Australian Journal of Basic and Applied Sciences
2019 January; 13(1): pages 23-27
DOI: 10.22587/ajbas.2019.13.1.4
Original paper
AENSI Publications
Journal home page: www.ajbasweb.com

Calcium and Boron Apply Via Leaf On Reproductive Stages R1 and R3 in Soybean Culture

[1]Claudia Manteli, [2]Marcos da Rosa, [3]Alberto Ricardo Stefeni, [4] Rayanah Stival Svidzinski, [5] Fernando Luiz Schneider, [6]Claudia Regina Barbieri

[1]Agronomist engineer, Teaching Union of the Southwest of Paraná (Unisep), Dois Vizinhos, PR, 85660-000, Brazil.
[2]Agronomist engineer, Union of the Southwest of Paraná (Unisep), Dois Vizinhos, PR, 85660-000, Brazil.
[3]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.
[4]Department of Agroecosystem, Federal Technological University of Paraná (UTFPR), Dois Vizinhos, PR, 85660-000, Brazil.
[5]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.
[6] Department of Agroecosystem, Federal Technological University of Paraná (UTFPR), Dois Vizinhos, PR, 85660-000, Brazil.

Correspondence Author: Alberto Ricardo Stefeni, *Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.*
E-mail: Albertostefeni@yahoo.com.br

Received date: 11 December 2018, **Accepted date:** 22 Janaury 2018, **Online date:** 29 January 2019

Abstract

Great as a source of income, soybeans are also considered to be an important source of food, so it is necessary for the maximization of productivity. Many factors affect the productivity of this crop, and nutrition is one of the most relevant, so fertilizer application in certain stages of development may be decisive for the good yield of the crop in question. The objective of this work is to evaluate the productivity and development of soybean crop with the application of different concentrations of fertilizers based on Ca and B applied through foliar stages in the reproductive stages R1 and R3. The experiment was carried out in the agricultural year 2015/2016. The experimental design was completely randomized blocks, with five replicates and four treatments, the treatments being divided by the products used: T1; T2; T3; T4. The variables evaluated were mean plant height, productivity, the height of the first pod insertion, abortion of flowers and pods and the variables of income components. Number of pods per plant, number of grains per pod, the total number of grains, total number of pods and weight of one thousand grains. When analyzing the yield components, only the variable number of grains obtained significant results with the application of calcium and boron via leaf. However, we can highlight when analyzed the number of aborted flowers the control had the highest number, thus becoming indispensable to the application of boron via foliar in stage R1, because the abortion of flowers is related to its deficiency. We conclude that the concentrations of foliar fertilizers used in this work based on calcium (Ca) and boron (B) did not influence positively on the variables, average height of the plant, productivity, height of the first pod insertion, abortion of flowers and pods, number of pods per plant, total number of grains, total number of pods and weight of one thousand grains, only the number of grains per pod yielded satisfactory results. The application of calcium and boron in the concentrations 13.4% and 1.34 respectively in the reproductive stage R1 is indicated, because it allows a greater number of grains per pod.

Key words: *Micronutrients. Fertilization. Glycine max.*

INTRODUCTION

Soy is considered one of the main commodities produced and exported by Brazil to countries such as China and the United States. Its applicability is in its in-nature consumption, but mainly in the industrialization giving rise to by-products which are intended for human and animal consumption.

With the increasing demand for consumption it becomes necessary to maximize the productivity of this culture. The culture i n question is demanding in nutrition mainly in macronutrients, in this way it is indispensable to the adoption of techniques that allow better yield.

Citation: Claudia Manteli, *et al.*, Calcium and Boron Apply Via Leaf On Reproductive Stages R1 and R3 in Soybean Culture. Australian Journal of Basic and Applied Sciences, 13(1): 23-27. DOI: 10.22587/ajbas.2019.13.1.4

In recent years companies in the plant nutrition sector have been promoting the use of foliar fertilizers, with the goal of maintaining plant nutritional balance more quickly and economically. However, this fomentation is still seen with some distrust by the producer, generated by the few information related to the functionality of the products available in the market.

Among the foliar fertilizers commercialized we have calcium and boron-based products, considered as essential nutrients for the plants acting in several functions, but it is still little known the best stage of development to apply these nutrients.

Therefore, the work had the objective of evaluating the productivity and development of soybean crop with the application of different concentrations of Ca and B fertilizers applied through foliar stages in the reproductive stages R1 and R3**.**

MATERIAL AND METHODS

The experiment was conducted in the agricultural year 2015/2016, in the municipality of Chopinzinho - PR, at the geographical coordinates: latitude 25º 51 '21 " S, longitude 52º 31' 24" W and approximate altitude of 650 meters. The climate in this municipality is classified as Cfb, and the temperate climate is humid with summer,according to the KÖPPEN classification (Alvares et al., 2013).

The area was prepared 30 days prior to sowing with the application of the herbicide Glyphosate ® (N-phosphonomethyl) glycine, $C_3 H_8 NO_5 P$) at the dose of 2.0 L ha $^{-1}$ of the commercial product. The plant remains were kept in the area of sowing, for was used the planting system direct.

The same was done on November 11, 2014. The grow crops used was from Dow 5D634RR ®. The seeds were properly treated with fungicide based on Carbedazim ® 150 g L $^{-1}$ + Thiram ® 350 g L $^{-1}$ at the dose 200 ml / 100 kg of seed and insecticide based on Imadacloprid ® 150 g L $^{-1}$ + Thiodicarbe ® 450 g L $^{-}$ 1 at dose of 300 ml / 100 kg of seed.

After sowing, we monitored pests, diseases and weeds when necessary, and for pest control Insecticide was applied to the base Lambda Cyhalothrin ® 106 g L $^{-1}$ + Thiamethoxam ® 141 g L $^{-1}$ in the dose 200 ml ha $^{-1}$ and Chlorantraniliprole ® 200 g L $^{-1}$ in the dose 50 ml ha $^{-1}$, the fungicides based on ciproconazole ® 80 g L $^{-1}$ were used for the control of diseases in the dose of 300 ml ha $^{-1}$ and picoxystrobin ® 250 g L $^{-1}$ in the dose 600 ml ha $^{-1}$ and for the control of weeds the herbicide based on Glyphosate ® 2 L ha $^{-1}$.

The experimental design was completely randomized blocks with five replicates and four treatments. The treatments were constituted by the application of mineral fertilizers means via leaf, based on Ca and B being the witness the only water test that was used (Table 1).

The application of foliar fertilizers was carried out with a back sprayer, these applications being carried out in this matching phenological stages R1 and R3 of the soybeans culture. Concentrations of the fertilizers were stipulated according to the dosage recommended by the manufacturer for $^{a-1}$.

Table 1 - Detail and concentration of calcium (Ca) boron (B) of the foliar fertilizers used as treatments in the experiment. Chopinzinho – PR, 2016.

Treatments	% Ca	% B
T1	13,4	1,34
T2	8	2
T3	14	0,5
T4	0	0

The plots are composed of nine lines planting 2.5m long and 3.6m wide, with a spacing of 0.40 m. For the purpose of the useful plot, the seven central rows were removed by removing 0.5m from each end of the rows, leaving a 4m^2 utilized area.

The evaluated variables were mean plant height (m), productivity (kg /h^{-1}), average height of the first pod (m), abortion of flowers and pods and variable yield components and these number of pods per plant, number of seeds per pod, the total number of seeds, total number of pods and weight a thousand grains (g).

In order to account for the number of aborted flowers and pods at the beginning of flowering, a permeable fabric was installed between the soybean lines, so that the aborted flowers and buds of the plants fell into this tissue. Counting was performed every 3 days.

For the average height of the plants was obtained when they were at the physiological stage (R8), being measured from the soil surface to the insertion of the racemic apex d the main stem of the plant. The average insertion height of the first pod was measured from the soil surface to the lower end of the first pod. Both were determined from the mean height of 10 plants randomly sampled in each portion.

The experimental harvest occurred 140 days after implantation. It was done manually, starting the plants and separating by treatment. After the counting and evaluation of the variables of interest.

The number of pods per plant was evaluated at maturity (R8), counting the number of pods present in 10 plants, randomly sampled in the useful area. The number of grains per pod was provided by the ratio between the total number of grains and the total number of pods in the selected plants randomly sampled in each plot.

In order to evaluate the average weight of 1000 grains, it was carried out by random collection and counting of these by experimental plot weighed with the aid of analytical balance, considering four digits after the comma.

Citation: Claudia Manteli, *et al.*, Calcium and Boron Apply Via Leaf On Reproductive Stages R1 and R3 in Soybean Culture. Australian Journal of Basic and Applied Sciences, 13(1): 23-27. DOI: 10.22587/ajbas.2019.13.1.4

The average grain yield was evaluated at the final maturity (harvest point), determined after harvesting and processing, with manual threshing of the pods, and weighing the grains harvested in the useful area of each plot (Figure 9), with standardized humidity to 13%.

For each variable the Test F (5%) was applied and when significant the Tukey Test (5%) was applied. The statistical software ASSISTAT (Computer program developed for analysis of variance) (AZEVEDO, 2002) was used.

RESULTS AND DISCUSSION

It is possible to observe that for plant height and the height of insertion of the first pod there was no statistical difference between the treatments, and these products did not influence plant height. The coefficient of variation was 3.55 % and 15.92 %, respectively, indicating homogeneity with low dispersion among the results (Table 2).

In relation to the height of insertion of the first pod, Santos (2013), showed that there was no difference in their work, showing that with different doses or stages of application of fertilizer based on Ca and B influenced these characteristics of the plant. As for plant height and insertion of the first pod, genetic characteristics are little or not changeable when subjected to these types of treatment.

Table 2 - Height of the plant (m) and a height of insertion of the first pod (m) soybean subjected to application of different concentrations of foliar fertilizers based on calcium (Ca) and boron (B) via leaf. Chopinzinho - PR, 2016.

Treatments	Height of the plant (m)	Height of the first pod (m)
T1	1,25 ^{ns}	0,20 ^{ns}
T2	1,24	0,22
T3	1,28	0,20
T4	1,28	0,18
C.V (%)	3,55	15,92
DMS	0,08	0,06

*Means followed by the same letters in the column, do not differ by the Tukey test (5%) DMS - Minimum significant difference; CV - Coefficient of variation. NS: Not significant.

When analyzing the number of pods per plant (Table 3), there was no statistical difference between treatments. The coefficient of variation obtained is 11.07 % indicating homogeneity with low dispersion.

The number of grains per pod (Table 3) presented a statistical difference between the treatments, the T1 was different from the others. It has been shown that if applied to leaf Ca and B base, in stages R1 and R3 will aid in grain growth per pod.

Similar data were found in the work of Arantes et al. (2009), showed that there was no significant difference between the number of pods per plant, nor was there any difference in the number of grains per pods, with the application of Ca and B via foliar in the soybean crop.

However, Bevilaqua et al. (2002), presented in his work, that the foliar application of Ca and B did not influence in the number of grains per pod, and in relation to the number of pods there was an increase when applied in the stage of flowering.

Table 3 - Number of pods per plant and grains per pod submitted to the application of different concentrations of foliar fertilizers based on calcium (Ca) and boron (B) foliar. Chopinzinho - PR, 2016.

Treatments	Nº of pods/Plants	Grains per pods
T1	57,82^{ns}	2,64 a
T2	53.54	2,40 b
T3	57,46	2,41 b
T4	58,98	2,28 b
C.V (%)	11,07	3,81
DMS	118,44	0,17

* Means followed by the same letters in the column, do not differ by the Tukey test (5%) DM S - Minimum significant difference; CV - Coefficient of variation. NS: Not significant.

In relation to 1000 grains (Table 4), the T3 presented the highest weight, being 2208.00 g, but there was no statistical difference between treatments, the coefficient of variation was 8.69 % presented homogeneity with low dispersal.

Regarding yield (Table 4) there was no statistical difference between treatments, however, we observe that T3 showed the highest weight per hectare, and of 5339 kg/ha $^{-1}$ approximately 89 bags. The second largest production was the T1 with 5,133 kg/ha^{-1}, approximately 86 bags. T4 yielded 5.063 kg/ha $^{-}$ 1, approximately 84 sacks, and finally T2 with 4.619 kg/ha $^{-}$ 1, approximately 77 sacks.

Work performed by Seidel and Basso, (2012), found that the average number of grains per pod and mass of 1000 grains also did not differ statistically with the foliar application of Ca and B, according to them, coming from a good water availability for plants and also due to the adequate content of these nutrients in ground.

Citation: Claudia Manteli, *et al.*, Calcium and Boron Apply Via Leaf On Reproductive Stages R1 and R3 in Soybean Culture. Australian Journal of Basic and Applied Sciences, 13(1): 23-27. DOI: 10.22587/ajbas.2019.13.1.4

Nevertheless, Bevilaqua et al. (2002), showed a different result, where the weight of grains per soybean plant had an increase, after application of Ca and B via leaf, in soils did not affect the physiological quality of soybean seeds. In Santos' work (2013), it shows that positive results on the soybean crop yield on the application of Ca and B, and where were applied at the R3 stage of the culture, higher production occurred.

Regarding productivity, CONAB (2015) showed that in Brazil the average yield of soybeans in the 13/14 crop was 3,393 kg/ha ¯ 1, and in the 14/15 crop, it was 3,609 kg/ha ¯ 1. In relation to Paraná, in the 13/14 harvest the average production was 3,691 Kg/ha $^{-1}$ and in the 14/15 harvest, it was 3,995 Kg/ha ¯ 1. We can say, then, that the data of the experiment are above the average of Brazil and Paraná in productivity of grains, kilogram per hectare, in all treatments.

Table 4 - Weight of 1000 grains (g) and yield (kg/ha $^{-1}$) of soybean submitted to the application of different concentrations of foliar fertilizers based on calcium (Ca) and boron (B) foliar. Chopinzinho - PR, 2016.

Treatments	Weight of a 1000 grains (g)	Kg / ha^{-1}
T1	2195,50 ^{ns}	5.173 ^{ns}
T2	1958,00	4.619
T3	2208,00	5.339
T4	2133,00	5.063
C.V (%)	8,69	
DMS	346,54	

* Means followed by the same letters in the column, do not differ by the Tukey test (5%) DM S - Minimum significant difference; CV - Coefficient of variation. NS: Not significant.

For the variable abortion of pods and flowers, (Table 5), it was observed that there was no statistical difference between the treatments, but it was observed that in the abortion of the pods there was a low difference between the treatments, the coefficient of variation was 17.77 %, presenting homogeneity with low dispersion. The control abortion was the most significant among the treatments, approximately 88 abortions, the coefficient of variation was 22.50 %, being a considerable dispersion among the treatments, not having a good homogeneity.

The high number of flower abortions observed in the control can be related to the concentrations of boron because the low availability and/or the deficiency of this element in the plants can directly affect the reproductive phase of the plant.

In other works consulted, these variables were not mentioned, but a methodology was adapted to quantify them. It was imagined that if these were directly affected by the applied nutrients (Ca and B) they reflected in the other variables. And this has been proven. No significant differences were found for the other variables studied, which justify a Ca via leaf application, except for boron in flowering.

Table 5 - Abortion of soybean pods and flowers, submitted to the application of different concentrations of foliar fertilizers based on calcium (Ca) and boron (B) foliar. Chopinzinho - PR, 2016.

Tratamentos	Abortion of knives – NS	Abortion of flowering – NS
T1	35,00	69,00
T2	37,00	64,00
T3	37,00	64,00
T4	35,00	88,20
C.V (%)	17,77	22,50
DMS	12,08	30,22

* Means followed by the same letters in the column, do not differ by the Tukey test (5%) DM S - Minimum significant difference; CV - Coefficient of variation. NS: Not significant.

CONCLUSIONS

We conclude that the concentrations of foliar fertilizers used in this work based on calcium (Ca) and boron (B) did not influence positively on the variables, average height of the plant, productivity, height of the first pod insertion, abortion of flowers and pods, number of pods per plant, total number of grains, total number of pods and weight of one thousand grains, only the number of grains per pod yielded satisfactory results. The application of calcium and boron in the concentrations 13.4% and 1.34 respectively in the reproductive stage R1 is indicated, because it allows a greater number of grains per pod.

TRABALHOS FUTUROS

Application of boron, calcium and mycorrhiza in soybean crop planting groove

REFERENCES

Citation: Claudia Manteli, *et al.*, Calcium and Boron Apply Via Leaf On Reproductive Stages R1 and R3 in Soybean Culture. Australian Journal of Basic and Applied Sciences, 13(1): 23-27. DOI: 10.22587/ajbas.2019.13.1.4

Alvares, C.A. et al., 2013. Koppen's climate classification map for Brazil. Meteorologische Zeitschrift, Stuttgart, 22(6):711-728.

Arantes, R.P, Cury, T.N, Leão, F.D.P, Junior, V.A.M., 2009. Aplicação foliar de cálcio e boro com produto industrializado para avaliação de rendimento e qualidade de semente de soja. Nucleus, Ituverava, 6(2):111–114.

Belivaqua, G.A.P, Silva, F. Pedro, Possenti, J.C, 2002. Aplicação foliar de cálcio e boro e componentes de rendimento e qualidade de sementes de soja. Ciência Rural, Santa Maria, 32(1):31-34.

Companhia Nacional de Abastecimento-CONAB. 2015. Acompanhamento da safra brasileira de grãos. v. 2 - Safra 2014/15, n. 12 - Décimo Segundo Levantamento, set.

Santos, E. A. Dos, 2013. Influência da aplicação foliar de cálcio e boro em pré e pós - floração sobre os componentes de produção e na produtividade da soja. Dissertação. Universidade Federal do Piauí.

Seidel E.P, Basso W.L, 2012. Adubação foliar a base de cálcio e boro no cultivo da soja (Glycine *max*), Scientia Agraria Paranaenis, 11(2):75-81.