

SOYBEAN YIELD SUBMITTED LATE NITROGEN FOLIAR APPLICATION

ABSTRACT: For the soybean crop achieves high productivity, a balanced fertilization is fundamental, therefore, appropriate management during the period in which the plant requires larger amounts of nitrogen is needed, since this element is very extracted by the plant. The aim of this study to evaluate the response of late nitrogen fertilization with ammonium sulfate applied on soybean leaves. The experiment was conducted in 2015/2016 crop in Piauí State, from Brazil. Nitrogen were applied by foliar and were made in D1 doses - zero kg ha⁻¹ (control); D2 - 3 kg ha⁻¹; D3 - 6 kg ha⁻¹; D4 - 9 kg ha⁻¹; D5 - 12 kg ha⁻¹; D6 - 15 kg ha⁻¹ in the early stage of grain filling (R5). The experimental design was a randomized block with four repetitions, consisting of 10 lines with five meters in length and spacing between lines was 0.5 m. The variables analyzed were the number and length of pods, thousand seed weight and productivity. The results showed no significant difference in grain yield. It was noted with the study that there is no response a late application plant to nitrogen fertilizer for soybean.

Keywords: *Glycine max*, plant nutrition, foliar application, productivity.

1. INTRODUCTION

Soybeans are an important source of protein and are important for food and feed. The soybean yield has been growing over the years and the harvest of 2014/15 Brazilian production reached a record 96.24 million tons.

Nitrogen is part of most organic compounds as proteins, chlorophyll, hormones, nucleic acids and amino acids with it becomes essential for the life of plants (MALAVOLTA, 2006). The increased demand of nutrients period is in the flowering and have the maximum amount of grain in stages (between R1 and R6) (LAMOND & WESLEY, 2001; MAEHLER *et al.*, 2003). Much of nitrogen is required by the culture of the fixation process and through genus *Bradyrhizobium* bacteria that perform symbiosis process, the remainder is the soil, by mineralization of organic matter (AMADO *et al.*, 2010). However, several factors hamper the fixation process, for example, deficit or excess water, acid, soil temperature, fertility, competition with wild strains and the presence of excess nitrate (PURCELL *et al.*, 2004; SINCLAIR *et al.*, 2007).

Nitrogen fertilization comes as an alternative to complement the biological fixation process, therefore, ammonium sulphate {(NH₄)₂SO₄} is often used is the second most widely used source in Brazil (ANDA, 2006). This formula shows 21% nitrogen and also has on average 24% of sulfur (S), in addition, it has advantages such as low hygroscopicity, low loss by volatilization of N, low nitrification and good physical properties, and increasing phosphorus solubility and soil manganese through the

sulfur (COLLAMER et al., 2007). Given the above, the aim of the present study was to evaluate soybean production due to the late application of different foliar ammonium sulfate doses.

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41 2. MATERIAL E METHODS

42 The research was conducted in the field of soybean production of São João Farm, along the
43 Brazilian Cerrado in Piauí State (9° 3'25.69"S and 44° 33'12.89" W, and altitude of 570 m. The study
44 was conducted between the months of December / 2015 to March / 2016. The climate is classified as
45 warm tropical Aw, according to Köppen, with rainy and hot summer. Precipitation and average
46 monthly temperatures were monitored during the study period, from November 2015 to April 2016, it
47 rained about 746 mm, the average temperature was 26.5 °C.

48 The fertilization was based on soil analysis of the area (table 1) and recommendation for
49 culture. Heldseed treatment and seed inoculation with *Bradyrhizobium* bacteria at the concentration 5
50 x 10⁹ colony forming unit.

51

52 **Table 1.** Soil analysis of the experimental area at different depths.

Deph	pH	OM	P	K	Ca	Mg	Al	SB	SAND	CLAY	SILT
cm	CaC ₂	g/dm ³	mg/dm ³	-----mmolc/dm ³ -----				-----g/kg-----			
0-10	4,8	26,4	30,3	3,8	38,3	7,6	0	49,7	660	280	60
10-20	4,2	20,5	11,1	1,4	14,4	2,9	5	18,7	610	300	90
20-40	3,1	14,3	6,3	0,7	1	0,9	12	2,6	590	330	80

53 *Deph* = soil depth; *pH* = potential of hydrogen; *OM* = organic matter; *P* = phosphor; *K* = potassium; *Ca* = calcium;
54 *Mg* = magnesium; *Al* = aluminum; *SB* = base saturation.

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56 Sowing of soybean was made at the end of November 2015, the cultivar presented a
57 determined growth habit, medium height of 77 cm, average cycle 110 days, maturity group 8.6. This
58 cultivar has a high yield potential and good adaptation to regions with less than 600 meters. The
59 experimental design was a randomized block design, using six ammonium sulfate doses of {(NH₄)
60 2SO₄}: D1 - control, 0 kg ha⁻¹; D2 - 3 kg ha⁻¹; D3 - 6 kg ha⁻¹; D4 - 9 kg ha⁻¹; D5 - 12 kg ha⁻¹; D6 - 15 kg
61 ha⁻¹, with 4 repetitions.

62 Each plot had 10 rows of 5 meters in length, spaced 0.50 m between the lines, totaling 25 m².
63 The useful area of the experimental unit was formed by the three central rows, excluding 0.5 m from
64 each end of the lines. It used the ammonium sulphate (21% N and 24% S) as a source of fertilizer.
65 For the application of N in liquid form, we used a knapsack sprayer 20 liters in the period from the end
66 of the pod formation stage (R4) to the beginning of the grain filling stage (R5). To carry out the
67 assessments were collected only plant useful area of the plot. Harvest was done manually, when the
68 plants have reached the developmental stage R8, when 95% of the pods had the typical staining
69 mature pod. For the assessment of yield components of culture were evaluated:

70 Soybean yield: collected to the plants of the useful area of the plot by measuring the total
71 weight of the grains of the collected plants. The result was presented in kg ha^{-1} (with humidity
72 adjusted to 13%).

73 Thousand seed weight: eight samples collected up to 100 seeds at random from each plot,
74 where each sample was weighed with the use of balance with the decimal scale and then applied to
75 the formula described in Brazil (2009). The results were expressed in grams.

76 Pod number per plant: collected up five plants in each plot, and was count of pods and was
77 later calculated the average of 5 plants.

78 Length of the pods: Were collected five plants and 10 pods per plant were taken to measure
79 the length, using a digital caliper and then obtaining the average per plant.

80 Data were submitted to analysis of variance (ANOVA) by applying the F test and processed
81 by the R software (version 3.2.3).

82

83 3. RESULTS AND DISCUSSION

84 Table 2 illustrates the results of the analysis of variance. It is observed that the number of
85 pods, there was no significant difference, showing that different doses applied late (R4-R5) foliar does
86 not respond to fertilization. This result differs from Zocca and Fancelli (2013), tested N foliar
87 applications in soybeans, which had a significant increase in the number of pods per plant compared
88 to the control.

89 For the length of pods, the result was also not significant. According to the authors mentioned
90 above, this result may be related to lack of biological nitrogen fixation in the final stage of the crop.

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92

93 **Table 2:** Analysis of variance for number of pods (NP), length pods (LP), thousand seed weight (TSW)
94 and productivity (PROD).

Source of variation	Freedom degree	NP (unit/plant)	LP (cm)	TSW	PROD
Dose	5	147,94 ^{ns}	3,07 ^{ns}	35,16 ^{ns}	126,69 ^{ns}
Blocks	3	116,02 ^{ns}	0,09 ^{ns}	27,99 ^{ns}	25,89 ^{ns}
Residue	15	164,85	1,54	17,31	92,73
Coefficient of variation (%)		23,08	2,82	6,77	30,18

95 ^{ns}: no significant

96

97 For TSW (table 2), significant difference was not observed, this may have happened because
98 of high water stress had in the region in the grain filling period (R5), thus providing pods with
99 malformed grains and low weight. Sohrabi [et al.](#) (2012), in experiments in Iran, with urea, they
100 observed that the treatments with application of 50 kg ha^{-1} and 100 kg ha^{-1} in the R1 and R5 stages,
101 did not obtain significant difference for 1000 grain weight between treatments, thus showing that late
102 applications also showed no significant response.

Productivity kg ha^{-1} (table 2) was also not affected by the late application of ammonium sulfate. These results contradict the Zocca and Fancelli (2013), which had an output of $3890.50 \text{ kg ha}^{-1}$ and $3940.50 \text{ kg ha}^{-1}$ using leaf N (25%) at a dose of 10 L ha^{-1} at the stage of R5 and R1 + R5. However, Pasqualli and Pittelkow (2014) in an experiment with nitrogen (32%) in three forms: nitrate, ammonium and amidic in the same fertilizer in soybean noted an increase in productivity at doses of 3 and 5 L ha^{-1} , however the results showed no significant difference statistically. Rose et al. (2015) also reported that the application of foliar N (30%) in the reproductive stages R4 and R5 have not increased productivity when used in two doses of 4 L ha^{-1} .

Table 3. Average for number of pods (NP), length pods (LP), thousand seed weight (TSW) and productivity (PROD) of different nitrogen doses used.

DOSE	NP Unit/plant	LP Cm	TSW g	PROD kg/ha^{-1}
0	58,35	42,45	95,85	1.750,20
3	63,15	44,84	95,63	2.406,10
6	49,85	43,82	93,75	1.667,97
9	61,00	43,63	88,38	1.406,29
12	52,95	44,15	91,63	2.013,47
15	48,45	44,76	90,58	2.139,71

For applying foliar observed toxicity symptoms caused at doses of 6, 9, 12 and 15 kg ha^{-1} , only the dose of 3 kg ha^{-1} did not show symptoms, but the plants have recovered and complete its cycle. According Rosolem & Boaretto (1989), the application of considerable amounts foliar nitrogen may run into the problem of the occurrence of toxicity symptoms, which can be minimized with the choice of nutrient source, the nozzle and spray volume, as well as the time of application.

Are recently discussed questions about the inefficiency of fixation to supply the demand of N in grain filling stage (R5). However, it should be noted that some practices and used chemicals for seed treatment are incompatible with N_2 fixing bacteria, leading to the death of them (Ferreira et al., 2011) and thus impairing the final production. The mineral forms in N NH_4^+ and NO_3^- affects not only the biological fixation, but also the nodulation of the plants, for inhibiting the formation of lumps or causing senescence already formed (BOTTOMLEY & MYROLD, 2007).

4. CONCLUSION

The soybean crop does not respond to ammonium sulfate application $\{(\text{NH}_4)_2\text{SO}_4\}$ foliar, in the grain filling period (R4 to R5).

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