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USE OF THE STRIPS WITH PLANT MIXTURE AS METHOD OF INCREASING BIODIVERSITY AND HEALTHINESS OF ORGANIC POTATO PLANTS

Summary

These studies present the results of use of mixture of sunflower (Helianthus annuus L.), climbing bean (Phaseolus vulgaris L.) and marigold (Tagetes L.) which was sown on the margins of organic potato fields. The necessary agrotechnical measures were performed. The plants on the margins were used as the mechanical barrier for spores of. P. infestans. Also beneficial insects occurring on margins were observed. As a control area it was used the field without the strips with mix of plants, but with the same agricultural practices. During growing season the healthiness of plants was monitored. Symptoms of late blight were noted. Beneficial insect living in the strips according to adjacent crops were noted, most insects were observed in the strips from the field of rape.
***Key words**: beneficial insects, mix plants, organic farming, Phytophthora infestans, potato*

UŻYCIE PASÓW Z MIESZANKĄ ROŚLIN JAKO METODA PODNOSZENIA BIORÓŻNORODNOŚCI I ZDROWIA ZIEMNIAKÓW W UPRAWIE EKOLOGICZNEJ

Streszczenie

W pracy przedstawiono wyniki zastosowania mieszaniny roślin: słonecznika (Helianthus annuus L.), fasoli tycznej (Phaseolus vulgaris L.) i aksamitki wzniesionej (Tagetes L.), która została zasiana jak pas brzeżny na polach ziemniaka, gdzie przeprowadzono niezbędne zabiegi agrotechniczne. Rośliny w mieszance wykorzystano jako barierę mechaniczną dla zarodników. P. infestans. Notowano występowanie owadów pożytecznych na obrzeżach. Jako powierzchnię kontrolną wykorzystano pole bez siewu brzeżnego, z tymi samymi zabiegami pielęgnacyjnymi. Zdrowotność roślin była monitorowana, notowano niższe objawy zarazy ziemniaka na powierzchni z obsiewem. Liczebność owadów pożytecznych była zróżnicowana w zależności od uprawy przylegającej do pasa brzeżnego, najwięcej owadów obserwowano od strony pola z rzepakiem.
***Słowa kluczowe**: owady pożyteczne, mieszanka roślin, rolnictwo ekologiczne, Phytophthora infestans, ziemniaki*

1. Introduction

Biological control plays a major role in sustainable and organic agriculture and aims to strengthen biological agents that regulate populations of insect pests. Biological control of pests by natural enemies is a major ecosystem service delivered to agriculture worldwide. Landscape complexity is known to benefit natural enemies, but its effects on interactions between natural enemies and the consequences for crop damage and yield are unclear [6]. Organic farming operates without synthetic pesticides, herbicides and inorganic fertilizers, and usually with a more diverse crop rotation. It has been suggested that this system enhances biodiversity in agricultural landscapes. Flowering plants can be added, along (flower strip) the crop field, be resources of foods for parasitoid [1]. Organic farming usually increases species richness, having on average 30% higher species richness than conventional farming systems [3]. However, the results were variable among studies, and 16% of them actually showed a negative effect of organic farming on species richness [3].

Managed field margins can be effectively deliver multiple services and take account of agronomic practically in their management, are essential for the delivery of environmental benefits through agri-environment schemes, field margins show great promise and have the potential to be key components within insect control management [2].

The structure of the agricultural fields should be the most close to natural habitats. Thereby it can help increase the abundance of species and biodiversity. These elements of biocenosis can be used as a natural method to increasing resistance of environment for infection by pathogens and reduce the damage caused by pests. The use of mixtures of plant's species is developing direction finding methods to increase the possibility of crop protection. In organic farming an important part of biodiversity is structure of the fields, buffer zones and field margins because these places are habitats for beneficial organisms. Growing plants on margins fields should not be only random groupings of plants, but composed as the most attractive mix of species being:1) attractant for beneficial insects - natural enemies of pests, 2) confusing or repellent to pests, 3) mechanical barrier to pathogens.

The focus of this research is to evaluate the efficacy of mixture with three different species plants (with different high of plants) sowing in the strips next to potato fields, which could be useful as 1) attractant for beneficial insects - natural enemies of pests, 2) mechanical barrier to pathogen, *Phytophthora infestans*.

2. Material and methods

The assays was carried out in 2014 in Winna Góra, Wielkpolska region, where is located the field research station of the Institute of Plant Protection – NRI. Two hectares are certified as organic field. Edges composed of three species were tested - sunflower (*Helianthus annuus* L.), climbing bean (*Phaseolus vulgaris* L.) and marigold (*Tagetes*

L.). The experimental potato field was divided in two separate areas with size 200 m^2 each: one area with the strip of 3 m^2 and the second area without the strips. Potato were planting at 23 of April, during whole vegetation were performed the treatments under organic conditions, three weeding were made, two treatments with spinosad at dose 24 g s.a./ha in order to control of Colorado potato beetles (*Leptinotarsa decemlineata* L.) were performed. Non fungicides were used to control of *Phytophthora infestans* and *Alternaria* spp.

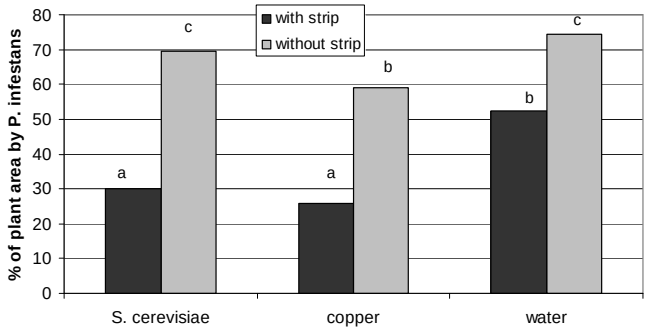
The mixture of plants as the strips was sown in spring using seeder. In trials were evaluated:1) beneficial insects on the sunflower in the strip, 2) level of infestation of potato plants by *P.infestans* – high plants of sunflower were used as mechanical barrier for spores of *P. infestans* transferred by wind.

The strips with sunflower were adjacent to different big plots – winter oilseed rape (WOSR) field, potato field, dirt road without plants. Flower visitors were monitored by visual observation all planted plants on the high of eyes. Visitors were observed from 2 to 28 July 2014. The observation was repeated every week, once a week; all length (100 meters) of margins was monitored.

Degree of infection of potato by potato late blight (*P. infestans*) assessed was as a percentage of the whole surface of plants showing symptoms of disease. Observation (6 times from 02.07 to 04.08) on 20 randomly selected plants was performed in each treatment. Three combinations on the both areas, surrounded by the strip and without it were made: 1) the treatment based on a complex of *Saccharomyces cerevisiae* at a dose of 10 g · l^{-1} L of water, 2) the treatment based on the copper – cuprus oxide Cu_2O in a dose not exceeding 3.5 kg · ha^{-1}, 3) water 300 l · ha^{-1}. Six applications as foliar spraying were made.

3. Results and discussion

A total number of observed individuals in accordance to time of observation and different crops adjacent to the field margins is included in table 1. Beneficial insects that perform different roles in the environment (pollinators, predators) were noted. The strips may double role, are home to insects, and represent a barrier to spores of *P. infestans* spreading out with the wind. The impact of the strips to reduce the symptoms of potato blight depending on the presence or absence of the strips at the potato fields is shown in Fig. 1.



Source: own work

Fig. 1. Plant potato infection by *P. infestans* depending on the strip with mix plants and different treatments
Rys. 1. Porażenie roślin ziemniaka przez P. infestans w zależności od obecności pasa brzeżnego i kombinacji zabiegów

Table 1. Composition and abundance of specimens observed on the strips with the relation to the time of observation and crop adjacent
Tab. 1. Skład gatunkowy i liczebność obserwowanych owadów na pasach brzeżnych w zależności od czasu obserwacji i upraw graniczących z pasem brzeżnym

Date of observation	02.07.2014			07.07.2014			14.07.2014			21.07.2014			28.07.2014		
	Strip next to WOSR	Strip next to dirt road	Strip next to potato	Strip next to WOSR	Strip next to dirt road	Strip next to potato	Strip next to WOSR	Strip next to dirt road	Strip next to potato	Strip next to WOSR	Strip next to dirt road	Strip next to potato	Strip next to WOSR	Strip next to dirt road	Strip next to potato
Height of sunflower [cm]	20-50	20-80	10-40	20-80	50-100	10-50	50-120	50-120	20-50	30-150	30-170	30-130	50-180	50-180	30-150
C. septempunctata imago	3	2	-	4	2	-	3	1	2	2	4	-	19	4	8
C. quatuordecimpustulata imago	1	1	-	-	-	-	1	2	-	1	4	-	5	3	7
H. axyridis - imago	-	-	-	-	-	-	-	2	-	-	-	-	4	-	5
Araneae	1	1	-	10	-	-	9	4	2	7	12	2	5	13	2
Syrphidae - imago	3	-	-	6	5	-	-	-	-	8	6	-	8	10	1
Heteroptera - imago	2	4	1	-	-	-	39	34	16	45	50	4	96	110	19
Apidae	-	-	-	6	14	-	14	8	3	18	16	4	374	362	42
Bombus	-	-	-	-	-	-	4	-	2	-	-	-	46	53	2
Chrysopa vulgaris imago	-	1	-	-	-	-	3	5	3	-	1	-	-	2	-

C. septempunctata – Coccinella septempunctata – Biedronka siedmiokropka
C. quatuordecimpustulata – Coccinella quatuordecimpustulata – Biedronka łąkowa
H. axyridis – Harmonia axyridis – Biedronka azjatycka

Source: own work / Źródło: opracowanie własne

Along with the growth of plants in the strip was observed an increase in the diversity of species of insects. The obvious fact was that significant more bees were observed when all sunflowers were flowering, at later observation.

Most of the species and the largest variety of them reported on plants growing in the strip bordering with the rape, but after harvest of winter oilseed rape a lot more insects were observed in the strip which borders with the road dirt. The smallest value recorded on the plants bordering the potato field. Among the insects dominated Heteroptera species, only during the last observation (28.07.2014) was recorded a high number of Apidae, which was related to of blooming sunflowers. The third group of insects in terms of abundance was bumblebees. The least frequent were represented by Neuroptera, which were found mainly on the strip by the dirt road; there the spiders were found also.

Initially it can suggest the hypothesis that fields that adhere to the observed surface, can be indirectly affect on the abundance and species composition of the fauna present in the observed field. The crop, which borders with another field may be a place in where many beneficial insects are living and thus be their only habitat due to its attractiveness, for example be a source of feeding, both for pollinators and predators. Not observed increase in the number of beneficial insects diversity on potato plants surrounded by the strips. For Apidae and bumble bee this is understandable, but unfortunately there no were also Coccinelidae and Heteroptera which perform the roles as predators.

A management strategy developed for field margins to promote biodiversity on arable land was developed. It involved not spraying herbicides and pesticides in a strip 3 or 6 m wide on the edges of winter wheat, sugar beet and potato crops [5]. There was a pronounced effect on phytophage insects. The number of visits to the unsprayed edges also was increased. A cost-benefit analysis based on the yield losses showed that it is very feasible to incorporate unsprayed crop edges in the cultivation of winter wheat and potatoes. In sugar beet, however, the cost is too high. However, for reasons to do with agronomy, farming equipment and sociopsychology, farmers will accept unsprayed cereal edges or grass strips but not unsprayed potato edges [5].

The presence of the strip evidently was limiting for level of infestation of potato by the potato blight (Fig. 1). The best effective was the treatment based on copper (25.9% of infected area), even at a dose reduced (3.5 kg ha), also good result was obtained for the treatment with yeast (30.1%). It is very promising agent of protection which should be used in the next year, also.

In the case of the second experimental area, no surrounded by the strip, observed significantly higher levels of disease than on the surface parallel, surrounded. The effectiveness of the treatments against *P. infestans* was lower in comparison to previously discussed. The treatment of the copper was the most effective, 59% of plants were infected, in combination with water it was noted as 74.5%. The treatment of yeast (69.5%) was less effective than copper.

The effects of strip cropping of potatoes with cereals or a grass-clover mix in and perpendicular to the main wind direction on foliar late blight severity and tuber yield were studied in large-scale field experiments in Germany [4]. In 2000, plot size was 3 × 10 m and there were no disease reductions. In 2001 and 2002, with plot sizes of 6 × 18 and 6 × 36 m in strip-cropped potatoes, disease was significantly reduced by 9-20% and 4-12%, respectively, compared to pure stands of potato [4]. As conclusion was defined that strip intercropping might be a useful component in an overall management strategy to reduce incoming late blight inoculum. It is in line with here presented results.

In summary, be on the basis preliminary observation can conclude that the mix of plants (3 meter marginal strip) is an attractive habitat for beneficial insects, especially when bordered with rape (for pollinators) or dirt road, where there were predatory insects. In addition, the margin is a mechanical barrier to spores *P. infestans* and surrounded potato plants were much healthier. The problem, however, was the performance of mechanical treatments (weeds control) which should be intensified in the later stage of potato plants but it is impossible cause of growing of mix plants in the strips.

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5. References

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