Janina GOSPODAREK, Natalia KWIECIEŃ
University of Agriculture in Krakow, Faculty of Agriculture and Economics
Department of Agricultural Environment Protection
Al. Mickiewicza 21, 31-120 Kraków, Poland
e-mail: rrjgospo@cyf-kr.edu.pl

Received: 2018-05-25 ; Accepted: 2018-06-14

THE EFFECT OF BROAD BEAN INTERCROPPING WITH WHITE MUSTARD ON WEEVILS (*Sitona* spp.) FEEDING

Summary

The object of research was to determine the impact of broad bean coordinate cultivation (Vicia faba L.), Bartek variety, with a white mustard (Sinapis alba L.) in two row spacing on the dynamics of feeding among imagines of pea leaf weevil (Sitona spp.). The investigations were conducted in the years 2014 and 2015 at the Experimental Station of the University of Agriculture, in Prusy near Cracow. The field experiment comprised the following objects: broad bean, Bartek cv. in pure culture, sown at standard 50 cm x 15 cm spacing (V); broad bean spaced 65 cm x 15 cm with white mustard as the crop intersown between the rows (V+S65); broad bean spaced 80 cm x 15 cm with white mustard as above (V+S80) and broad bean in pure culture, sown at standard 50 cm x 15 cm spacing, but chemically protected with insecticides Fastac 100 EC and Decis 2,5 EC (V ch). The evaluation of the feeding intensity of adult pea weevils was conducted on 25 randomly selected plants from each plot, by measuring the surface area of eaten leaves, counting injured and non-injured leaves and calculating the loss of leaf blade as the result of their feeding. The cultivation of broad bean with a white mustard in row spacing of 80 cm contributed significantly to the reduction in a degree of broad bean leaves damage by pea leaf weevil beetles. The use of smaller spacing - 65 cm limited the area of feeds but only in one of the research seasons. The effectiveness of broad bean protection through cultivation with a white mustard is a few times lower than for chemical protection.
***Key words**: intercropping, Sitona spp., broad bean, white mustard*

WPŁYW UPRAWY WSPÓŁRZĘDNEJ BOBU Z GORCZYCĄ BIAŁĄ NA ŻEROWANIE OPRZĘDZIKÓW (*Sitona* spp.)

Streszczenie

Celem badań było określenie wpływu uprawy współrzędnej bobu (Vicia faba L.) odmiany Bartek z gorczycą białą (Sinapis alba L.) w dwóch rozstawach międzyrzędzi na przebieg dynamiki żerowania chrząszczy z rodzaju oprzędziki Sitona spp. Doświadczenie przeprowadzono w latach 2014-2015 w Stacji Doświadczalnej – Prusy należącej do Uniwersytetu Rolniczego w Krakowie. Obejmowało ono następujące obiekty: bób odmiany Bartek wysiewany jako uprawa jednorodna w rozstawie standardowej 50 cm x 15 cm (V); bób uprawiany współrzędnie z gorczycą białą w rozstawie 65 cm x 15 cm (V+S65); bób uprawiany współrzędnie z gorczycą białą w rozstawie 80 cm x 15 cm(V+S80); bób wysiewany jako uprawa jednorodna w rozstawie standardowej 50 cm x 15 cm, chroniony chemicznie insektycydami Fastac 100 EC i Decis 2,5 EC (V ch). Przebieg dynamiki żerowania chrząszczy oceniano na 25 losowo wybranych roślinach z poletka przez mierzenie powierzchni wyżerek, liczenie liści uszkodzonych i nieuszkodzonych oraz wyliczenie ubytku blaszki liściowej w wyniku ich żerowania. Uprawa bobu wspólnie z gorczycą białą w międzyrzędziach przy zachowaniu rozstawy 80 cm, przyczyniła się do istotnego zmniejszenia stopnia uszkodzenia liści bobu przez chrząszcze oprzędzików. Zastosowanie rozstawy mniejszej (65 cm) wpłynęło ograniczająco na powierzchnię wyżerek, ale tylko w jednym z sezonów badawczych. Efektywność ochrony bobu przez uprawę współrzędną z gorczycą białą jest jednak kilkakrotnie niższa niż przy zastosowaniu ochrony chemicznej.
***Słowa kluczowe**: uprawa współrzędna, Sitona spp., bób, gorczyca biała*

1. Introduction

A need for finding plant pest protection methods alternative to a chemical method is of a particular importance in the ecological agriculture. Integrated plant protection also gives priority to non-chemical methods. A species diversification of crops in the same location and time is one of manners which obstructs finding a host plant by a pest. Furthermore, pollen and nectar plants (e.g. white mustard) fulfil a significant role as a food source for pests natural enemies.

White mustard (*Sinapis alba* L.), due to produced root secretions, limits feeding of some soil pests, e.g. beet cyst eelworm *Heterodera schachtii* Schmidt. [12, 13]. It is also an object of research in terms of using it in the production of pro-ecological herbicides [9]. Due to the structure of the root system, its presence in the cultivation of e.g. horse bean leads to the increase in roots density in deeper soil layers, which is possibly better use of nutrients. At the same time, it is a fast-growing plant, reaching significant sizes and it may be competitive for a main plant in mixed cultivations, resulting in crops reduction [10]. Therefore, it is crucial to select proper distance of plants cultivated in coordination [11].

As to the use of a white mustard as a plant accompanying in crops in order to limit the occurrence of pests, it is known that in peas cultivation it limited the feeding of pea leaf weevils and together with lacy phacelia affects adversely the feeding of pea thrips [14, 15].

Pea leaf weevil imago (*Sitona* sp.) belongs to main pests attacking the bean family (Fabaceae) in their early growth phases [1, 2, 5, 8]. These beetles eat the edges of a leaf blade what results in depletion of a few to several % [4].

The object of research was to determine the impact of broad bean coordinate cultivation (*Vicia faba* L.), Bartek

variety, with a white mustard (*Sinapis alba* L.) in two row spacing on the dynamics of feeding among imagines of pea leaf weevil (*Sitona* sp.).

2. Material and methods

The investigations were conducted in the years 2014 and 2015 in the area of the Experimental Station of the University of Agriculture, in Prusy near Cracow (47˚24'N lat., 7˚19'E long., 300 m a.s.l.). The field experiment comprised the following objects: broad bean, Bartek cv. in pure culture, sown at standard 50 cm x 15 cm spacing (V); broad bean spaced 65 cm x 15 cm with white mustard as the crop intersown between the rows (V+S65); broad bean spaced 80 cm x 15 cm with white mustard (V+S80) and broad bean in pure culture, sown at standard 50 cm x 15 cm spacing but chemically protected with insecticides (V ch). Fastac 100 EC and Decis 2,5 EC were used in one week interval, when the first injuries on plant leaves were observed. The spacing in objects with white mustard must be greater than standard (50 cm x 15 cm) because of the competition effect towards broad beans plants, which was proved in earlier research [10]. The experiment was set up in four replications. The plot area was 20 m^2. The assessment of weevil beetles feeding intensity was conducted at 25 randomly selected and marked plants per plot, by measuring the area consumed (using plotting paper), determining the percentage of injured leaves and computing the leaf blade loss due to their feeding. Analysis of injuries was conducted four times in each season of the investigations, at 5-6 days intervals, starting from the moment when the first injuries were spotted.

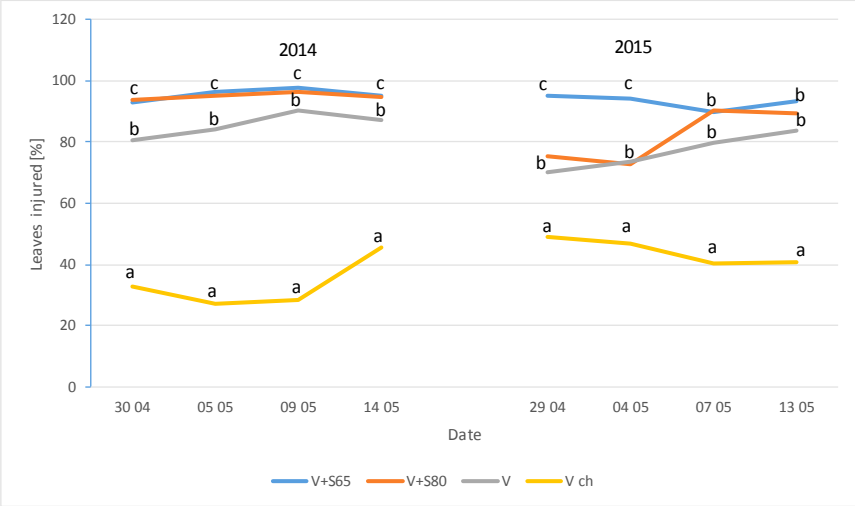
Statistical analysis of obtained results was conducted by means of Statistica 10.0.PL programme. The significance of differences between means was tested by one-way ANOVA and the means were differentiated using NIR Fischer test on significance level α =0.05.

3. Results and discussion

A percentage of leaves with damage caused by pea leaf weevil beetles depended on a season, an observation date and an object within significant limits and it ranged from 27% to 97% (Fig. 1). In 2014 and 2015, the least quantity of damaged leaves was observed in pure broad bean cultivation with the use of chemical protection (object V ch). In the entire observation season in 2014, slightly more leaves with damage were observed compared to pure unprotected cultivation in objects where broad bean cultivation was accompanied by a white mustard. In 2015, a similar trend was recorded in the first two observations, in spacing of 65 cm between broad bean rows; afterwards, no significant impact of a white mustard was observed on the percentage of damaged leaves. Also, our earlier research, when fennel or coriander was used as a plant accompanying broad bean, did not demonstrate any significant impact of the presence of an accompanying plant on the percentage of leaves with damage caused by *Sitona* sp. imago [3].

The consumed area of leaves increased as the pests continued their feeding and it was similar in both seasons (Fig. 2). During all the observations, the lowest values of this parameter were recorded in the cultivation protected with chemicals. An advantageous impact of a white mustard presence was noticeable particularly particularly in 2014, when during all the observations in the unprotected pure broad bean cultivation, the area of damage was considerably higher than in objects with an accompanying plant. Comparing various row spacing in the pests initial feeding period, when their feeding is of greatest importance, lower areas of feeds were observed among plants growing in a greater spacing – 80 cm which was also confirmed in 2015.

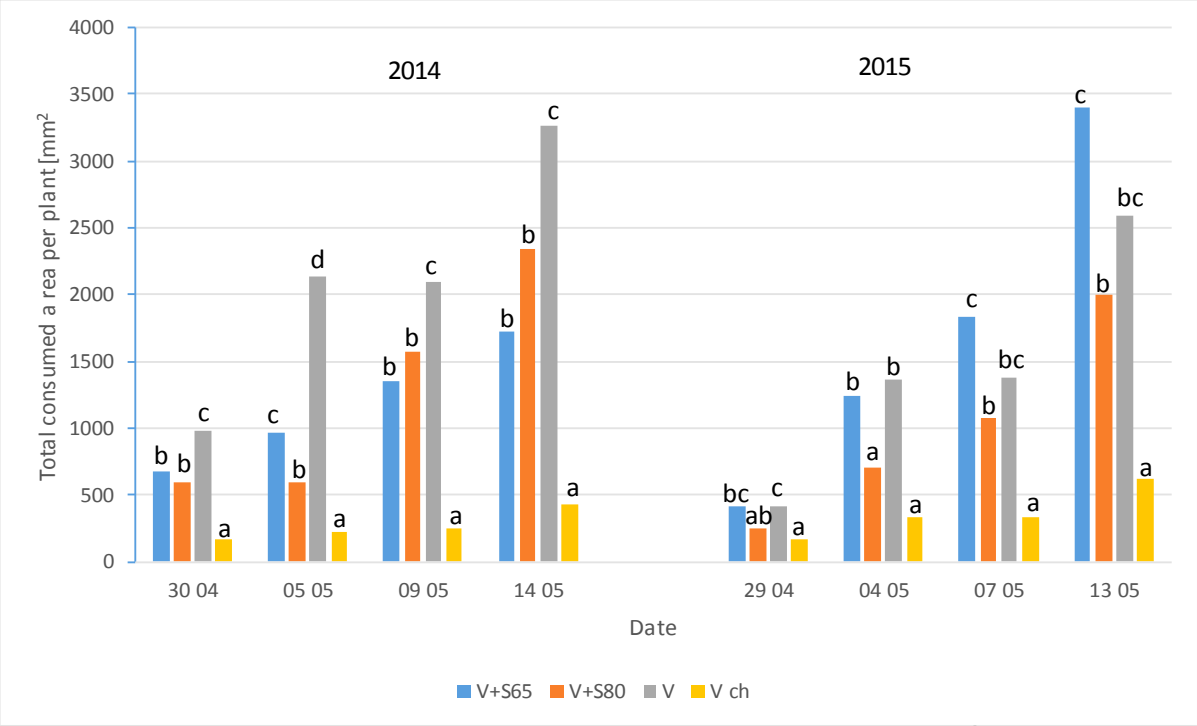
Leaf blade loss, calculated through referring the area of feeds to the total leaf area on a plant, was clearly higher in 2015, reaching nearly 10% (Fig. 3).



Source: own work / Źródło:opracowanie własne

Fig. 1. Leaves of broad bean injured by *Sitona* sp. adult (percent of total number of leaves) depending on cultivation system: V+S65 - broad bean spaced 65 cm x 15 cm with white mustard as the crop intersown between the rows; V+S80 - broad bean spaced 80 cm x 15 cm with white mustard as above; V - broad bean in pure culture, sown at 50 cm x 15 cm spacing; V ch - broad bean in pure culture, sown at 50 cm x 15 cm spacing, chemically protected with insecticides. Means followed by the same letter in a given date respectively are not significantly different at α = 0.05

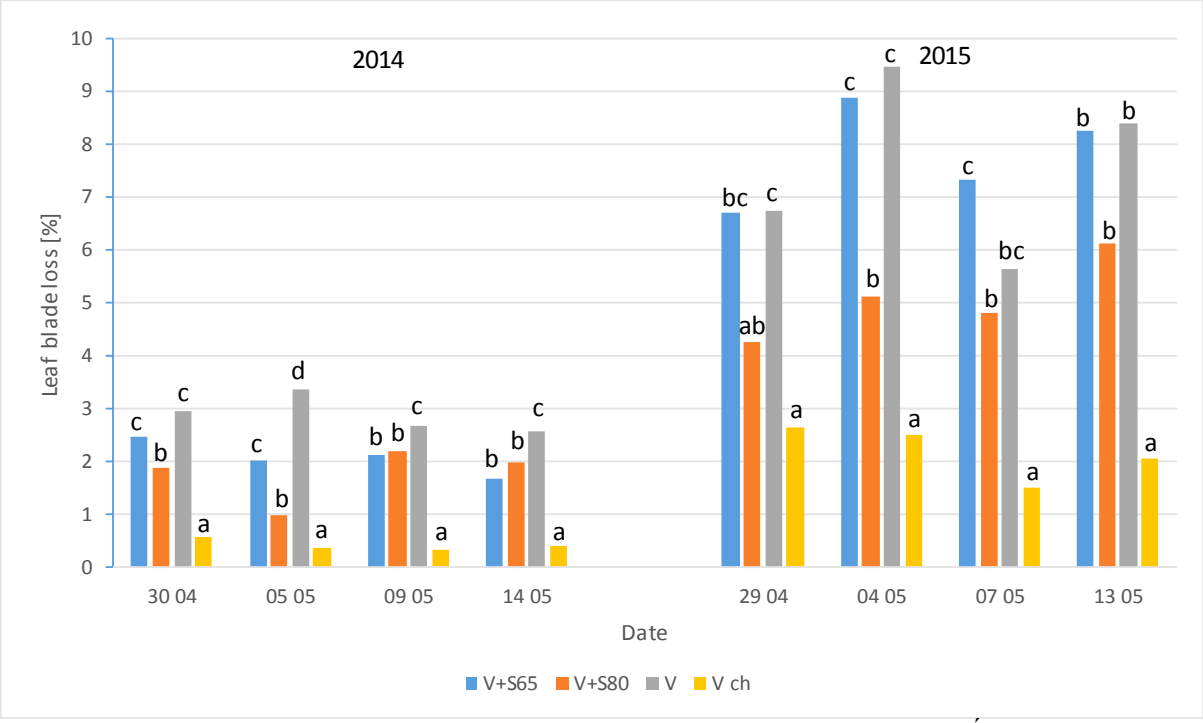
Rys. 1. Liście bobu uszkodzone przez chrząszcze oprzędzików (odsetek ogółu liści) zależnie od sposobu uprawy: V+S65 – bób w rozstawie 65 cm x 15 cm uprawiany wraz z gorczycą białą w międzyrzędziach; V+S80 - bób w rozstawie 80 cm x 15 cm uprawiany wraz z gorczycą białą jak wyżej; V – bób w uprawie jednorodnej w rozstawie 50 cm x 15 cm; V ch – bób w uprawie jednorodnej w rozstawie 50 cm x 15 cm, chroniony chemicznie z użyciem insektycydów. Średnie oznaczone takimi samymi literami odpowiednio dla danego terminu, nie różnią się istotnie przy α = 0,05



Source: own work / Źródło:opracowanie własne

Fig. 2. Total consumed area (mm^2) caused by *Sitona* sp. adult depending on cultivation system. For explanations see Fig. 1. Means followed by the same letter in a given date respectively are not significantly different at α = 0.05

Rys. 2. Powierzchnia wyżerek (mm^2) spowodowanych przez chrząszcze oprzędzików zależnie od sposobu uprawy. Objaśnienia jak na rys. 1. Średnie oznaczone takimi samymi literami odpowiednio dla danego terminu, nie różnią się istotnie przy α = 0,05



Source: own work / Źródło:opracowanie własne

Fig. 3. Leaf blade loss of broad bean (percent of total leaf area) caused by *Sitona* sp. adult depending on cultivation system. For explanations see Fig. 1. Means followed by the same letter in a given date respectively are not significantly different at α = 0.05

Rys. 3. Ubytek blaszki liściowej bobu (procent ogólnej powierzchni liści) spowodowany przez chrząszcze oprzędzików zależnie od sposobu uprawy. Objaśnienia jak na rys. 1. Średnie oznaczone takimi samymi literami odpowiednio dla danego terminu, nie różnią się istotnie przy α = 0,05

A statistically proved limiting impact of a white mustard in this index during all the observations was recorded for spacing of 80 cm between broad bean rows. The cultivation of a white mustard in broad bean row spacing of 65 cm affected the reduction in the leaf bade depletion only in 2014. The effectiveness of chemical protection within the limitation of the leaf blade loss was considerably higher than the protection with the use of cultivation with a white mustard.

The obtained effects of the limitation of broad bean damage caused by pea leaf weevils imago through the adjacent cultivation of a white mustard are confirmed in the case of peas [15]. Low quantity of *Sitona* beetles in weed strips with considerable share of a white mustard was also observed by Lethmayer at al. [7]. The results obtained by us confirm the soundness of introducing this plant as an element of mixed cultivations or as a boundary belt, especially because, according to literature, pea leaf weevils respond poorly to such a type of protection. For example, mixed sowing of wheat with narrow leaf lupin did not affect the number of feeds caused by *Sitona macularius* (Marsham) [6] and horse beans cultivated with barley or wheat was characteristic even for a higher degree of damage by *Sitona lineatus* L. than in pure sowing [10].

4. Conclusions

1. The cultivation of broad bean with a white mustard in row spacing of 80 cm contributed significantly to the reduction of a degree of broad bean leaves damage by pea leaf weevil beetles. The use of smaller spacing - 65 cm limited the area of feeds but only in one of the research seasons.
2. The effectiveness of broad bean protection through cultivation with a white mustard is a few times lower than for chemical protection.

5. References

[1] Corre-Hellou G., Crozat Y.: N_2 fixation and N supply in organic pea (*Pisum sativum* L.) cropping systems as affected by weeds and peaweevil (*Sitona lineatus* L.). Eur. J. Agronomy, 2005, 22, 449-458.

[2] Dor´e T., Meynard J.M.: On-farm approch of attacks by the pea weevil (*Sitona lineatus* L., *Col., Curculionidae*) and the resulting damage to pea (*Pisum sativum* L.) crops. J. Appl. Entomol., 1995, 119, 49-54.

[3] Gospodarek J., Gleń K., Boligłowa E.: The effect of broad bean cultivar Windsor Biały intercropping with selected herbs on *Sitona* sp. beetles feeding. J. Res. Appl. Agric. Engng, 2011, 56 (3), 117-121.

[4] Gospodarek J., Gleń-Karolczyk K., Boligłowa E.: The effect of non-chemical and chemical broad bean protection against diseases and pests on the feeding of pea weevils (*Sitona* spp). J. Res. Appl. Agric. Engng, 2016, 61 (3), 151-155.

[5] Hanavan R.P., Bosque-Perez N.A.: Influence of no-tillage practices and later planting date on the pea leaf weevil, Sitona lineatus, in pea, Pisum sativum. Entomol. Exp. Appl., 2017, 162, 77-85.

[6] Hurej M., Twardowski J., Kozak M.: Weevil (Coleoptera: Curculionidae) assemblages in the fields of narrow-leafed lupin sown as pure stand and intercropped with spring triticale. Zemdirbyste-Agriculture, 2013, Vol. 100(4), 393-400.

[7] Lethmayer C., Nentwig W., Frank T.: Effects of weed strips on the occurrence of noxious coleopteran species (Nitidulidae, Chrysomelidae, Curculionidae). Z. Pflanzenkrank. Pflanzenschutz, 1997, Vol. 104(1), 75-92.

[8] Nikolova I. M.: Response of vetch varieties to *Sitona lineatus* L. in organic farming. Biol. Agric. Hortic, 2016, 32, 63-71.

[9] Sawicka B., Kotiuk E.: Gorczyce jako rośliny wielofunkcyjne. Acta Sci. Pol., Agricultura, 2007, Vol. 6(2), 17-27.

[10] Schröder D., Köpke U.: Faba bean (*Vicia faba* L.) intercropped with oil crops – a strategy to enhance rooting density and to optimize nitrogen use and grain production? Field Crop. Res., 2012, Vol. 135, 74-81.

[11] Singh K.K, Rathi K.S.: Dry matter production and productivity as influenced by staggered sowing of mustard intercropped at different row ratios with chickpea. J. Agron. Crop Sci., 2003, 189, 169-175.

[12] Szymczak-Nowak J., Nowakowski M.: Efekt antymątwikowy i plonowanie gorczycy białej, facelii błękitnej i rzodkwi oleistej uprawianych w plonie głównym. Rośl. Oleiste − Oilseed Crops, 2000, XXI(1), 285-292.

[13] Szymczak-Nowak J., Nowakowski M.: Plonowanie gorczycy białej, rzodkwi oleistej i facelii błękitnej uprawianych w plonie głównym oraz ich wpływ na populację mątwika burakowego. Rośl. Oleiste – Oilseed Crops, 2002, XXIII(2), 223-234.

[14] Wnuk A.: Effect of intercropping of pea with tansy phacelia and white mustard on occurrence of pests. Folia Hort., 1998, 10(1), 67-74.

[15] Wnuk A., Wiech K.: The effect of spacing, date of sowing and intercropping on the occurrence of pea pests. Roczn. Nauk Roln. / E-Ochrona Roślin, 1996, 25, 1-2, 9-14.

Acknowledgements
This Research was financed by the Ministry of Science and Higher Education of the Republic of Poland.
Badania zostały sfinansowane z dotacji przyznanej przez MNiSW na działalność statutową.