The effect of foliar application of boron on alfalfa seed yield

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Abstract

The effect of foliar application of boron on yield of alfalfa seed was investigated in the present study. Objective of the study was to investigate the influence of fertilization with boron on yield of alfalfa seed in agro-ecological conditions of Kruševac in the model of seed production of dual utilization (production of forage and production of seed). In foliar boron fertilization 0,5% boric acid was used. Fertilization was with divided application. First application was carried out in the stage of intensive seed growth, and the second application at the beginning of blossoming of crops. The most pronounced effect on yield and yield components was recorded for meteorological factors during the year. Foliar fertilization with boron influenced forming of slightly higher number of pods per plant and more seeds in the pod. Boron influenced average increase of yield, with slightly greater difference compared to control in dry years.

Key words: alfalfa, boron, foliar application, seed, yield

Introduction

Alfalfa is well adapted to a wide range of growing conditions and soils, nutritional disorders caused by boron (B) deficiency are quite common. Symptoms of nutrient deficiency, however, often become cleary visible only after a deficiency is acute and growth and yield are already severally depresed (Bell, 1997; Dordas, 2006). Alfalfa is B sufficient when B concetration is between 30 and 80 mg kg^{-1}. These critical values were determined on visual symptoms and not on yield response especially in crops grown for seed production (Bergmann, 1992). There are several reports in number of crops which demonstrate that B can be deficient and has a significant effect on yield even when there are no vegetative signs of deficiency and even when B concentration is at adequate range (Nyomora et al., 1999; Dordas 2006). It was reported that there was an increase in alfalfa seed yield with B foliar applications (Vučković, 1994; Dordas, 2006). Some authors (Rincker et al., 1988) reported that application of microelements did not contribute to significant increase in alfalfa seed yield. The effect of foliar application of boron on yield of alfalfa seed was investigated in the present study. Objective of the study was to investigate the influence of fertilization with boron on yield of alfalfa seed in agro-ecological conditions of Kruševac.

Materials and Methods

The experiments were performed at the experimental field of the Institute for Forage Crops in Kruševac. This study present results for 2005, 2006 and 2007. The experimental plot was 10.5 m^2. Pre-forage harvest was done in different phases. In foliar boron fertilization 0,5% boric acid was used. Fertilization was foliar with divided application with 1000 literes per ha of water/application. First application was carried out in the stage of intensive plant growth, and the second application at the beginning of blossoming of crops. The land on which the research was conducted was low acidity soils and B content in the soil was 0.56 ppm.

Results and Discussion

Looking at average seed yield per year, large differences in yield depending on the year can be observed. The lowest average yield was achieved in 2005 (70.2 and 77.6 kg^{-1}) while in 2006 (433.3 and 481.3$kgha^{-1}$) and especially in the dry year of 2007 when much higher yield was realized (579.3 and 657.8 kg ha^{-1}). Climatic conditions have had a major impact on seed yield. In 2005 during June, July and August precipitation dropped to 274mm. In year 2006, in June, July and August it was 167 mm, while the driest period occurred in the year 2007, when for the same period precipitation was only 136 mm. Žarinov and Kljuj (1983) citation Erić (1995) as one of the optimal parameters for the pollination of flowers state that the precipitation in June, July and August should be maximum of 180 mm. Large variations in the climatic factors in investigation years has contributed to large differences in yield.

Table 1. Yield components and seed yield of alfalfa

Yield components	2005		2006		2007		Average	
	Ø	B	Ø	B	Ø	B	Ø	B
Number plant per m^{-2}	92.4	93.7	77.9	79.6	48	49.7	72.8	74.3
Plant height	92.5	91.8	69.6	70.1	78.3	79.7	80.1	80.5
Number stems per plant	2.96	2.99	4.93	5.08	5.57	5.67	4.5	4.6
Number stems per m^{-2}	265	268	372	390	246	263	294.3	307
Number branches per plant	20.7	21	41.1	42.6	35.7	36.7	32.5	33.4
Number branches per m^{-2}	1860	1891	3194	3188	1565	1732	2206	2270
Number pods per plant	13.19	14.06	67.2	71.9	157.5	169.2	79.3	85.1
Number pods per m^{-2}	1192	1263	4994	5460	679	767	2288	2497
Number seeds per pods	3.58	3.72	4.71	4.94	4.43	4.62	4.24	4.43
Seed yield per plant (g)	0.086	0.095	0.61	0.68	1.41	1.58 *	0.70	0.79
Seed yield per ha (kg)	70.2	77.6	433.3	481.3*	579.3	657.8**	361	406

*denote significantly different P<0.05; ** denote significantly different P<0.01

Many authors (Erić, 1995, Vučković, 1994; Karagić, 2004; Stanisavljević, 2006) agree in their assessment that the variation in the yield of alfalfa was mostly influenced by environmental conditions during the year.

In addition to climatic conditions during the year, the application of boron has also affected some yield components and seed yield. Foliar boron fertilization affected that in all the years a slightly higher number of seeds per pod (4.4) was formed compared to controls, although the differences were not statistically significant in any year. Similar results about the effects of boron fertilization on the number of seeds per pod are reported by Vučković (1994), Du et al**.** (2009). Looking at the number of pods per m^{-2} depending on foliar boron, boron foliar fertilization increased the number of pods in each year and an average increase of pods by approx. 11% of per unit area observed.

Analyzing the increase per years it can be seen that the average increase in the number of pods per unit area compared to untreated variant was about 6% in year 2005, 9% in 2006 and 13% in 2007. One of the main problems in the production of alfalfa seed pods is pod abortion. This is caused by the distribution of assimilative, but the real cause is not known (Gender et al., 1997). Dordas (2006) stated that B applied foliar may affect fertilization, development of seeds and pods and increase the seed yield. The author suggests that B may play a significant role in abortion of pods.

In all three years, the variant with boron achieved a higher seed yield per plant, while in year 2007 the difference was statistically significant. In regard to seed yield it can be observed that the seed yield in the variant where the B was applied is higher in all years. Boron content in the soil in our studies

(0.56 ppm) is within the limits (B> 0.5 ppm), which are considered adequate (Koening et al., 1999, Brown and Barbour, 2004). Analysis of plant material was established 61 ppm, which according to Undersander et al. (2004) represents a high level (B> 60 ppm). According to Bergmann (1992) concentrations between 30 and 80 ppm are considered to be satisfactory, but the authors noted that the given values are for the forage and there should be cautious in the use in the production of seed. Despite the fact that the boron content in soil and plant material was satisfactory, boron fertilization resulted in higher yield, with the greater difference to the control in the dry year 2007 (13.5%) compared to 2006 (11.1%) and 2005 (10.5%). Higher seed yield in treatments with boron is in agreement with the results obtained by Vučković (1994), Dordas (2006), Du et al. (2009), Terzić (2010).

Higher seed yield (77.6, 481.3, 657.8 kg ha^{-1}) in the variant treated with boron is due to the number of pods and more seeds per pod, which is consistent with the view that boron has a special significance in flowering and pollination. Boron has a direct role in flowering, pollen germination, seed and fruit formation. There are many issues on which there is no answer to how B affects the yield and how it moves in the process of development of flowers and seeds and fruits. The main limitation of movement of B taken from the root are under developed xylem connections between seed and maternal tissues. Since flowers and seeds do not transpire as leaves, they are not able to adopt B directly from the soil. This is one of the reasons why many studies show a significant effect of foliar B application on seed yield and fruit (Dell et al. 2002).

On the other hand, the relative increase in yield in our studies (10.5%, 11,1% and 13,5%) is less than the yield (37%) in the study conducted by Dordas (2006) and yield (22-53%) in study Du et al. (2009). Different conditions in which our research was conducted (pH and precipitation) are likely to cause different results. Roy et al. (2006) suggest that the increase in pH reduces the availability of boron and the depressing effect is more noticeable in soils with a pH greater than 6. The impact of drought on boron deficit is particularly stated by Lanyon and Griffith (1988), Vučković (1994) and others.

The results of our research are consistent with the opinion of many authors (Lanyon and Griffith, 1988, Dordas, 2006 etc..) who point out that B may be in deficit and have a significant impact on the yield, even when there are no symptoms in the vegetative parts of the plant and when the concentration is in the appropriate range.

Yield components such as number of plants m^{-2}, plant height, number stems per m^{-2}, number stems per plant, branches per plant, number branches per m^{-2} had consistent values with no major deviations and statistically significant differences.

Conclusions

Ecological conditions, among which the most important were the amount and distribution position of precipitation, had the most prominent influence on the yield and the components of alfalfa seed yield.

Foliar B application had no influence on the number of plants, height of plants, number of stems per plant, number of stems per m^2, as well as the number of branches per plant.

Foliar B application influenced the increase of the number of pods in all the years. The average increase in the number of pods per plant is around 7% when compared to control version, that is, 11% when we take the unit of surface into consideration.

Foliar B application influenced the formation of somewhat higher number of seeds in a pod in all the years, but the differences were not statistically justified in any of the given years. Application B showed higher yield of seeds per plant (0.79 g) when compared to control version (0.70g). In all the given years B version showed somewhat higher seed yield per plant, whereas in 2007 the difference was of statistical importance.

Foliar B application showed higher yield in all the given years, where the difference in relation to control was higher in arid 2007 (13.5%) than in 2006 (11.1%) and 2005 (10.5%).

Acknowledgements

Research was financed by the Ministry of Science and Technological Development, Republic of Serbia, project TR 31057 (2011-2014)

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