

INTENSITY OF BROAD BEAN FUNGAL DISEASES IN INTERCROPPING WITH SELECTED SPECIES OF HERBS

Summary

The purpose of research was to evaluate the impact that intercropping of broad beans with coriander (*Coriandrum sativum* L.) and fennel (*Foeniculum vulgare* Mill.) has on the health of leaves and pods of two varieties of legumes (White Windsor, White Hangdown). The field research was conducted in the years 2010-2012 at the Agricultural Experimental Farm in Prusy, near Cracow. On the basis of the conducted research, it was found that intercropping of broad beans with coriander and fennel has significantly limited the infection of pods by *Botrytis fabae* (chocolate spot disease), *Ascochyta fabae* (ascochyta blight), *Uromyces fabae* (rust) and *Botrytis cinerea* (grey mould), but only in relation to the control group. The presence of fungal diseases on the leaves of the tested plants was not significantly dependant on the applied protection method. From among the tested varieties, the White Hangdown (industrial strain) was the only one characterised by a significantly lower infection of pods by *Botrytis cinerea* (grey mould). The intensity of broad bean fungal diseases was significantly dependant on the year that the research was conducted.

Keywords: broad bean, intercropping, diseases, herbs

NASILENIE WYSTĘPOWANIA CHORÓB GRZYBOWYCH BOBU W UPRAWIE WSPÓLRZĘDNEJ Z WYBRANYMI GATUNKAMI ZIÓŁ

Streszczenie

Celem badań była ocena wpływu uprawy współrzędnej bobu z kolendrą siewną (*Coriandrum sativum* L.) i koprem włoskim (*Foeniculum vulgare* Mill.) na stan zdrowotny liści i strąków dwóch odmian (Windsor Biały, Hangdown Biały). Doświadczenia polowe prowadzono w latach 2010-2012 w Rolniczym Gospodarstwie Doświadczalnym w Prusach k. Krakowa. W oparciu o przeprowadzone badania stwierdzono, że siew współrzędny bobu z kolendrą siewną i koprem włoskim istotnie ograniczał porażenie strąków przez *Botrytis fabae* (czekoladowa plamistość), *Ascochyta fabae* (askochytoza), *Uromyces fabae* (rdza) i *Botrytis cinerea* (szara pleśń), lecz tylko w odniesieniu do kontroli. Obecność chorób grzybowych na liściach testowanych roślin nie zależała istotnie od zastosowanej ochrony. Z testowanych odmian, Hangdown Biały (odmiana przemysłowa) w porównaniu do Windsor Biały (przeznaczona do bezpośredniej konsumpcji) odznaczała się istotnie niższym porażeniem strąków jedynie przez *Botrytis cinerea* (szara pleśń). Nasilenie występowania chorób grzybowych na roślinach bobu zależało istotnie od roku badań.

Słowa kluczowe: bób, uprawa współrzędna, choroby, zioła

1. Introduction

The broad bean qualifies as a legume. In Poland, the broad bean was a little-known plant until recently; however, it became a more widespread species (grown and consumed more frequently) after the introduction of new and interesting varieties. Unfortunately, it is still not grown on a large scale. During the vegetative phase, broad beans are often attacked by diseases and pests. On broad bean plantations, most of the damage is caused by fungal diseases, which include ascochyta blight of broad beans (*Ascochyta fabae*), chocolate spot disease of broad beans (*Botrytis fabae*), grey mould of broad beans (*Botrytis cinerea*), rust of broad beans (*Uromyces fabae*) as well as fusarium head blight of broad bean shoots (*Fusarium* spp.) [1, 5, 16]. One of the methods of protecting this plant against pests in ecological farming is intercropping of broad beans with herbs (accompanying plants). According to Senderski [14] and Stoyanova [17], coriander belongs to such herbs, and as a result of its high content of essential oils, it proves to be highly useful, among others, for protecting plants against weeds and pests [7]. Many literature reports [6, 12, 19] confirm the

usefulness of accompanying plants (herbs), including coriander and fennel, in the protection against pests. According to Silva and Domingues [13], the essential oil of coriander also exhibits an antimicrobial effect. In the available literature, there is a lack of reports concerning the effect of accompanying (intercropped) plants of coriander and fennel on the intensity of broad bean fungal diseases. According to Sobkowicz [15], as well as Leszczyńska and Cacak-Pietrzak [9], mixed sowing contributes to the increase in the genetic diversity of plants located within a plant community, while simultaneously having an impact on the improved exploitation of habitat and production environment factors. Moreover, plants grown using mixed sowing have a higher yield volume than those grown using pure sowing; they also reduce the amount of pests [6,12] and are characterised by better health because they limit the dispersion of fungal pathogens [8, 9, 10].

The purpose of this paper was to evaluate the impact that intercropping of broad beans with coriander (*Coriandrum sativum* L.) and fennel (*Foeniculum vulgare* Mill.) has on the health of leaves and pods of two of legumes (White Windsor, White Hangdown).

2. Research material and methods

The field research was conducted in the years 2010-2012 at the Agricultural Research Farm (Rolnicze Gospodarstwo Doświadczalne) located in Prusy near Kraków. The two-factor studies were conducted in a randomized split-plot design experiment, in three repetitions, on the soil of a very good wheat complex. The first factor included the varieties (White Windsor – eatable, White Hangdown – industrial). The second factor comprised the method of protecting broad beans (control group, broad beans + coriander, broad beans + fennel, biological protection). Cultivation and fertilisation were conducted in accordance with the constraints and principles of ecological farming. Before sowing, the broad bean seeds, excluding the control group, were treated with the Polyversum WP biological preparation in the amount of 10 g per 1 kg of seeds. The seeds were sown during the first ten days of April, at a depth of 6 cm, 50 cm apart between rows and 10 cm apart within rows. The companion plants (coriander, fennel) were sown in the following amounts: 1/3 less than in the case of pure sowing.

During the vegetative phase, the broad bean was mechanically protected against weeds, whereas the occurrence of diseases and pests was reduced using the following protection combinations:

1. control group (without treatment and foliar protection),
2. treatment of seeds using Polyversum WP, intercropping of broad beans with coriander,
3. treatment of seeds using Polyversum WP, intercropping of broad beans with fennel,
4. treatment of seeds using Polyversum WP + 4 x Bioczos BR + 1 x Biosept 33 SL.

The Biosept 33 SL preparation was applied onto the leaves in the amount of 2 l/ha right before the plants flowered in order to reduce fungal diseases. On the other hand, Bioczos BR was applied in the amount of 4 cubes/l of water as soon as the first aphids appeared as well as against diseases and against the broad bean weevil at the time when the first level of the broad bean inflorescence began to shed blossom. The application of this preparation was repeated every seven days.

In the BBCH (70-79) development phase of broad beans, a health assessment was conducted using 25 plants that were randomly collected from the plot. The occurrence of specific fungal diseases on leaves and pods was assessed using a 5-step scale (1-5), which expressed an increasing infection of plants. The results were presented in the form of an infection index [18] and were subject to variation analysis, and the relevance of the average differences was verified using Tukey's test to be at a level of $\alpha = 0.05$.

3. Results and discussion

During the vegetative phase, the following fungal diseases were observed on the leaves and pods of broad beans: chocolate spot disease (*Botrytis fabae*), ascochyta blight of broad beans (*Ascochyta fabae*), and additionally, the presence of grey mould (*Botrytis cinerea*) as well as broad bean rust (*Uromyces fabae*) was observed on the pods. The presence of the same fungal diseases on the same plant species – horse beans – is confirmed by authors of other papers [3, 4, 8].

The weather conditions in the years when the research was conducted (2010-2012) had an impact on the health condition of the leaves and pods of the tested plants. According to Olszewska [11], broad bean plants need anywhere from 300 to 450 mm of rainfall during the vegetation phase for correct development. Both excess and insufficient rainfall have a negative impact on the yield and health condition of these plants. In general, when considering the research conducted between the months of April and July, the year 2010 can be considered as being very humid (582.30 mm of rainfall) with an average air temperature of 14.82°C; the year 2012 was warmer (15.53°C) and it was also the driest (299.30 mm of rainfall). In comparison to the multi-annual period, in the year 2010, May, June and July stood out as the months with the most amount of rainfall. In the said vegetative season, May especially stood out with the largest amount of rainfall (294.60 mm) while also being the coolest (an average of 12.60°C). Nevertheless, in 2010, the index of infection of the leaves and pods of broad beans by pathogenic fungi was the lowest (tab. 1). In 2011, the total rainfall between April and July was 377.40 mm and it was closest to the optimal condition required by this plant species. However, the months of April and July of 2011 were characterised by excess of humidity, especially July, when occurred 194.40 mm of rainfall. In the most humid month of July, the average air temperature was 17.57°C and it was lower than the average air temperature during the multi-annual period (18.19°C). The weather conditions that occurred in 2011 only significantly limited pod diseases – ascochyta blight (*A. fabae*), rust (*U. fabae*) and grey mould (*B. cinerea*). On the other hand, the broad bean vegetative season of 2012 was characterised by insufficient humidity in May (22.80 mm of rainfall) and July (68.70 mm of rainfall). In May, the amount of rainfall was three times lower than in the multiannual period (for this month). In 2012, the only increase in humidity was observed in June (143.10 mm of rainfall). This unbeneficial distribution of rainfall in 2012 contributed to the increase in chocolate spot disease (*B. fabae*) on leaves and pods as well as ascochyta blight (*A. fabae*), rust (*U. fabae*) and grey mould (*B. cinerea*) on pods.

Table 1. Average index (ip %) of broad bean infection by pathogenic fungi in the years 2010-2012

Tab. 1. Średni indeks porażenia bobu przez grzyby chorobotwórcze w latach 2010-2012

Fungal diseases	Years			LSD _{0,05}
	2010	2011	2012	
<i>Fungi diseases on leaves:</i>				
broad bean chocolate blotch (<i>B. fabae</i>)	46.26	53.83	65.33	6.96
broad bean ascochytoxis (<i>A. fabae</i>)	35.28	52.75	44.75	3.31
<i>Fungi diseases on pods</i>				
broad bean chocolate blotch (<i>B. fabae</i>)	33.64	33.75	49.83	5.97
broad bean ascochytoxis (<i>A. fabae</i>)	38.72	34.50	51.67	3.71
rust (<i>U. fabae</i>)	34.45	26.83	37.42	5.30
gray mould (<i>B. cinerea</i>)	42.58	33.17	44.42	6.17

Source: own work / Źródło: opracowanie własne

Table 2. Average infection index (ip %) of the over-ground part of different varieties of broad bean by fungal pathogens
 Tab. 2. Średni indeks porażenia (ip %) części nadziemnej odmian bobu przez patogeny grzybowe

Fungal diseases	Varieties		LSD 0,05
	Windsor Biały	Hangdown Biały	
<i>Fungi diseases on leaves:</i>			
broad bean chocolate blotch (<i>B. fabae</i>)	55.36	54.93	n. s.
broad bean ascochyta (<i>A. fabae</i>)	44.50	44.02	n. s.
<i>Fungi diseases on pods</i>			
broad bean chocolate blotch (<i>B. fabae</i>)	37.20	40.95	n. s.
broad bean ascochyta (<i>A. fabae</i>)	40.81	42.45	n. s.
rust (<i>U. fabae</i>)	32.13	33.67	n. s.
gray mould (<i>B. cinerea</i>)	42.09	38.02	2.36

n.s.- not significant difference

Source: own work/ Źródło: opracowanie własne

Regardless of the applied method of protection, the tested varieties of broad beans did not differ significantly from each other as regards the intensity of fungal diseases on leaves and pods, with the exception of grey mould (*B. cinerea*) (tab. 2). The obtained results are analogous with the reports of Boligłowa et al. [1]. In the case of the industrial strain – the White Hangdown – a tendency of increased infection index of pods by *B. fabae*, *A. fabae*, *U. fabae* was observed in relation to the White Windsor variety intended for early use. At the same time, the pods of the same variety (White Hangdown) were characterised by a significantly lower index of infection by *B. cinerea* (grey mould).

In the author's own research, it was determined that broad beans grown with coriander and fennel are characterised by an insignificant increase of the index of infection of leaves by *B. fabae* (chocolate spot disease) and *A. fabae* (ascochyta blight) in relation to the control group as well as biological protection (tab. 2, 3). This means that both the coriander and the fennel are too competitive towards broad beans. In this situation, intercropping contributed to an increase in humidity in the broad bean field, which, as a consequence, favoured the infection of plants by pathogenic diseases. Dłużniewska et al. [2] express a different opinion, although their research concerned horse beans with a different accompanying plant. The obtained results also do not comply with the results obtained by Kurowski et al. [8] regarding the effect of undersown mustard on the health of horse beans. Chocolate spot disease (*B. fabae*) had the biggest impact on the observed plants. According to Dłużniewska et al. [2, 3, 4, 8] as well as Boligłowa et al. [1], along with ascochyta blight, the chocolate spot disease of leaves belongs to the most commonly occurring bean plant diseases.

Table 3. Impact of intercropping of broad beans with herbs on the average infection index (ip %) of the over-ground parts of broad beans by *B. fabae* (chocolate spot disease)

Tab. 3. Wpływ uprawy współrzędnej bobu z ziołami na średni indeks porażenia (ip %) części nadziemnych bobu przez *B. fabae* (czekoladowa plamistość)

Plant protection combination	Infection index (ip %)	
	leaves	pods
1. Control	53.64	41.19
2. Broad bean + coriander	56.52	37.94
3. Broad bean + fennel	56.93	38.47
4. Biological protection	53.48	38.69
LSD 0,05	n. s.	2.23

n.s.- not significant difference

Source: own work / Źródło: opracowanie własne

Table 4. Impact of intercropping of broad beans with herbs on the average infection index (ip %) of the over-ground parts of broad beans by *A. fabae* (ascochyta blight)

Tab. 4. Wpływ uprawy współrzędnej bobu z ziołami na średni indeks porażenia (ip %) części nadziemnych bobu przez *A. fabae* (askochytoza)

Plant protection combination	Infection index (ip %)	
	leaves	pods
1. Control	44.00	44.54
2. Broad bean + coriander	45.67	41.32
3. Broad bean + fennel	44.70	39.49
4. Biological protection	42.67	39.16
LSD 0,05	n. s.	2.98

n.s.- not significant difference

Source: own work/ Źródło: opracowanie własne

In the research it was stated that when compared to leaves, when compared to leaves, broad bean pods were characterised by a lower index of infection by *B. fabae* and *A. fabae*. The obtained results confirm the previous studies performed by Boligłowa et al. [1]. Intercropping of broad beans with coriander has significantly lowered the index of pod infection by *B. fabae* only when compared to the control group. A similar reaction was observed in the case of ascochyta blight (*A. fabae*). However, fennel has also contributed to limiting the development of ascochyta blight. In the author's own research, the presence of broad bean rust (*U. fabae*) as well as grey mould (*B. cinerea*) was observed on pods (tab. 5). Significantly positive protection against broad bean rust and grey mould was provided by intercropping of broad beans with coriander as well as biological protection of plants (a fivefold foliar application of bio-technical preparations).

Table 5. Average infection index (ip %) of broad bean pods by other pathogenic fungi depending on the protection combination

Tab. 5. Średni indeks porażenia (ip %) strąków bobu przez inne grzyby chorobotwórcze w zależności od kombinacji ochrony

Plant protection combination	Infection index (ip %) by:	
	<i>Uromyces fabae</i> (rust)	<i>Botrytis cinerea</i> (grey mould)
1. Control	37.65	45.10
2. Broad bean + coriander	31.22	40.65
3. Broad bean + fennel	34.90	40.39
4. Biological protection	27.83	34.08
LSD 0,05	5.73	4.30

Source: own work/ Źródło: opracowanie własne

4. Conclusions

Based on the conducted research, it was found that intercropping of broad beans with coriander (*Coriandrum sativum* L.) and fennel (*Foeniculum vulgare* Mill.) has significantly limited the infection of pods by *Botrytis fabae* (chocolate spot disease), *Ascochyta fabae* (ascochyta blight), *Uromyces fabae* (rust) and *Botrytis cinerea* (grey mould), but only in relation to the control group. The presence of fungal diseases on the leaves of the tested plants was not significantly dependant on the applied protection method. From among the tested varieties, the White Hang-down (industrial strain) was the only one characterised by a significantly lower infection of pods by *Botrytis cinerea* (grey mould). The intensity of broad bean fungal diseases depended significantly on the year when the research was conducted.

5. References

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The study financed from the funds for the science in the years 2010–2012 as a research project NN 310 038 438.