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THE EFFECT OF WHITE MUSTARD PROXIMITY ON BROAD BEAN INJURIES DUE TO WEEVILS (SITONA SPP.)

Summary

The investigations aimed at an assessment of white mustard effect, as an accompanying crop, cultivated in two variants: parallely and as strips surrounding the main crop – broad bean, Bartek c.v., on the degree of the main crop injuries due to weevil beetles and larvae. The field experiment comprised the following objects: broad bean, Bartek cv. in pure culture, sown at 50 cm x10 cm spacing; broad bean spaced 60 cm x10 cm with white mustard as the crop intersown between the rows and broad bean spaced 50 x 10 cm, with a 50 cm wide mustard stripe surrounding the plot (in this case the width of broad bean stripes was 3 m). The assessment of weevil beetles feeding intensity was conducted by measuring the area consumed, determining the percentage of injured leaves and computing the leaf blade loss due to their feeding. In order to determine the larvae harmfulness, the underground plant parts were analyzed. Broad bean cultivated together with white mustard, both in the interrows and as surrounding stripes contributed to a considerable decrease in broad bean leaves injuries due to Sitona beetles. On the other hand, broad bean cultivation as surrounding stripes contributed to a considerably decreased injury of root nodules caused by weevil larvae.
***Key words**: intercropping, Vicia faba* L., *Sinapis alba* L., *Sitona* spp.

WPŁYW SĄSIEDZTWA GORCZYCY BIAŁEJ NA STOPIEŃ USZKODZENIA BOBU PRZEZ OPRZĘDZIKI (*SITONA* SPP.)

Streszczenie

Celem badań była ocena wpływu gorczycy białej, jako rośliny towarzyszącej, uprawianej w dwóch wariantach: współrzędnie oraz w postaci pasów dookoła rośliny głównej - bobu odmiany Bartek, na stopień uszkodzenia rośliny głównej przez chrząszcze i larwy oprzędzików. Doświadczenie polowe obejmowało następujące obiekty: bób odmiany Bartek w uprawie jednorodnej wysiany w rozstawie 50 cm x10 cm; bób w rozstawie 60 cm x 10 cm z gorczycą wsianą pomiędzy rzędami oraz bób w rozstawie 50 x 10 cm obsiany dookoła pasem gorczycy o szerokości 50 cm (szerokość pasów bobu wynosiła w tym przypadku 3 m). Ocenę intensywności żerowania chrząszczy oprzędzików przeprowadzono mierząc powierzchnię uszkodzeń, określając odsetek liści uszkodzonych oraz wyliczając ubytek blaszki liściowej w wyniku ich żerowania. Dla określenia szkodliwości larw analizowano podziemne części roślin. Uprawa bobu wspólnie z gorczycą białą w międzyrzędziach, jak i w postaci obsiewu, przyczyniła się do istotnego zmniejszenia stopnia uszkodzenia liści bobu przez chrząszcze oprzędzików. Uprawa bobu z gorczycą w postaci obsiewu przyczyniła się natomiast do istotnego zmniejszenia uszkodzenia brodawek korzeniowych przez larwy oprzędzików.
***Słowa kluczowe**: uprawa współrzędna, Vicia faba* L., *Sinapis alba* L., *Sitona* spp.

1. Introduction

Introducing crops accompanying the main crops, particularly these which produce considerable amounts of pollen (like white mustard), is an excellent method to increase biodiversity and stability of ecological balance in agrocenoses [1–3]. It may be also an alternative for plant protection using chemical preparations, particularly in view of application in pro-ecological farming systems. White mustard is well known for its influence limiting feeding of some soil pests, e.g. sugar beet cysts nematode (*Heterodera schachtii* Schmidt). Its root secretions, owing to their allelopathic properties, are investigated for their possible utilization for manufacturing pro-ecological herbicides [4]. Its introduction to e.g. field been crops leads to a better root density in deeper soil layers and therefore to potentially better nutrient utilization. At the same time, a high competition of white mustard has been emphasized concerning the above-ground parts, which leads to a decrease in seed yield e.g. in field bean [5]. Thus, a proper selection of the spacing between parallel cultivated crops is crucial. So far, little information has been gathered about this plant effect on the occurrence of crop pests. White mustard cultivated in the vicinity of pea, among others has a limiting effect on weevil feeding [6].

Broad bean (despite its not large acreage) and due to the fact that it is attacked by many pests of considerable economic importance, which appear also on other crops (weevils, black bean aphid, *Bruchidae*) is the most useful model plant for investigating various factors effect on the above mentioned pests. *Curculionidae, Sitona* spp. beetles usually appear first on broad bean plantations. Their numerous presence during emergencies period may sometimes necessitate a liquidation of the plantation. Feeding of their larvae, destroying root nodules is also dangerous, as it limits atmospheric nitrogen fixation [7].

The investigations aimed at an assessment of white mustard effect, as an accompanying crop, cultivated in two variants: parallel and as strips surrounding the main crop – broad bean, Bartek c.v., on the degree of the main crop injuries due to weevil beetles and larvae.

2. Material and methods

The investigations were conducted in the years 2013 and 2014 in the area of a private agricultural holding in Igołomia village (Malopolska voivodship). The field experiment comprised the following objects: broad bean, Bartek cv. in pure culture, sown at 50 cm x10 cm spacing (V); broad bean spaced 60 cm x10 cm with white mustard as the crop intersown between the rows (VSi) and broad bean spaced 50 x 10 cm, with a 50 cm wide mustard stripe surrounding the plot (in this case the width of broad bean stripes was 3m) (VSs). The experiment was set up in three replications. The plot area was 12 m^2. The assessment of weevil beetles feeding intensity was conducted at 25 randomly selected and marked plants per plot, by measuring the consumed area (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 weekly intervals, starting from the moment when the first injuries were spotted. In order to determine the larvae harmfulness, the underground plant parts were analysed after their washing, total number of root nodules were counted, as well as the number of injured nodules. This analysis was conducted once by the end of June.
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

The percentage of plants injured by *Sitona* beetles fluctuated depending on the season, observation date and object, from c.a. 2% to 19% (Fig. 1). Usually it was decreasing over time and with the appearance of subsequent leaves. It should be emphasized that registered number of injured leaves was quite low. Previous investigations indicated considerable divergences in the number of leaves injured by weevil beetles among various investigated seasons (from 20% to even 80%) [8]. The reason for low intensity of *Sitona* harmfulness in the presented experiment might have been also quite rare appearance of bean crops (and therefore their accompanying enthomofauna) in the area where the research was conducted. The most numerous leaves with consumed area were spotted in places where only broad bean was cultivated. The limiting effect of white mustard (both as the parallel crop and a stripe surrounding the plot) was more apparent with the plant growth and continuing beetle feeding. On the other hand, the Authors' previous research on the effect of parallel broad bean cultivation with fennel or coriander did not demonstrate that the percentage of leaves injured by weevils was undergoing any marked changes under the influence of this factor. Only during one observation, at the initial period of weevil feeding, a lower value of this index was noted in the vicinity of coriander than in the pure broad bean culture [8].

The consumed area was increasing with continuing pest feeding and reached higher values in the 2013 season (Fig. 2). However, no significant effect of mustard presence on the above mentioned parameter was observed, for a major part of the period of observations, although like in case of the percentage of injured leaves, the largest consumed area was registered in the pure broad bean culture. The differences were statistically proved once in 2013 and 2014 for the objects with accompanying mustard.

The leaf blade loss, computed by referring the consumed area to total leaf area per plant, revealed the highest values at the initial period of the pest feeding (Fig. 3), which suggests that the rate of plant growth considerably exceeded the rate of *Sitona* beetles feeding.

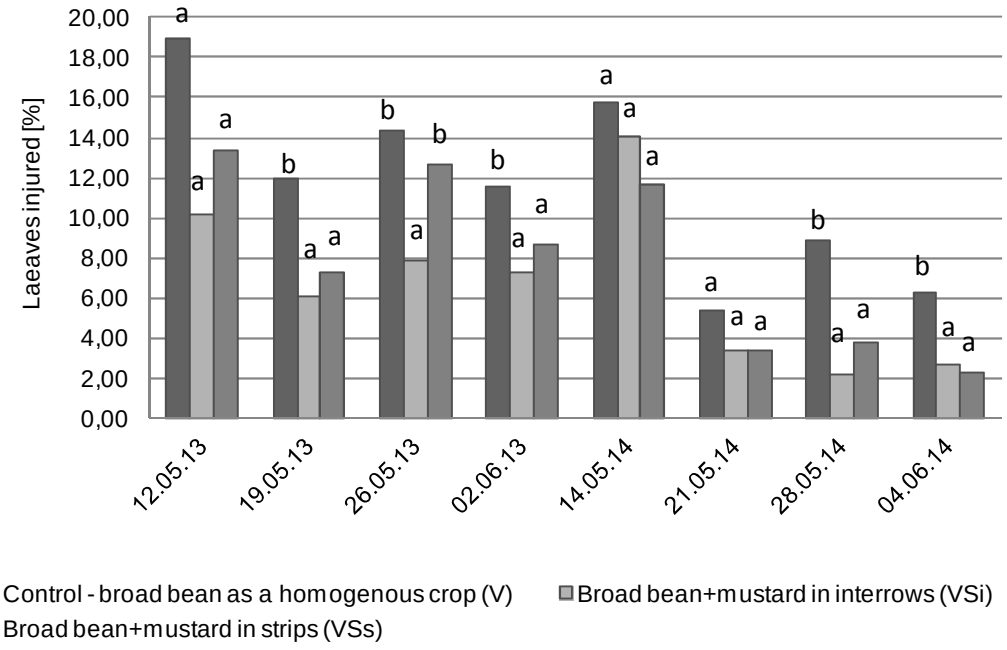

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Fig. 1. Leaves of broad bean injured by *Sitona* spp. adult (per cent of total number of leaves) depending on cultivation system. Mean followed by the same letter in a given date respectively are not significantly different at α = 0.05
Rys. 1. Liście bobu uszkodzone przez chrząszcze oprzędzików (odsetek ogółu liści) zależnie od sposobu uprawy. Średnie oznaczone takimi samymi literami odpowiednio dla danego terminu, nie różnią się istotnie przy α = 0,05

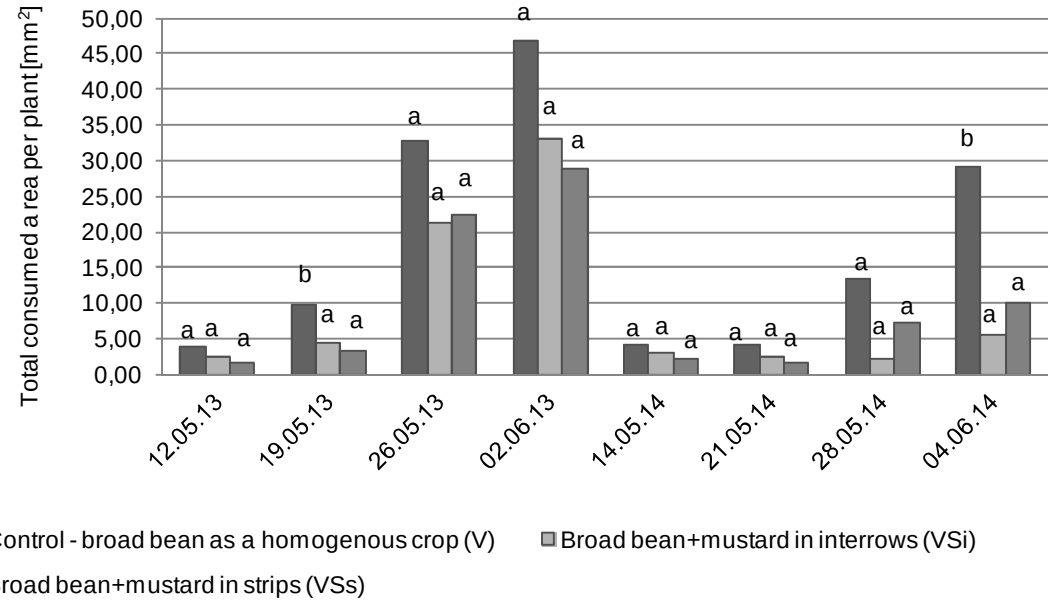

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Fig. 2. Total consumed area (mm^2) caused by *Sitona* spp. adult depending on cultivation system. Mean followed by the same letter in a given date respectively are not significantly different at $\alpha = 0.05$

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

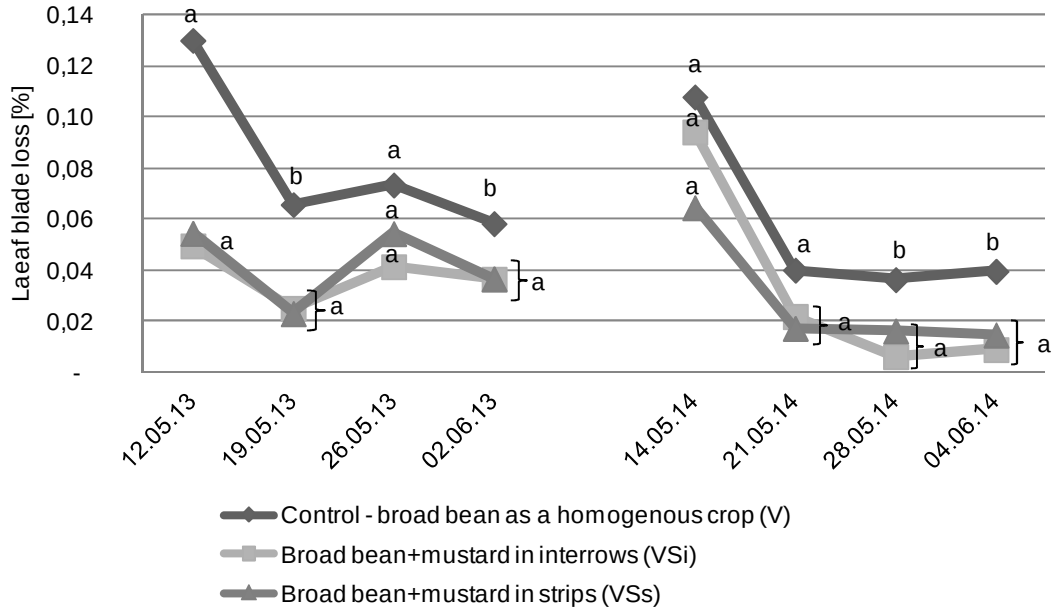

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Fig. 3. Leaf blade loss of broad bean (per cent of total leaf area) caused by *Sitona* spp. adult depending on cultivation system. Mean followed by the same letter in a given date respectively are not significantly different at $\alpha = 0.05$

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

Statistically proved limiting effect of white mustard concerning this index, was registered more frequently at the later period of the insects feeding (and plant growth), which points to a mechanism which interferes with pest's host finding. The growth rate of broad bean and mustard is initially similar, later a strong competition of mustard shoots, which usually grow above broad bean plants, becomes apparent. Gols et al. [9] described a similar mechanism while analysing searching behavior of *Diadegma semiclausum* parasitoid in *Brassica olerace* monoculture and at parallel cabbage cultivation with *Sinapis alba*. They stated that plant height influenced host finding. Wasps found host-infested plants faster when it was accompanied by short *Sinapis* plant than when *Sinapis* plants were high.

Statistical analysis conducted on the data for the whole research season points to a significant effect of mustard

proximity, limiting the degree of broad bean leaves injury by weevils, however the way in which this plant is introduced (as a parallel crop or stripes surrounding the plots) was of not significantly importance (Fig. 4).

The percentage of root nodules injured by weevil larvae ranged from 27 to 68%, depending on the object and season of research (Fig. 5). Also in this case, a statistically proved beneficial effect of mustard presence was registered, visible as about 12-30% lower percentage of injured root nodules, however in the 2014 season, statistically significant differences were registered only for the object where white mustard was sown as a stripe around the broad bean plot. A similar effect was noted for pea cultivated with white mustard – the company of white mustard contributed to decrease injuries from both adult weevils and their larvae [6]. Also Lethmayer et al. [1] in their research on the effects of weed stripes on the occurrence of noxious coleopteran species (*Nitidulidae*, *Chrysomelidae* and *Curculionidae*) found a low abundance of *Sitona* weevils in the stripes with *Sinapis alba.*

The data on the effect of other crops company on the occurrence and harmfulness of weevils are quite diversified. Hurej et al. [10], who analysed weevil (*Coleoptera*: *Curculionidae*) assemblages (among others: *Sitona macularis*) in the fields of narrow-leafed lupine sown as pure stand and intercropped with spring triticale, stated that weevils were more numerous in the pure stands of lupine. However, the number of notches caused by weevils on the leaf margins were similar, irrespectively of lupine-triticale seed ratio. On the other hand, Wnuk and Wojciechowicz-Żytko [11] did not find any significant effect of phacelia as an accompanying crop in broad bean stand on the number of injuries caused by weevil beetles and larvae. Also, the research on the effect of coriander and fennel proximity on weevil larvae feeding on broad bean, White Windsor cv. revealed no marked changes in comparison with the pure stand [8], whereas the effect was not unanimous for beetles. On the other hand, field bean cultivated in a mixture with barley or wheat was injured by *Sitona lineatus* even to a higher degree than in pure culture [12].

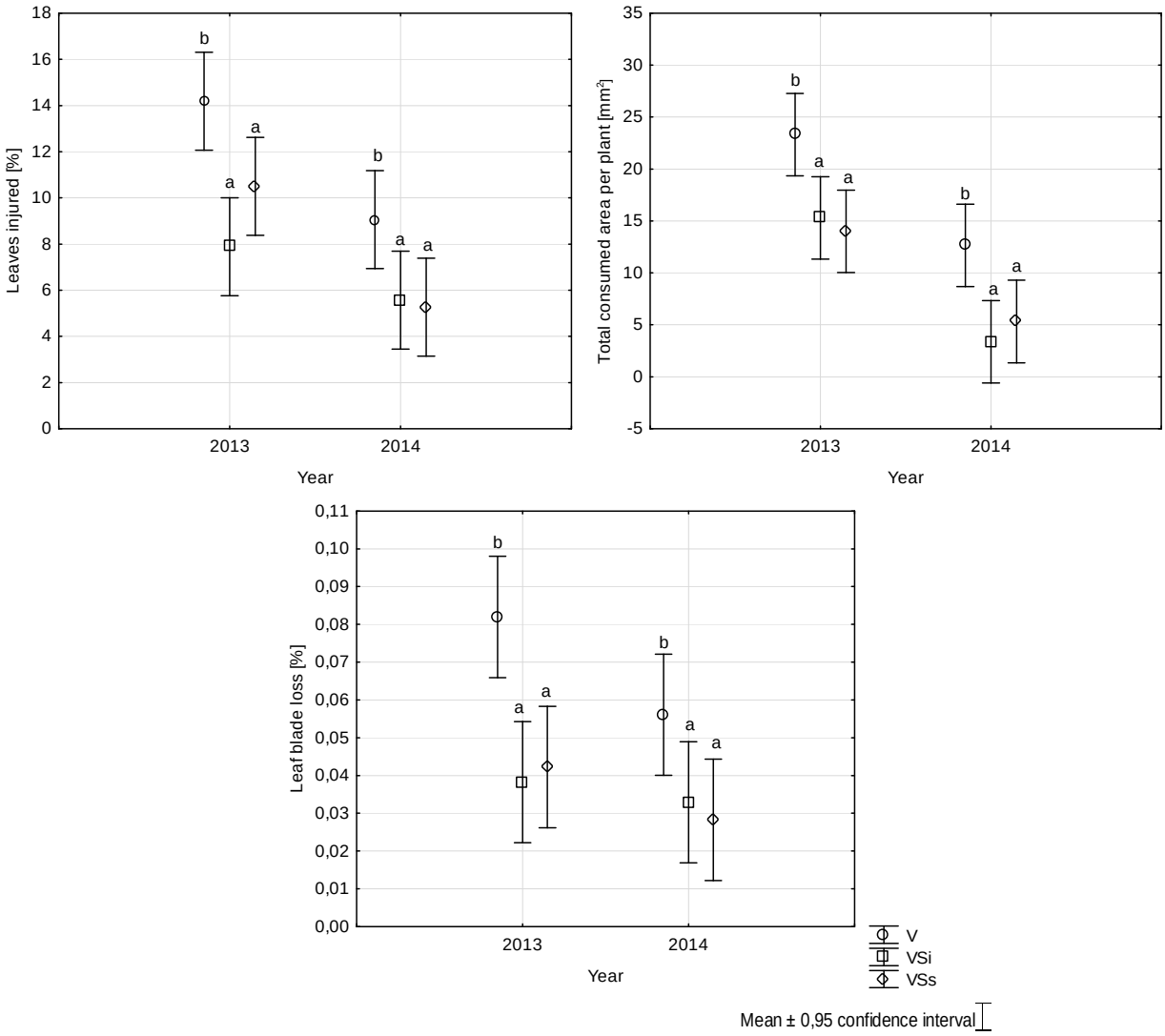

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Fig. 4. Damage of broad bean caused by *Sitona* spp. adult depending on cultivation system (mean in the years of experiment). Mean followed by the same letter are not significantly different at α = 0.05, factors: cultivation system x year
Rys. 4. Uszkodzenia bobu przez chrząszcze oprzędzików zależnie od sposobu uprawy (średnio w latach badań). Średnie oznaczone takimi samymi literami nie różnią się istotnie przy α = 0,05, czynniki: sposób uprawy x rok

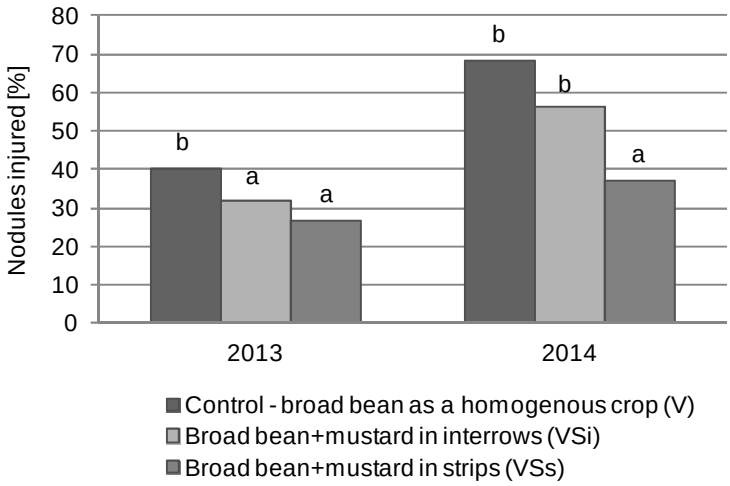

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Fig. 5. Damage of root nodules caused by *Sitona* spp. larvae (per cent of total nodule number) depending on cultivation system. Mean followed by the same letter in a given year respectively are not significantly different at $\alpha = 0.05$
Rys. 5. Uszkodzenie brodawek korzeniowych przez larwy oprzędzików (procent ogólnej liczby brodawek) zależnie od sposobu uprawy. Średnie oznaczone takimi samymi literami odpowiednio dla danego roku, nie różnią się istotnie przy α = 0,05

4. Conclusions

1. Broad bean cultivated together with white mustard, both in the interrows and as surrounding stripes contributed to a considerable decrease in injuries of broad bean leaves caused by *Sitona* beetles.
2. On the other hand, broad bean cultivation as surrounding stripes contributed to a considerably decreased injury of root nodules caused by weevil larvae.

5. References

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