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Effect of Asahi SL application on common bean yield

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Abstract

The experiment was carried out in 2010 and 2011 on experimental fields of the Institute of Agricultural Sciences of the State School of Higher Education in Chełm, Poland to study the effect of Asahi SL on bean (*Phaseolus vulgaris* L.) of Aura cultivar yielding. Bean seeds were sown at the depth of 3 - 4 cm, spacing of drills 45 cm, to achieve the density of 30 plants per 1 m². During the vegetation period 0.1% and 0.3% concentration of Asahi SL was applied in two application frequencies: single spraying of plants (in the 2 – 3 leaves stage) or double spraying of plants (first in the 2 – 3 leaves stage and second at the beginning of the bean's blooming). Four different variants of spraying with Asahi SL were compared with the control, where biostimulator was not applied. The number and weight of seeds, the number of pods and the weight of thousand seeds according to International Seed Testing Association (ISTA, 2010) method were recorded. It was found that single spraying of plants with Asahi SL advantageously influenced on bean yield increasing the number and the weight of seeds and the number of pods. Control, where biostimulator was not applied was characterized with the lowest yield factor parameters. The highest thousand seeds weight was found for the application of 0.1% Asahi SL solution and in the control.

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1. Introduction

Sustainable agriculture is the management of conditions and means of agricultural production, which takes into account the needs of present and future generations, both in terms of production efficiency and sustainability of ecosystems with the involvement of scientific, technological and institutional progress (Neher 1992). Production of safe, high quality food in a way that protects the environment supports the use of bio-stimulators especially in condition of stress factors which negatively affects a crop yield. Biostimulators are preparations containing biologically active substances, which modifying metabolism allows obtaining a higher yield of plants. Asahi SL, occurring also under the name of Atonik belongs to the group of such preparations. It includes simple phenolic compounds, which occur naturally in a plant in low amounts (Przybysz et al., 2010). Spraying plants with this preparation is beneficial for their vegetative and generative growth and biomass production. After the application of Asahi SL the increase of the amount and quality of yield in many plants was reported, in particular when during the cultivation, disadvantageous environmental conditions occurred (Basak and Mikos-Bielak, 2008; Kozak et al., 2008a; 2008b; Przybysz et al., 2010; 2014). The use of this biostimulator advantageously influences the effectiveness of photosynthesis and the increase of the organic and mineral compounds content influencing the improvement of yield factor parameters (Przybysz et al., 2010; 2014; Majkowska-Gadomska and Wierzbicka, 2013; Tomczyk and Elkner, 2015).

The aim of the study is to investigate the effect of Asahi SL bio-stimulator on common bean (*Phaseolus vulgaris* L.) of Aura cultivar yielding.

2. Materials and Methods

2.1. Plant materials and growth conditions

The study was carried out in 2010 and 2011 on experimental fields of the Institute of Agricultural Sciences of the State School of Higher Education in Chełm located in Deputycze Królewskie, Poland (51°07'N; 23°43'E). Soil type was characterized as Brown Rendzina belonging to Rendzinas soil group. It is alkaline (pH in 1M KCl – 7.4-7.5) and rich in phosphorus, potassium, and magnesium. The experiment was established in a randomized block design in four replications with an elementary experimental plot area of 4.5 m² (1,35 x 3,33 m). Bean seeds of cultivar Aura were sown on the 8th of May 2010 and on the 11th of May 2011 at the depth of 3 - 4 cm, spacing of drills 45 cm, to achieve the density of 30 plants per 1 m². During the growing season plants treated with Asahi SL which contains: sodium ortho-nitrophenolate ONP (0.2%), sodium para-nitrophenolate PNP (0.3%) and sodium 5-nitroguaiacolate 5NG (0.1%). 0.1% and 0.3% solution of Asahi SL was applied in two application frequencies: single spraying of plants (in the 2 – 3 leaves stage) or double spraying of plants (first in the 2 – 3 leaves stage and second at the beginning of the bean's blooming). It was applied with a battery sprayer GARLAND FUM 12B field sprayer (Lecher LU 120-03) at a pressure of 0.30 MPa, using 300 l of liquid per hectare. The four different variants of spraying with Asahi SL were compared with the control, where bio-stimulator was not applied. Tillage for bean was done using good agricultural practices. Mineral fertilization in kg of nutrient per hectare was as follows: 30 kg N·ha⁻¹, 60 kg P·ha⁻¹, 120 kg K·ha⁻¹. It was not used pesticides (pests do not exceed the thresholds of harmfulness).

2.2. Plant yield determination

Upon harvesting, the number and weight of seeds, the number of pods and the weight of a thousand seeds for each plot (four replications of each combination) according to International Seed Testing Association (ISTA, 2010) method were recorded.

2.3. Statistical analysis

The results were statistically analysed by analysis of variance ANOVA by Statistica. To verify the significance of differences between the treatments means the confidence interval of Tukey's test were used at significance level $P \leq 0.05$. Results marked with the same letter do not differ significantly from each other.

3. Results and Discussions

The study analysed the influence of Asahi SL bio-stimulator on bean yielding. Single plant spraying with 0.3% Asahi SL solution in 2010 significantly increased the number and the weight of bean seeds (enhanced by 53% and 47%, respectively, in comparison with control) (table 1 and 2). In the subsequent year of study the highest yield of seeds was reported in the combination, where single spraying of plants with 0.1% solution was applied (increase the number of seeds by 45% and the weight of seeds by 38% in comparison with control). In 2011 single foliar applications on plants with a higher concentration of Asahi SL (0.3%) resulted in a 27% and 25% increase in the average number and weight of seeds, in comparison with control. Double application of Asahi SL caused decrease in the number and the weight of seeds in comparison to single application of this preparation, except for combination, where 0.1% of bio-stimulator solution in the first year of research was applied.

Table 1. Number of bean seeds depending on concentration and application number of Asahi SL (No*m⁻²).

Concentration of Asahi SL	0.1%		0.3%		Control	
Year	2010	2011	2010	2011	2010	2011
Application method						
Single spraying	610.3 bc	673.5 a	869.3 a	590.0 ab	568.0 c	465.8 b
Double spraying	729.3 ab	498.5 b	692.8 bc	561.0 ab		

Means in the same column with different letters are significantly different ($\alpha=0.05$) (relates to the same year).

Table 2. Weight of bean seeds depending on concentration and application number of Asahi SL (g*m⁻²).

Concentration of Asahi SL	0.1%		0.3%		Control	
Year	2010	2011	2010	2011	2010	2011
Application method						
Single spraying	278.0 bc	297.9 a	382.3 a	269.0 ab	260.9 c	215.2 b
Double spraying	341.8 ab	219.7 b	284.2 bc	253.1 ab		

Means in the same column with different letters are significantly different ($\alpha=0.05$) (relates to the same year).

So far, no results concerning the impact of application of Asahi SL on been yield. Kocira et al. (2013) found, that Kelpak is one of bio-stimulators positively influencing the yield of beans. Also application of amino acids bio-stimulator (Terra Sorb Complex) increased the yield of bean (Kocira et al., 2015). Numerous authors proved that Asahi SL (Atonik) positively influences yielding of different plants (Harasimowicz-Hermann and Borowska, 2006; Marjańska-Cichoń and Sapięha-Waszkiewicz, 2010; Matysiak et al., 2011). Kozak et al's research (2008a) prove that Asahi SL used in the button phase increased the seeds and soya straw yield. The application of Asahi SL increased the yield of rapeseeds (Malarz et al., 2008; Matysiak et al., 2011), particularly in case of stress conditions (Harasimowicz-Hermann and Borowska, 2006). Michalski et al. (2008a) and Matysiak et al. (2011) proved that the application of this preparation positively influenced grains yielding, increasing seeds of barley, barley mixture with wheat and wheat. Double application of this preparation in maize cultivation seems to be justified, which is confirmed by the results obtained by Michalski et al. (2008b). Moreover, Asahi SL (Atonik) positively influenced on vegetable plants, orchard and agricultural plants yielding increasing the yield of roots in case of chicory and sugar beet, celery, leek and onion bulbs, potato tubers, strawberry fruit, tomato and pepper fruit (Cerny et al., 2008; Cwalina-Ambroziak and Amarowicz, 2012; Djanaguiraman et al., 2005; Dobrzański et al., 2008; Marjańska-Cichoń and Sapięha-Waszkiewicz, 2010; Matysiak et al., 2011).

In study single spraying of plants with 0.3% Asahi SL solution in 2010 and 0.1% solution in 2011 increased the number of pods developed on a plant (enhanced by 41% and 46%, respectively, in comparison with control) (table 3). The increase of the frequency of preparation application to double resulted in the decrease of pods number in the combination with 0.1% of Asahi SL solution in 2011 and in the combination with 0.3% with bio-stimulator solution in both years of study. In the first year, higher number of pods at the double application of lower concentration of bio-stimulator in comparison to its single application was reported.

Table 3. Number of pods depending on concentration and application number of Asahi SL (No*m⁻²).

Concentration of Asahi SL	0.1%		0.3%		Control	
Year	2010	2011	2010	2011	2010	2011
Application method						
Single spraying	195.5 b	219.0 a	264.0 a	189.3 ab	187.8 b	150.0 b
Double spraying	221.5 ab	169.3 b	225.8 ab	180.8 ab		

Means in the same column with different letters are significantly different ($\alpha=0.05$) (relates to the same year).

Kozak et al. (2008a) proved that application of Asahi SL in soya cultivation increased the number of pods developed on a plant. Furthermore, plants *Arabidopsis thaliana* L., winter rapeseed and spring rapeseed treated with this bio-stimulator were characterised with a higher number of siliques (Harasimowicz-Hermann and Borowska, 2006; Malarz et al., 2008; Przybysz et al., 2010).

Plants, which in 2010 were sprayed with 0.1% Asahi SL solution, independently from the frequency of applying preparation as well as plants from the control obtained the highest weight of thousand seeds (increase by 14% and 11%, respectively) (table 4). The lowest weight of thousand seeds was reported in the combination with double spraying of plants 0.3% with bio-stimulator solution. In 2011, a tendency to increase the weight of thousand seeds in control, where the preparation was not used, was reported.

Table 4. Weight of thousand seeds of bean seeds depending on concentration and application number of Asahi SL (g).

Concentration of Asahi SL	0.1%		0.3%		Control	
Year	2010	2011	2010	2011	2010	2011
Application method						
Single spraying	457.2 a	442.4 a	440.4 ab	445.6 a	459.2 a	461.9 a
Double spraying	469.4 a	443.2 a	410.1 b	450.8 a		

Means in the same column with different letters are significantly different ($\alpha=0.05$) (relates to the same year).

The application of Asahi SL in soya cultivation positively influenced the weight of thousand seeds (Kozak et al., 2008b). The study carried out by Malarz et al. (2008) and Matysiak et al. (2011) confirmed that application of this bio-stimulator in rapeseed cultivation, it concerns both the winter form as well as the spring form, slightly increased the weight of thousand seeds. Michalski et al. (2008b) found a positive effect of Asahi SL on the increase of the weight of thousand seeds of maize.

4. Conclusions

Asahi SL bio-stimulator, which is one of the elements of sustainable agriculture, has a positive effect on common bean yield. Single spraying of plants with Asahi SL is increasing the number and the weight of seeds and the number of pods. Control, where bio-stimulator was not applied is characterized with the lowest yield factor parameters. The highest thousand seeds weight is found for the application of 0.1% Asahi SL solution and in the control combination.

References

- Basak, A., Mikos-Bielak, M., 2008. The use of some biostimulators on apple and pear trees, in "Biostimulators in Modern Agriculture. Fruit Crops". In: Sadowski, A. (Ed.), Editorial House Wieś Jutra, Warsaw, pp. 7-17.
- Cerny, I., Pacuta, V., Kovar, M., 2008. Yield and quality of cichory (*Cichorium intybus* L.) in dependence on variety and foliar application of Atonik and Polybor 150. Journal of Central European Agriculture 9, 3, 425–430.
- Cwalina-Ambroziak, B., Amarowicz, R., 2012. Effects of biological and fungicidal environmental protection. Effects of chemical composition of tomato and red pepper fruits. Polish Journal of Environmental Studies 21, 4, 831–836.

- Djanaguiraman, M., Pandiyan, M., Durga Devi, D., 2005. Abscission of tomato fruit follows oxidative damage and its manipulation by Atonik spray. *International Journal of Agriculture and Biology* 7, 1, 39–44.
- Dobrzański, A., Anyszka, Z., Palczyński, J., 2008. Response of onion and carrot to Asahi SL biostimulator used with herbicides in “*Biostimulators in Modern Agriculture. Field Crops*”. In: Dąbrowski, Z.T. (Ed.). Editorial House Wieś Jutra, Warsaw pp. 7–20.
- Harasimowicz-Hermann, G., Borowska, M., 2006. Effect of bio-stimulant Asahi SL in winter rapessed depending on pluviothermic conditions. *Oilseed Crops* 27, 95–106.
- ISTA, International Seed Testing Association 2010. International Rules for Seed Testing. ISTA, Switzerland.
- Kocira, A., Kornas, R., Kocira, S., 2013. Effect assessment of Kelpak SL on the bean yield (*Phaseolus vulgaris* L.). *Journal of Central European Agriculture* 14, 2, 545-554. DOI: <http://dx.doi.org/10.5513/JCEA01/14.2.1234>.
- Kocira S, Kocira A, Szmigielski M, Piecak A, Sagan A, Malaga-Toboła U. 2015. Effect of an amino acids – containing biostimulator on common bean crop. *Przemysł Chemiczny* 94, 10, 1732-1736. DOI:10.15199/62.2015.10.16.
- Kozak, M., Malarz, W., Serafin-Andrzejewska, M., Kotecki, A., 2008a. The effects of sowing rate and Asahi SL biostimulator on soybean growth and yield in “*Biostimulators in Modern Agriculture. Field Crops*”. In: Dąbrowski, Z.T. (Ed.). Editorial House Wieś Jutra, Warsaw, pp. 77-84.
- Kozak, M., Malarz, W., Serafin-Andrzejewska, M., Kotecki, A., 2008b. The effects of different sowing rate and Asahi SL treatments on soybean seed sowing value in “*Biostimulators in Modern Agriculture. Field Crops*”. In: Dąbrowski, Z.T. (Ed.). Editorial House Wieś Jutra, Warsaw, pp. 85-91.
- Majkowska-Gadomska, J., Wierzbicka, B., 2013. Effect of the biostimulator Asahi SL on the mineral content of eggplants (*Solanum melongenum* L.) grown in an unheated plastic tunnel. *Journal of Elementology* 18, 2, 269–276. DOI: 10.5601/jelem.2013.18.2.06.
- Malarz, W., Kozak, M., Kotecki, A., 2008. The use of Asahi SL biostimulator in spring rape growing in “*Biostimulators in Modern Agriculture. Field Crops*”. In: Dąbrowski, Z.T. (Ed.). Editorial House Wieś Jutra, Warsaw, pp. 25–32.
- Marjańska-Cichoń, B., Sapięha-Waszkiewicz, A., 2010. The influence of preparations Asahi SL and Tytanit on the Salut strawberry growth and crop. *Progress in Plant Protection* 50, 1, 383–388.
- Matysiak, K., Adamczewski, K., Kaczmarek, S., 2011. Response of some crops cultivated in Great Poland to application of Asahi SL. *Progress in Plant Protection* 51, 4, 1849–1856.
- Michalski, T., Horoszkiewicz-Janka, J., Bartos-Spychała, M., 2008a. Efficiency of Asahi SL in protection of barley and wheat mixture in comparison with pure sowing, in “*Biostimulators in Modern Agriculture. Field Crops*”. In: Dąbrowski, Z.T. (Ed.). Editorial House Wieś Jutra, Warsaw, pp. 50–59.
- Michalski, T., Bartos-Spychała, M., Maciejewski, T., Jarosz, A., 2008b. Effect of biostimulator Asahi SL on cropping of maize grown for grain, in “*Biostimulators in Modern Agriculture. Field Crops*”. In: Dąbrowski, Z.T. (Ed.). Editorial House Wieś Jutra, Warsaw, pp. 66–76.
- Neher D. 1992. Ecological sustainability in agricultural systems. *Journal of Sustainable Agriculture* 2, 3, 51–61.
- Przybysz, A., Wrochna, M., Słowiński, A., Gawrońska, H., 2010. Stymulatory effect of Asahi SL on selected plant species. *Acta Scientiarum Polonorum, Hortorum Cultus* 9, 2, 53-64.
- Przybysz, A., Gawrońska, H., Gajc-Wolska, J., 2014. Biological mode of action of a nitrophenolates-based biostimulant: case study. *Frontiers in Plant Science* 5, article 713: 1-15. DOI: 10.3389/fpls.2014.00713.
- Tomczyk, A., Elkner, J., 2015. Effect of biostimulants Asahi SL and Siapton 10 L on tolerance of cucumber plants to injury caused by western flower thrips (*Frankliniella occidentalis* Pergande). *Progress in Plant Protection* 55, 2. DOI: 10.14199/ppp-2015-037.