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EVALUATION OF CHEMICAL PROTECTION EFFECT ON HEALTHINESS OF BROAD BEAN LEAVES AND ELEMENTS OF YIELDING

OCENA ODDZIAŁYWANIA CHEMICZNEJ OCHRONY NA ZDROWOTNOŚĆ LIŚCI I ELEMENTY PLONOWANIA BOBU

Abstract: The paper aimed at an evaluation of chemical protection means (Vitavax 200FS, Decis 2.5 EC, Fastac 100EC and Penncozeb 80 WP) effect on leaf healthiness of two broad bean cultivars (White Windsor and White Hangdown), and the elements of seed yield structure. Obtained results demonstrated that years significantly diversified intensity of fungal diseases on broad bean leaves and the elements of seed yield structure. Excessive moisture during vegetation period favours leaf infection by brown spot (*B. fabae*) and worsens the elements of seed yield structure. Broad bean leaves susceptibility to fungal diseases and seed structure elements depend on the cultivar. White Windsor cultivar, intended for early harvest is characterized by markedly greater sensitivity to fungal diseases and produces more seeds per pod with higher 1000 grain weight. Foliar application of chemical protection means, conducted three or four times (2 x insecticide +1 x fungicide or 3 x insecticide + 1 x fungicide) guarantees better health state of plants and favours increase in 1000 grain weight.

Keywords: broad bean, pesticides, leaf diseases, elements seed yielding

Introduction

In some regions of Poland (in Zulawy Wislane, Lubelskie and Mazowieckie Provinces and in the south) broad bean is cultivated as a vegetable plant [1]. In recent years the interest in this plant has been growing due to its taste values, high protein content in the seeds and other nutrients [2]. During vegetation period, broad bean as a legume and field bean are attacked by the same agrophages which cause losses in yield and worsen seed quality. According to Robak and Szwejda [3], Dluzniewska et al [4] *Botrytis fabae* and *Ascochyta fabae* are the diseases most frequently occurring on field bean leaves during vegetation period. These diseases may to the greatest extent contribute to losses in yield. Legume plant healthiness during vegetation period depends on many factors: weather conditions, applied agrotechnical measures (among others: crop rotation, cultivar or protection) [5-7]. Appropriate agrotechnical measures, including chemical protection, should be applied to prevent the occurrence of legume plant diseases [5, 8]. Therefore, chemical means of broad bean protection have been sought, which would meet the requirements of plant protection against the agrophages, would be highly selective and safe for humans and the environment. In result, chemicals used for broad bean protection would not accumulate in the seeds. There is a lack of reports on these problems.

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The paper evaluated the effect of plant chemical protection means (Vitavax 200FS, Decis 2.5 EC, Fastac 100 EC, Penncozeb 80WP) on leaf healthiness of two broad bean cultivars (White Windsor and White Hangdown) and the elements of seed yield structure.

Materials and methods

Field experiments were conducted in 2010-2011 at Agricultural Experimental Farm of the University of Agriculture in Krakow situated in Prusy. Two factor experiment was carried out using randomised sub-block method in three replications on the soil of very good wheat complex. The first experimental factor were broad bean cultivars (White Windsor and White Hangdown) and the second their chemical protection (control, seed dressing with Vitavax 200FS, Decis 2.5 EC, Fastac 100EC and Penncozeb 80WP preparations). Prior to sowing broad bean seeds, except the control object, were dressed with 4 cm^3/1 kg of seeds dose of Vitavax preparation. The seeds were sown in the first decade of April to the depth of 6 cm with row spacing 50 cm and 10 seeds per row. Soil tillage and fertilization were conducted in compliance with agrotechnical requirements for this plant species. During vegetation period broad bean was protected against weeds by mechanical methods. Diseases and pests were controlled by means of the following combinations of chemical protection:

K1 - control (without protection)
K2 - seed dressing against diseases with Vitavax 200FS preparation,
K3 - seed dressing against diseases with Vitavax 200FS preparation + Decis 2.5 (insecticide) EC + Fastac 100EC (insecticide) + Penncozeb 80W (fungicide),
K4 - seed dressing against diseases with Vitavax 200FS + 2 x Decis 2.5 EC (insecticide) + Fastac 100EC (insecticide) + Penncozeb 80 WP (fungicide).

Decis 2.5EC preparation dosed 0.25 dm^3/ha was applied foliarly to control aphids. The first plant protection measure with this chemical means was conducted at the moment of aphid appearance. In the fourth combination this preparation was applied repeatedly after 7 days. On the other hand, Fastac 100EC dosed 0.09 dm^3/ha was used against *Bruchus rufimanus* during the flowering cessation of the first level of broad bean inflorescence. On the other hand, Penncozeb 80WP preparation dosed 2 kg/ha against fungal diseases was applied before plant flowering.

At the development stage of broad bean BBCH (70-79) leaf health state was evaluated on 25 leaves randomly selected from a plot. Occurrence of individual fungal diseases on leaves was assessed on a 5-degree scale (1-5) showing increasing plant infection. The broad bean yielding components were also assessed: 1000 grain weight, number of pods per plant and number of seeds per pod. Results referring to the intensity of fungal diseases on plant leaves were presented as infection index. Subsequently, all results were subjected to the analysis of variance and the significance of mean differences was verified by means of Tukey's test $\alpha = 0.05$.

Results and discussion

During vegetation period broad bean leaves were attacked mainly by brown spot disease (*B. fabae*) and ascochytosis (*A. fabae*). Occurrence of these fungal diseases on the same plant species, *ie* field bean was confirmed also by other authors [4, 7, 8].

A considerable diversification of the weather conditions was observed from April to July in the investigated years 2010-2011, which influenced the state of plant health. An excess of rainfall was registered in May (294.60 mm) and June (155.50 mm) 2010, both in comparison with multiannual period (respectively for these months 65.26-80.04 mm) and the year 2011 (60.70-44.40 mm). Also, the beginning and end of broad bean vegetation in 2011 were characterized by the excess of moisture (April - 77.90 mm, July - 194.40 mm). Considering the period of observations, July 2010 may be regarded as warmer (air temperature 20.50ºC) and drier (rainfall 92.70 mm), whereas in 2011 July was a wet month (rainfall 194.40 mm) and cooler (air temperature 17.57ºC). Generally the year 2010 featured heavy rainfalls (rainfall total from April to July reaching 582.30 mm) in comparison with 2011 (rainfall total for the same period was 377.40 mm). Mean air temperature from April to July was on a similar level in both years. In the opinion of Podlesny [5, 6] and Majchrzak and Kurowski [4] field bean and other legumes are greatly sensitive both to the excess and deficit of moisture during vegetation period. Such conditions favour increased intensity of fungal diseases and contribute to losses in seed yield. In the Authors' own investigations, irrespective of applied plant protection, years had a significant influence on the index of leaf infection by *B. fabae* (brown spot) and *A. fabae* (ascochytosis), and on elements of yield structure. An assessment of broad bean healthiness conducted in 2011 at the beginning of the second decade of July (which was a very wet month) revealed a notable increase in ascochytosis (*A. fabae*) on leaves (Table 1). Also a significant increase in 1000 grain weight and the number of seeds formed per pod were registered in the analysed year. On the other hand, the weather conditions in 2010 favoured a marked increase in brown spot disease on leaves (*B. fabae*) and contributed to a decrease in the number of seeds per pod and 1000 grain weight. However, irrespectively of the years, mean leaf infection index by *B. fabae* and *A. fabae* was high.

Table 1

Mean infection index of broad bean leaves by fungal pathogens and elements of yielding in 2010-1011

Specification	Years		$LSD_{0.05}$
	2010	2011	
Leaf fungal diseases:			
brown spot (*B. fabae*)	45.78	34.25	4.31
ascochytosis (*A. fabae*)	35.39	47.00	6.26
Elements of yielding:			
1000 grain weight [g]	1058.99	3311.25	297.35
number of pods per plant [pcs.]	8.48	9.69	n.s.
number of seeds per pod [pcs.]	2.53	3.39	0.743

n.s. - non-significant difference

In Authors' own research its was found that intensification of fungal diseases on broad bean leaves and seed yield structure depended also on the cultivar (Table 2). In comparison with White Hangdown (industrial variety), White Windsor variety intended for direct consumption revealed a greater sensitivity to fungal infections. Leaves of this variety revealed a significantly higher mean infection index by the above-mentioned pathogenic fungi. Seeds of White Windsor cultivar were characterized by a higher 1000 grain weight

and pods produced more seeds. On the other hand, White Hangdown variety set more pods but with a lesser number of seeds and lower 1000 grain weight.

Table 2

Mean infection index of broad bean cultivars leaves by fungal pathogens and elements of yielding (irrespective of years)

Specification	Cultivars		$LSD_{0.05}$
	White Windsor	White Hangdown	
Leaf fungal diseases			
brown spot (*B. fabae*)	42.53	37.50	4.32
ascochytosis (*A. fabae*)	42.81	39.58	2.36
Yielding elements			
1000 grain weight [g]	2352.88	2017.36	296.52
number of pods per plant [pcs.]	8.77	10.40	1.51
number of seeds per pod [pcs.]	3.24	2.69	0.16

The programme of chemical protection applied in the Authors' own investigations significantly diversified intensification of brown spot disease (*B. fabae*) and ascochytosis (*A. fabae*) on broad bean leaves (Table 3). Irrespective of the cultivar, full chemical plant protection (K4) composed of 4 measures, *ie* seed dressing with Vitavax 200 FS preparation and two times foliar application of Decis 2.5 EC + single application of Fastac 100 EC and Penncozeb 80 WP preparations prior to seed sowing, produced the best results of leaves protection against these diseases. Similarly, Dluzniewska et al [4] and Podlesny [5] point out that full chemical protection best guards plants against fungal diseases. Obtained results of the Authors' own investigations reveal also that limiting the activities to only one measure, *ie* seed dressing with Vitavax 200 FS (K2) preparation before sowing, does not guard the plant against infection by *B. fabae* and *A. fabae* fungi. Seed dressing limits disease development in the initial period of plant vegetation. Also Lenartowicz [9], Martyniuk [10] and Glen et al [11] addressed this issue.

Table 3

Effect of chemical protection on mean infection index of broad bean leaves by *B. fabae* (brown spot) and *A. fabae* (ascochytosis) and elements of yieldings

Chemical plant protection - combination	Leaf infection index by		Elements of yielding		
	B. fabae **(brown spot)**	***A. fabae*** **(ascochytosis)**	**1000 grain weight [g]**	**number of pods [pcs./plant]**	**number of seeds per pod [pcs.]**
K1	38.61	43.17	2007.37	9.33	2.76
K2	45.56	46.83	2055.55	9.70	3.14
K3	40.22	37.00	2366.11	9.89	2.95
K4	35.67	37.78	2311.46	9.43	2.99
$LSD_{0,05}$	8.13	4.51	343,96	n. s.	n. s.

K1-K4 as in methodology; n.s.- not significant difference

Considering yield structure elements, the yielding is determined by 1000 grain weight. Applied K3 and K4 combinations of chemical protection, *ie* foliar application of chemicals (K3 - 2 x insecticide + 1 x fungicide or K4 - 3 x insecticide + 1 x fungicide) carried out three or four times contributed to a significant increase in this feature by respectively 17.87 and 15.15% in comparison with the control. Results of Authors' own investigations

are approximate to reports of Kulig et al [8]. On the other hand, applied chemical protection did not diversify the other elements of yield structure. The results were not confirmed by research conducted by Kulig et al [8], who demonstrated that intensive chemical protection of field bean contributes to increase in the number of seeds per pod and the number of pods.

Conclusions

1. Years significantly diversify intensity of fungal diseases on broad bean leaves and elements of seed yield structure.
2. Excess of moisture during vegetation period favours increased leaf infection by brown spot (*B. fabae*) and worsens elements of seed yield structure.
3. Broad bean leaves susceptibility to fungal diseases and seed yield structure elements depend on the cultivar. White Windsor broad bean cultivar intended for early harvest is characterized by a significantly higher susceptibility to fungal diseases and produces more seeds per pod with a higher 1000 grain weight.
4. Foliar application of chemical means of plant protection (2 x insecticide + 1 x fungicide or 3 x insecticide+ 1 x fungicide) carried out three or four times ensures a better health state of plants and favours increase in 1000 broad bean grain weight.

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OCENA ODDZIAŁYWANIA CHEMICZNEJ OCHRONY NA ZDROWOTNOŚĆ LIŚCI I ELEMENTY PLONOWANIA BOBU

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Abstrakt: Celem pracy była ocena wpływu środków chemicznej ochrony (Vitavax 200 FS, Decis 2,5 EC, Fstac 100 EC, Penncozeb 80 WP) na zdrowotność liści dwóch odmian bobu (Windsor Biały i Hangdown Biały) oraz elementy struktury plonu nasion. Uzyskane wyniki wykazały, że lata istotnie różnicują nasilenie chorób grzybowych na liściach bobu oraz elementy struktury plonu nasion. Nadmiar wilgoci w okresie wegetacji sprzyja wzrostowi porażenia liści przez czekoladową plamistość (*B. fabae*) i pogarsza elementy struktury plonu nasion. Podatność liści bobu na choroby grzybowe oraz elementy struktury plonu nasion zależą od odmiany. Odmiana bobu Windsor Biały przeznaczona na wczesny zbiór cechuje się istotnie większą wrażliwością na choroby grzybowe i wytwarza więcej nasion w strąku o większej masie 1000 nasion. Trzykrotna lub czterokrotna aplikacja nalistna środków chemicznej ochrony (2x insektycyd + 1x fungicyd lub 3 x insektycyd + 1x fungicyd) zapewnia lepszy stan zdrowotny roślin i sprzyja wzrostowi masy 1000 nasion bobu.

Słowa kluczowe: bób, pestycydy, choroby liści, elementy plonowania nasion