliae* greatly reducing broad bean seed infestation. However there are no effective treatments for this pest control allowed to use in organic farming.

The presented study investigated the response of cultivars to broad bean weevil attack as well as the influence of sowing date on the pest feeding in conventional and organic cultivation.

MATERIALS AND METHODS

During 2010-2011 broad bean was cultivated with two methods organic and conventional one. Two experiments were situated on nearby fields under the same soil and climatic conditions (podsolc soil with 1.15% of organic matter and pH 7.0). The experiments were set up in a two factorial split plot design in 4 replicates on the 10 m² plots on each field separately. The factor of the first order

was a sowing date (10 or 20th April), the factor of the second order was a cultivar (Windsor Biały, Makler and Bartom). The seeds were sown on 10 m² plots with the distance of 20 × 45 cm adequate to growing recommendations for this species.

On the conventional field the mineral fertilization according to soil analysis was applied (80 kg P₂O₅ and 200 kg·ha⁻¹ K₂O before vegetative season and 50 kg of nitrogen as a starting dose in the spring. The chemical weed and pest management was used. In dependence on the year four or five applications of pyrethroids such as chlorpyrifos and alpha – cypermethrin (0.5 L·ha⁻¹) and deltamethrin (0.2 L·ha⁻¹) were taken for insect control. On the organic field the experiment was settled on the stand after cereals enriched by 20 t·ha⁻¹ of compost. Mechanical and hand weed control was provided 3 times per season. The presence of *Bruchus rufimanus* was observed from the moment of flower formation on ten individual plants selected on each plot. The number of damaged and healthy seeds was taken from first, second and third cluster separately. At the harvest time the seeds were divided into following grades: marketable, small, seeds with presence of eggs and larvae of *Bruchus rufimanus*, diseased seeds. Seeds recognized as marketable were healthy with no sign of damage and disease with weight ≥ 2 g per piece. The small seeds were healthy, with the weight below 2 g. Calculation of the share of each grade was based on the number of seeds in the fraction. Data concerning yield amount and structure were taken from all plants per plot.

The evaluation of results was conducted for each experiment individually, but for reading convenience in each table data for both cultivation method are placed.

The results were statistically calculated by means of the analysis of variance. The significance of differences between treatment mean values was determined by Newman-Keul's test at $P=0.05$.

RESULTS AND DISCUSSION

Plant emergence and stand at the outset of growing did not differ between treatments.

The influence of examined factors became visible as the plants developed and finally affected the yield quality and quantity of broad bean (Table 1 & 2). In 2010 the average seed yield from organic cultivation reached 2.62 kg per 10 m⁻² and 3.86

kg from conventional one. In 2011 the plants yielded better and the adequate data were 3.42 kg for organic cultivation and 5.21 kg for conventional. In general plants grown organically produced by 33% less seeds in first year and by 34% in the second year of the experiment. In both years the delay of sowing caused lowering of seed yield. The mean yield of organic broad bean from the second sowing date (April 20) was by 2.1 to 13.2% lower as compared to the first sowing term. In case of conventional method the sowing delay caused 1.1 to 17.0% reduction of the yield.

The effect of cultivar on broad bean yield was pronounced only in conventional cultivation where cv. Bartom produced the highest yield in both years. In organic cultivation it is hard to distinguish the exact cultivar.

Table 1. The effect of sowing date and the cultivar on the total yield of fresh broad bean seeds (kg·10⁻²)

Sowing date	Cultivar	2010	2011	mean
Organic method				
10.04	Windsor	2.55 a	4.38 a	3.47
	Makler	2.46 a	3.28 bc	2.87
	Bartom	2.91 a	3.33 b	3.12
20.04	Windsor	2.64 a	3.25 bc	2.95
	Makler	2.49 a	2.82 c	2.66
	Bartom	2.64 a	3.47 b	3.05
mean		2.62	3.42	3.02
Conventional method				
10.04	Windsor	4.56 ab	4.71b	4.64
	Makler	4.68 a	4.97 ba	4.83
	Bartom	4.71 a	6.06 a	5.39
20.04	Windsor	3.61b	4.85 ba	3.98
	Makler	3.82b	5.04 ab	4.08
	Bartom	4.15 ba	5.67 ab	4.56
mean		3.86	5.21	4.53

Note: Mean values followed by the same letter within a column are not significantly different at $P=0.05$

The share of broad bean seed yield is shown in Table 2 & 3. The high diversity between examined seed grades have been observed in both years. The impact of the cultivar and date of sowing was found in both experiments, although in organic field the differences between data were higher. The earlier sowing the stronger seed damage. In organic cultivation the yield from first sowing contained 63.3% and 69.5% of damaged seeds in dependence on the years. The later the plant develop the less insect injury. Significantly less injury was found in seeds of second sowing; 28.6 % and 33.3% in dependence on the year.

In conventional cultivation the chemical bug control highly reduced seed damage. The percentage of injured seeds from earlier sowing reached 10.6 in the first year and 28.8% in the second year on average, whereas from later sowing 9.3 and 18.6% respectively. The use of chemicals reduced number of injured seeds down to the range of 9.3-28.8% on average in dependence on the year. In some years the broad bean protection is very difficult to manage. Using the chemical control Książak & Kuś (2005) restricted the insect injury down to 20% in conventional production of horse bean.

Table 2. The share of examined grades of broad bean seeds (%); 2010

Sowing date	Cultivar	Marketable yield	Small seeds	Injured seeds	Infested seeds
Organic method					
10. 04	Windsor	13.3 c	0.6	79.0 a	7.1
	Makler	54.9 b	4.3	39.4 b	1.4
	Bartom	20.9 c	2.0	71.6 ab	5.5
mean		29.7	2.3 b	63.3 a	4.7
20.04	Windsor	54.4 b	5.6	36.8 b	3.2
	Makler	75.6 a	11.6	12.0 c	0.8
	Bartom	53.3 b	5.8	37.0 b	3.9
mean		61.1	7.7a	28.6 b	2.6
Conventional method					
10.04	Windsor	81.1 a	6.2	10.0 b	2.7
	Makler	81.3 a	16.7	1.3 c	0.7
	Bartom	51.5 b	26.1	20.5 a	1.9
mean		71.3	16.3 a	10.6	1.8
20.04	Windsor	81.8 a	4.8	8.3 b	5.1
	Makler	83.1a	15.0	0.9 c	0.9
	Bartom	60.4 b	15.5	18.8 ab	5.3
mean		75.1	11.8 a	9.3	3.8

Note: see Table 1

Table 3. The share of examined grades of broad bean seeds (%); 2011

Sowing date	Cultivar	Marketable yield	Small seeds	Injured seeds	Infested seeds
Organic method					
10.04	Windsor	11.1c	1.9	76.8	10.2
	Makler	37.4bc	2.7	54.7	5.2
	Bartom	12.1c	1.7	76.9	9.1
mean		20.2	2.1 a	69.5 a	8.2a
20.04	Windsor	33.3cb	6.0	44.1	16.6
	Makler	77.4 a	6.6	13.7	2.3
	Bartom	46.9 b	3.6	42.3	7.2
mean		52.5	4.7 a	33.3 b	8.7a
Conventional method					
10.04	Windsor	51.8 b	2.0	37.0	9.2
	Makler	66.4 ab	5.0	18.1	10.5
	Bartom	55.0 ba	4.5	31.2	9.3
mean		57.7	3.8 a	28.8a	9.7
20.04	Windsor	60.4 ba	3.0	26.0	10.6
	Makler	82.2 a	7.5	6.5	3.8
	Bartom	64.4 ab	2.1	23.2	10.3
mean		69.0	4.2 a	18.6 b	8.2

Note: see Table 1

The different response of cultivars on insects harmfulness should be noticed (Table 4).

At first sowing date the lowest percentage of seeds damaged by broad bean weevil (28.4%) presented cv. Makler. Other cultivars Windsor Biały and Bartom showed over 50% of injured seeds. Similar response occurred in second sowing. This time only 8.3% of Makler seeds were injured as compared to 28.9 and 30.4% in two others. Cultivar Makler distinguished itself by the highest resistance to broad bean weevil feeding. Likewise Kaniuczak & Matłosz (2001) found differences between horse bean cultivars in susceptibility to *Bruchus rufimanus* feeding. Percentage of damaged seed varied from 39 to 69%

in dependence on cultivar (Matłosz 1998).

A plant resistance to insect feeding depends on many attributes like morphology, physiology and content of specific chemical components. According to Kozłowska & Konieczny (2003) cultivars with higher content of certain antioxidants better confined some insects attack. Also morphological structure affects the insect access into the plant. The discussed broad bean cultivar Makler developed few days later than two others. Delayed blossoming and pod forming might have restricted oviposition of females on Makler plants. Besides the seeds of the mentioned cultivar were violet which suggests the presence of anthocyanins.

Table 4. The effect of cultivar on broad bean weevil (*Bruchus rufimanus*) damage. Means of two years (%)

Sowing date	Cultivar	Organic method	Conventional method	Mean
10.04	Windsor	77.9	23.5	50.7
	Makler	47.1	9.7	28.4
	Bartom	74.3	25.9	50.1
mean		66.4 a	19.7 a	43.1
20.04	Windsor	40.5	17.2	28.9
	Makler	12.9	3.7	8.3
	Bartom	39.7	21.0	30.4
mean		31.0 b	14.0 a	22.5

Note: see Table 1

Observations of individual plants revealed a connection between seed damage caused by broad bean weevil and plant architecture, term of flowering and pot setting (Table 5).

In majority the plants formed 2-3 clusters with 3-5 seed pods. The earliest developed pods were the most often injured by insects. In organic

method the pods of first cluster were damaged by 9.4 to 71.9% in dependence on cultivar and sowing date. In conventional method the related data were 4.6 to 38.2%. The seeds of second and third cluster were slightly injured, on average by 0 to 16.5% in organic and 0 to 21.8% in conventional method.

Table 5. The influence of plant architecture on insect damage (%)

Sowing date	Cultivar	Organic method		Conventional method	
		I cluster	II+III cluster	I cluster	II+III cluster
10 April	Windsor	58.4	16.5	38.2	21.8
	Makler	27.8	9.1	20.7	0.6
	Bartom	71.9	0.0	38.1	0.7
mean		52.7a	8.5a	32.3a	7.7a
20 April	Windsor	37.1	1.9	28.5	9.7
	Makler	9.4	3.3	4.6	1.4
	Bartom	38.7	0.0	16.0	0.0
mean		28.4 b	1.7a	16.4b	3.7a
Mean for method		40.6	5.1	24.4	5.7

Note: see Table 1

CONCLUSIONS

1. The studies revealed different response of broad bean cultivars to *Bruchus rufimanus* feeding. The most resistant to the insect damage was cv. Makler irrespectively on sowing date and growing method.
2. Date of sowing affected both the insect feeding and the yield quantity.
3. Later sowing diminished weevil occurrence but also decreased seed yield.

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ROLA ODMIANY I TERMINU SIEWU W OCHRONIE BOBU
PRZED STRĄKOWCEM BOBOWYM (*BRUCHUS RUFIMANUS* BOH.)
W UPRAWIE EKOLOGICZNEJ

Streszczenie

W latach 2010-2011 prowadzono doświadczenia nad uprawą trzech odmian bobu Windsor Biały, Makler i Bartom metodą ekologiczną i konwencjonalną.

Celem badań była ocena wpływu odmiany oraz terminu siewu na wysokość plonu oraz stopień zasiedlenia nasion przez chrząszcze strąkowca bobowego. Nasiona wysiewano 10 i 20 kwietnia. Podczas zbioru plon dzielono na frakcje: nasiona handlowe, małe, uszkodzone przez strąkowca oraz chore. Prowadzono obserwacje wybranych pojedynczych roślin dla stwierdzenia stopnia uszkodzeń w zależności od morfologii rośliny.

Stwierdzono wpływ badanych czynników na stopień uszkodzenia nasion przez strąkowca oraz na plon i jego strukturę. Najmniej uszkodzonych nasion znaleziono u odmiany Makler, niezależnie od terminu siewu i metody uprawy. Różnice udowodniono statystycznie. Opóźnianie terminu siewu ograniczało procent nasion uszkodzonych przez strąkowca, ale jednocześnie zmniejszało wysokość plonu, w obu metodach uprawy. Grona usytuowane w wyższych partiach roślin zawierały nasiona mniej uszkodzone przez strąkowca.