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Kinetin and Nitrogen in Agronomic Characteristics of Soybean

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Abstract

The objective of this work was to evaluate the application of kinetin associated with nitrogen in coverage on the agronomic characteristics and soybean yield. In the 2016/2017 harvest, a 6x2 factorial scheme was used, six doses of kinetin (0; 0.30; 0.60; 0.90; 1.20; 1.50 g ha^{-1}) and two doses of N (20 and 40 kg ha^{-1}) and in the 2017/2018 harvest, factorial scheme 5x2 was used, five doses of kinetin (0; 0.25; 0.75; 1.00; 1.25 g ha^{-1}) and two doses of N (20 and 40 kg ha^{-1}). Agronomic plant height characteristics, first pod insertion height, number of grains per plant, number of pods per plant, number of grains per pod, number of grains per pod, hundred-grain mass and grain yield were evaluated. The use of N alone and associated with kinetin increased the number of pods and grains in the 2016/2017 harvest. In the 2017/2018 crop, kinetin caused a reduction of 8.9% at plant height and N caused an increase in plant height and first pod insertion and reduced the number of pods and grains per plant, grains per pods and productivity.

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Keywords: cytokine; phytoregulator; mineral nutrition.

1. Introduction

In soybean culture, abortion between 27% and 84% of reproductive structures is normal, reducing the productive potential of the crop [1, 2]. The fixation of vegetables is dependent on the availability of photoassimilates and nutrients available to vegetables [3] and the availability of some hormones present in seeds [4, 5].

According to [6], cytokinin and abscisic acid are considered the most decisive plant regulators for reproductive development. There are reports that endogenous cytokinin deficiency in the upper third in soybean plants results in a higher occurrence of abortion of plant reproductive structures [4, 7]. Studies with soybeans found that exogenous applications of synthetic cytokinin in racemes increased the number of vegetables produced by the plant [7, 8].

Plants under stressful conditions, such as nutrient deficiency, the level of endogenous cytokinin decreases in response to this condition and the exogenous application of cytokinin can relieve symptoms of nutritional deficiency [9, 10]. In Brazil, the current recommendation for soybean cultivation is the use of inoculant without supplementation with nitrogen fertilizers. However, nitrogen biological fixation rates (BNF) begin to fall rapidly after reproductive stage R5, a stage that requires a higher demand for protein synthesis [11].

Modern soybean cultivars may have, in certain situations, negative N balance, due to the low efficiency of biological fixation [12]. Thus, doubts have arisen about the need to use N fertilizers to ensure higher productivity [13]. But according to [14], the late application of nitrogen does not generate profit for producers due to the increase in cost with the input being higher than the increase in production.

The objective of this work was to evaluate the influence of the application of kinetin associated with nitrogen on the agronomic characteristics and soybean yield.

2. Material and methods

The work consisted of two experiments carried out on the same area in the experimental station of the Federal University of Tocantins Foundation - Gurupi Campus, in the 2016/2017 and 2017/2018 harvest, characterized by geographical coordinates 11° 44’ 48” of south latitude and 49° 03’ 12” west longitude, at an altitude of 285 m, in soil of the type dystrophic yellow Latosol of medium texture.

In the 2016/2017 harvest, the experimental design of randomized blocks with four replicates in factorial scheme 6x2 was used, six concentrations of the kinetin plant regulator (0; 0.30; 0.60; 0.90; 1.20; 1.50 g ha^{-1}) and two doses of N (20 and 40 kg ha^{-1}). In the 2017/2018 harvest, the experimental design of randomized blocks with three replicates in factorial scheme 5x2 was used, five concentrations of the kinetin plant regulator (0; 0.25; 0.75; 1.00; 1.25 g ha^{-1}) and two doses of N (20 and 40 kg ha^{-1}). The zero dosage corresponded to the control with water application only. In both seasons, kinetin was applied in the phenological stage R3 [15] on the leaf by means of spray with CO2 pressure, constant pressure of 2.8 kgf.cm^{-2}, and with syrup volume of 200 L ha^{-1} and N used in the form of urea applied to launch at the beginning of the formation of vegetables (R3).

The experimental plots consisted of four lines of 5 meters in length, spaced 0.45 m, considering useful area the two central rows, disregarding 0.50 m from the extremities.

In the 2016/2017 harvest, soybean grows crops BMX Bonus IPRO, early cycle and habit of undetermined growth were used. In the 2017/2018 harvest, the new cultivars MSOY 8808 IPRO, late-cycle and habit of determined growth were used. In both harvests the seeds were inoculated with *Bradyrhizobium japonicum*, Semia 5079 and Semia 5080 strains, at a minimum rate of 12x10^{-5} bacteria cells per seed, in sowing.

For sowing, desiccation was performed, followed by direct sowing in straw. Sowing fertilization was performed in the sowing groove, based on the results of chemical and physical analysis of the soil, with 500 kg ha^{-1} of fertilized formulated NPK (2-30-10). The remaining K fertilization was performed 30 days after seedling emergence at a dose of 80 kg ha^{-1} of K_2O in the form of potassium chloride (58% K_2O). Cultural treatment of pest control, diseases and weeds were carried out according to the need.

The agronomic characteristics of soybean crop were evaluated in R8 obtaining plant height (cm), first pod insertion height (cm), number of stems, number of grains per plant, number of pods per plant, number of grains per pod, mass of one hundred grains (g), and later the useful area was harvested to determine grain yield (kg ha^{-1}) to 13% moisture.

The data were submitted to variance analysis, with an application of the f-test, because it verified the significance of the effects of regression, the highest degree model was chosen. The analyses were performed using the computational application of Sisvar® [16].

3. Results and discussion

Table 1: Digest of the analysis of variance of plant height characteristics (HP), first pod insertion height (I1P), number of rods (NR), number of pods per plant (NPP), number of grains per plant (NG), number of grains per pod (NGP), mass of one hundred grains (MHG) and productivity (PROD) harvest 2016/2017.

Variation factors	GL	Medium squares							
		AP	A1V	NH	NVP	NGP	NGV	MCG	PROD
Blocks	3	781,36	28,37	0,16	1,44	16,83	0,03	4,43	102821,40
Kinetin (C)	5	10,48	1,27	0,43	10,52	49,73	0,03	0,87	258177,70
Nitrogen (N)	1	0,08	0,19	0,23	117,81*	800,33**	0,02	1,14	73633,33
C x N	5	38,38	1,75	0,84	94,59***	276,63**	0,03	0,76	175577,80
Residue	33	25,68	1,88	0,47	16,60	68,67	0,031	1,11	104869,90
Medium		90,2	20,0	4,0	43,5	83,3	1,9	18,0	3809,4
CV (%)		5,62	6,85	17,22	9,38	9,94	9,48	5,85	8,50

The *, ** and *** Significant at 5, 1 and 0.1% probability, respectively, by test-F

In the 2016/2017 harvest, kinetin doses did not influence the agronomic characteristics evaluated (Table 1). But, there was effect for the number of pods and the number of grains per plant with the application of N associated or not kinetin.

The dose of 40 kg ha^{-1} N increased the number of pods per plant and consequently the number of grains per plant, but was not enough to increase productivity (Table 2). The increase in the number of pods may be the result of the lower consumption of assimilated by biological fixation [17], due to the plant's preference to absorb readily assimilated nitrogen supplied by fertilizer [18], more photoassimilates left for the formation of pods.

Table 2: Digest of the analysis of variance of plant height characteristics (HP), first pod insertion height (I1P), number of rods (NR), number of pods per plant (NPP), number of grains per plant (NG), number of grains per pod (NGP), mass of one hundred grains (MHG) and productivity (PROD) harvest 2016/2017.

Doses of N	AP (cm)	A1V (cm)	NH (n)	NVP (n)	NGP (n)	NGV (n)	MCG (g)	PROD (kg ha^{-1})
20 kg ha^{-1}	90,2 a	20,1 a	3,9 a	41,9 b	79,3 b	1,9 a	17,8 a	3848 a
40 kg ha^{-1}	90,3 a	20,0 a	4,0 a	45,0 a	87,4 a	1,9 a	18,1 a	3770 a

Averages followed by the same letter in the column are not significantly different by t-test ($p \leq 0,05$).

The interaction occurred between kinetin and N for the number of pods per plant and the number of grains per plant (Figure 1). The number of pods per plant and number of grains per plant did not present interaction with 20 kg ha^{-1} of N, but the dose of 40 kg ha^{-1} of N presented quadratic behavior in both characteristics. For the number of pods per plant, maximum technical efficiency was obtained with 0.82 g ha^{-1} of kinetin, and for the characteristic number of grains per plant, maximum technical efficiency was obtained with 0.86 g ha^{-1} of kinetin. The application of kinetin can increase the translocation of assimilated to drains due to higher photosynthetic rate, thus increasing the number of pods [5] and consequently the number of grains per plant, and can still fix more units in improved cultivars resulting in higher means of number of grains and pods [19].

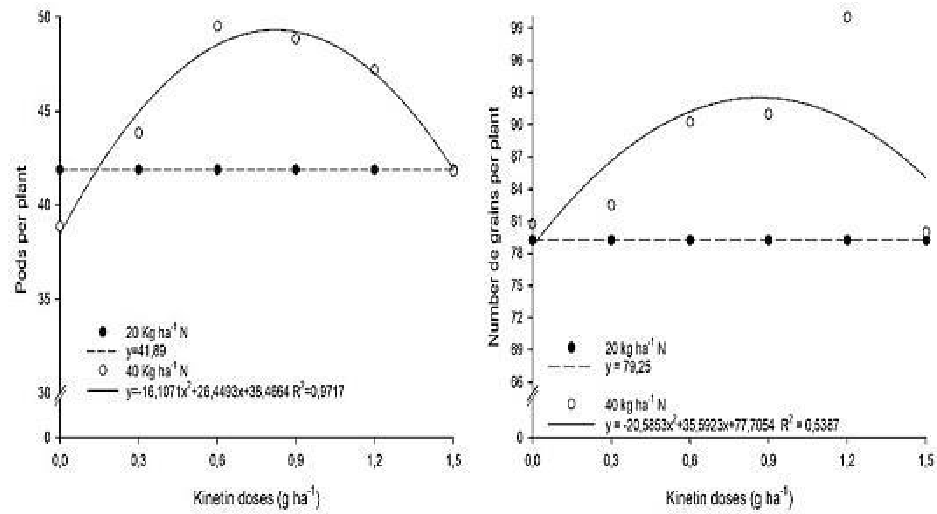

Figure 1: Interaction between kinetin e nitrogen for the number of the characteristic of pods per plant and the number of grains per plant harvest 2016/2017.

Table 3: Summary of variance analysis of plant height characteristics (AP), first pod insertion height (A1V), number of pods per plant (NVP), number of grains per plant (NGP), number of grains per pod (NGV), hundred-grain mass (MCG) productivity (PROD) harvest 2017/2018.

Variation factors	GL	Medium squares							
		AP	A1V	NH	NVP	NGP	NGV	MCG	PROD
Blocks	2	38,93	0,46	1,10	1,43	26,43	0,02	0,02	119902,50
Kinetin (C)	4	70,33*	8,09	1,82	139,13	714,38	0,02	0,69	210350,30
Nitrogen (N)	1	1400,83***	54,68***	2,03	1526,53**	12040,03***	0,28**	0,07	3444241,00***
C x N	4	5,33	3,69	1,15	133,53	733,62	0,01	0,28	439141,40
Residue	18	22,71	3,72	0,85	107,43	750,69	0,03	0,30	167767,70
Medium		80,2	15,2	5,6	58,1	122,4	2,1	9,7	3115,4
CV (%)		5,94	12,66	16,49	17,85	22,38	7,61	5,65	13,15

The *, ** and *** Significant to 5, 1 and 0,1% probability, respectively, by test-F.

There was a decrease of 8.9% (7.5 cm) at the time of plants with the application of kinetin (Figure 2). This behavior occurs due to the effect of cytokine on the breakdown of apical dominance promoting the growth of lateral buds reducing its growth [20].

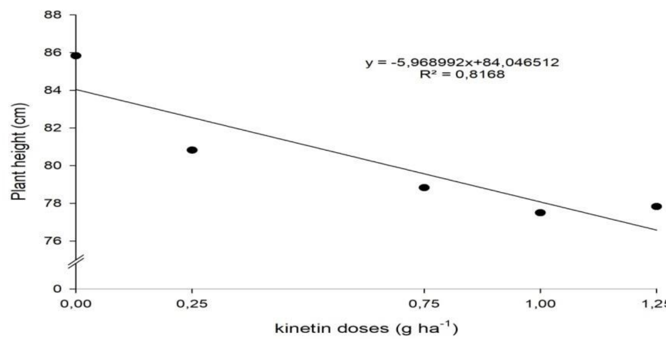

Figure 2: Plant height depending on the doses of kinetin Harvest 2017/2018.

The dose of 40 kg ha^{-1} of N provided an increase in plant height and insertion of the first pod, but reduced the number of pods per plant, number of grains per plant, number of grains per pod and grain yield (Table 4).

Table 4: Summary of variance analysis of plant height characteristics (AP), first pod insertion height (A1V), number of pods per plant (NVP), number of grains per plant (NGP), number of grains per pod (NGV), hundred-grain mass (MCG) productivity (PROD) harvest 2017/2018.

Doses de N	AP (cm)	A1V (cm)	NH (n)	NVP (n)	NGP (n)	NGV (n)	MCG (g)	PROD (kg ha^{-1})
20 kg ha^{-1}	72,8 b	13,9 b	5,3 a	65,2 a	142,5 a	2,18 a	9,6 a	3454 a
40 kg ha^{-1}	85,8 a	16,6 a	5,8 a	50,9 b	102,4 b	1,98 b	9,7 a	2777 b

Averages followed by the same letter in the column are not significantly different by t-test ($p \leq 0,05$).

Due to the plant still growing at the time of N application, the use of 40 kg ha^{-1} of this nutrient stimulated vegetative growth resulting in higher plant height and higher height of first pod insertion. However, the supply of N through fertilizers impairs the biological fixation of N causing a deficit of this nutrient [21]. What result in the reduction of the number of pods and grains per plant, number of grains per pods and grain yield. The use of 20 kg ha^{-1} of N was not enough to impair the biological fixation of N, resulting in 677 kg ha^{-1} more in productivity compared to the application of 40 kg ha^{-1} of N. The difference in the results obtained between the crops can be attributed to cultivars since each cultivar has a different nutritional requirement [22] and morphological characteristics that also vary within the same maturation group and type of growth. The use of kinetin could have obtained a higher result if there was an adverse climatic condition in both harvests. According to the reference [23] using bioregulation during stage R3, in a crop with Indian summer, obtained yield 932 kg ha^{-1} higher compared to treatment without application. To better understand the application of N associated kinetin, a study with a greater number of cultivars in different climatic conditions is necessary.

4. Conclusions

The application of N associated or not kinetin increases the number of pods and the number of grains per plant. The application of kinetin and 40 kg ha^{-1} of N do not result in productivity gains for the harvest.

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