ISSN (Online) = 2522-6754 ISSN (Print) = 2522-6746
WORLD JOURNAL OF BIOLOGY AND BIOTECHNOLOGY
Research Manuscript www.sciplatform.com

Role of boric acid on economic seed production of alfalfa under climatic conditions of Sargodha

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Authors' Contribution	"**A. Pervez**, **A. Razzaq** & **M. S. Akhtar** developed the concepts and executed the experiments. **M. S. Farooq** & **S. Hayat** performed soil analysis and statistical analysis of recorded data. **A. Basit**, **S. Raza** & **Shoaib Anwar Kohli** compiled results and discussion".
Article History	*Corresponding email address: assipervez@gmail.com **Received: 13 March 2020 Revised: 05 April 2020, Accepted: 09 April 2020 Published Online: 13 April 2020**

ABSTRACT

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Alfalfa is one of the most important forage crops worldwide because of its wide range of adaptability and good forage quality. Seed yield is generally considered to be of secondary importance and is characterized by often poor seed yield and seed quality. A field experiment was conducted to determine the impact of boric acid foliar applications along with a basal dose during anthesis to enhance the alfalfa seed yield in agro-ecological conditions of Sargodha. In foliar boric acid fertilization 0, 2, 4, 6, 8, 10 boric acid along with basal dose 23-80-50 (NPK kg ha^{-1}) was used. Phosphorous and potash were applied at the time of sowing while nitrogen will be applied in two split doses; half at sowing time and half of 1st irrigation. Two foliar applications, 1st at intensive plant growth stage and the 2ndat the beginning of the blossoming of the crop. The concentration of boric acid solutions used were 2 ,4 , 6 ,8 and 10 $glit^{-1}$ which produces a seed yield of 161.7, 167.9,171.3, 175.0,186.7 and 176.1 kg ha^{-1} in year 2015-16 while next year in 2016-17 produces a seed yield of 286.5, 299.2,304.6, 308.3, 312.1 and 310.1kg ha^{-1} respectively which is higher than year 2015-16. Foliar fertilization with boron influenced forming of slightly higher number of seeds in the pod. Boron influenced the average increase of yield, with a slightly greater difference compared to control. Number of seeds per pod in boric acid dose of 0, 2, 4, 6, 8 and 10 remained 6.1, 6.3, 6.4, 6.6, 6.8 and 6.7respectively in year 2016-17 which were higher than 4.3,4.4,4.5, 4.5,4.9 and 4.7 in year 2015-16. Overall 8 g $liter^{-1}$ boric acid foliar fertilization produces 8.9 % higher seed yield, 11.4 % higher no of seeds per pod compared to control in the year 2016-17 while produces 15.4% higher seed yield and 13.9 % higher no of seeds per pod as compared to control in the year 2015-16.

Keywords: Alfalfa, boron, foliar application, seed, yield

INTRODUCTION: Alfalfa seed produced throughout the world is primarily used for forage production. Alfalfa is used for grazing, green chop, silage and hay to support the livestock industry, including dairy, beef, horses, and sheep. Most researchers have been unable to detect increases in seed yield as a result of soil or foliar applications of fertilizer containing both major and minor elements. Production practices are tailored to the specific climatic conditions of Sargodha region. Irrigation must be carefully controlled to stress the plants to encourage flowering and seed production. Insect pests, especially lygus bugs, are managed throughout the season, Crops with higher boron requirements such as alfalfa, sunflowers, rapeseed, cauliflower and apples are most likely to respond to boron. It is also needed for the growth of the pollen tube during flower pollination and is therefore important for good seed set and fruit development. Boron is thought to increase nectar production of flowers, and this attracts pollinating insects. There are several reports in a number of crops which demonstrate that boron 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 in adequate range (Nyomora *et al.*, 1999; Dordas, 2006). It was reported that there was an increase in alfalfa seed yield with boron foliar applications (Dordas, 2006).

OBJECTIVES: Objective of the study was to investigate the effect of boric acid foliar fertilization on seed yield of Alfalfa in agro-ecological conditions of Sargodha.

MATERIALS AND METHODS: A field experiment was conducted during 2015-17 at Fodder Research Institute, Sargodha. The trial was laid out in randomized complete block design with three repeats having a plot size of $18m^2$. The soil characteristics were given in the table 1.

Soil characteristics	Year 2015-16	2016-17	Mean
Soil texture	Loam	Loam	Loam
pH	7.9	8.07	7.99
EC($mScm^{-1}$)	0.62	0.64	0.63
O.M. %	0.67	0.69	0.68
Available K mg kg^{-1}	125	129	127
B mg kg^{-1}	0.54	0.55	0.55

Table 1: Pre-sowing physico-chemical analysis of experimental soil.

The basal dose of fertilizer was applied as 23-80-50 (NPK kg ha^{-1}) at the time of sowing to all the treatments later on the foliar treatments were applied as 0,2,4,6,8 and 10 g lit^{-1} boric acid solutions. Alfalfa variety sgd. Lucerne was sown and seed was applied @ 2 kg per acre. Seed was sown by hand drill. After the final cut of alfalfa for green fodder yield the trial was left in the field for seed production. Two foliar applications, 1st at intensive plant growth stage and the2nd application at the beginning of blossoming of crops. Dilute solutions of boric acid as per treatment were applied at 100 litter of water per acre as a foliar spray at each stage. The data were significantly analyzed using analysis of variance at LSD at 5% level of significance was worked out

RESULT AND DISCUSSION: Looking at the average seed yield per year in table 2, large differences in yield depending on

Treatments	Number seeds per pod		No of branches per plant		1000 grain wt (g)		Seed yield (kg ha^{-1})	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1 23-80-50 (NPK kg ha^{-1}basal dose)	4.3 D	6.1 D	21.3 C	22.2 A	0.47 E	0.53 D	161.7 E	286.5 F
T_2 2glit^{-1} boric acid foliar spray + NPK basal dose	4.4 C	6.3 C	21.4 B	22.3 A	0.53 D	0.57 D	167.9 D	299.2 E
$T_3$4 g lit $^{-1}$ boric acid foliar spray+ NPK basal dose	4.5 BC	6.4 C	21.5 ABC	22.3 A	0.57 C	0.67 C	171.3 C	304.6 D
$T_4$6 g lit $^{-1}$ boric acid foliar spray+ NPK basal dose	4.5 BC	6.6 B	21.5 ABC	22.5 A	0.57 BC	0.70 BC	175.0 B	308.3 C
T_5 8g lit $^{-1}$ boric acid foliar spray+ NPK basal dose	4.9 A	6.8 A	21.7 A	22.5 A	0.63 A	0.77 A	186.7 A	312.1 A
T_6 10 g lit $^{-1}$ boric acid foliar spray+ NPK basal dose	4.7 B	6.7 B	21.6 AB	22.4 A	0.60 B	0.73 AB	176.1 B	310.1 B
LSD at 5%	0.23	0.19	0.26	2.47	0.029	0.047	3.10	1.36

Table 2: Yield components and seed yield of alfalfa.

Treatments	Average Seed yield (kg ha^{-1})	Increase yield over control (kg ha^{-1})	Net return of increased yield over control (Rs.)	Additional cost (Rs./ha)	Benefit cost ratio
T_1 23-80-50 (NPK kg ha^{-1}basal dose)	224.1	-		-	-
T_2 2glit^{-1} boric acid foliar spray + NPK basal dose	233.5	9.4	9400	845	11.12
T_3 4 g lit $^{-1}$ boric acid foliar spray + NPK basal dose	237.95	13.85	12465	1004	12.42
T_4 6 g lit $^{-1}$ boric acid foliar spray + NPK basal dose	241.65	17.55	15795	1162	13.59
T_5 8g lit $^{-1}$ boric acid foliar spray + NPK basal dose	249.4	25.3	22770	1321	17.24
T_6 10 g lit $^{-1}$ boric acid foliar spray + NPK basal dose	243.1	19.0	17100	1479	11.56

Table 3: Economic analysis on per hectare basis for each treatment for alfalfa seed yield as affected by boric acid foliar spray.

the year can be observed. The lowest average yield was recorded in 2015-16 (108.9 and 186.7 kg ha^{-1}) while in year 2016-17 (286.5 and 312.1 kg ha^{-1}). Climatic conditions have had a major impact on seed yield. In 2016-17 during February, March, April and May precipitation dropped to 94.49 mm. In year 2015-16, in February, March, April and May it was 160.58mm. Similarly Mueller (2008) also reported that Alfalfa seed production is well adapted to the arid climates of the western United States. A warm, dry production and harvest season is important to maximize seed yield and quality. It suggests that precipitation in March, April and May one of the most important parameters for the pollination of flowers and seed setting. Large variations in the climatic factors in investigation years have contributed to large differences in yield. Bolanos-Aguilar *et al.* (2002) was also agreed in their assessment that the large variation in seed yield among different cultivars of alfalfa in different climatic conditions was mostly influenced by environmental conditions during the year.

Some yield components and seed yield. Foliar boric acid fertilization produces higher number of seeds per pod in T5 which were 6.5 and 7.1 compared to controls 4.0 and 4.9 respectively. Similar results about the effects of boron fertilization on the number of seeds per pod are reported by Du *et al.* (2009). One of the main problems in the production of alfalfa is pod abortion. This is caused by the distribution of the assimilative, but the real cause is not known (Genter *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. Boron content in the soil in our studies 0.54 mg kg^{-1} which are considered adequate (Rashid, 2005). The T5 achieved a higher 1000 grain weight as compared to control in both years, in 2015-16 (34.04%) compared to 2016-17 (45.28%) higher 1000 grain weight in treatments with boron is in agreement with the results obtained by Dordas (2006) and Du *et al.* (2009). Higher seed yield in T5 is due to the number of seeds per pod and higher grain weight, 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, and seed formation. There are many issues on which there is no answer to how boron affects the yield and how it moves in the process of development of flowers and seeds. The main limitation of movement of boron taken from the root is under developed xylem connections between seed and maternal tissues.

Since flowers and seeds do not transpire as leaves, they are not able to adopt boron directly from the soil. This is one of the reasons why many studies show a significant effect of foliar B

application on seed yield (Goldbach *et al.*, 2002). Roy *et al.* (2006) suggested 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 Terzić *et al.* (2012). The results of our research are consistent with the opinion of different authors (Dordas, 2006; Terzić *et al.*, 2012), who point out that boron 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 had consistent values with no major deviations and statistically significant differences between both years. In both years the number of branches per plant had consistent values with no major deviations and statistically significant differences.

Economic analysis: Economic analysis as shown in table 3 was performed for each treatment combination. Treatment T_5 8gLit^{-1} boric acid foliar spray with NPK basal dose exhibited maximum benefit-cost ratio (17.24) with a net benefit of Rs. 22770, followed by treatment T_4 6 g lit^{-1} boric acid foliar spray With NPK basal dose (13.59) with a net benefit of Rs. 15795. While minimum benefit-cost ratio of 11.12 was computed in treatment T_2 2glit^{-1} boric acid foliar spray with NPK basal dose with a net benefit of Rs.9400.

CONCLUSION: Climatic conditions, among which the most important were the amount and distribution of rainfall, had the most prominent influence on the yield and the seed yield components of alfalfa. 8g lit -1 boric acid foliar application influenced the formation of higher number of seeds in a pod that's why also showed a higher seed yield in both years as compared to control.

CONFLICT OF INTEREST: Author has no conflict of interest.

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