

THE INFLUENCE OF HORMONAL COMBINATIONS WITH AUXINS ON POTATO VITRO PLANTS DEVELOPMENT

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Abstract

*In 2024, at NIRDPSB Brasov, Romania in Laboratory of Plant Tissue Culture was undertaken a study with whose main objective was to follow the evolution of the development of potato microplants under the influence of various concentrations of auxins. Bifactorial experiment, of the type: 4*12 with 48 variants, divided into 3 repetitions included: the experimental factor a, variety with four gradations: a1 - Azaria, a2 - Braşovia, a3 - Cosiana, a4 - Cezarina (considered control variety) and the factor b the culture medium with different amounts of auxin, with 12 gradations. Braşovia variety stood out with the highest average value of plant height (10.86 cm), followed by Cosiana variety (10.39 cm); for the other analysed parameters (number of leaves, root length and number of internodes), Cosiana variety records the highest values (leaves: 8.36; root length: 5.14 cm; number of internodes: 5.53). Significant differences existed among hormonal treatment, cultivars for all determinations. The differences in data across interaction between hormonal treatment and cultivar was not significant.*

Key words: auxins, growth regulators, microplants, potato, variety.

INTRODUCTION

Meristem culture was possibly the first biotechnological approach used to eliminate viruses from systemically infected potato clones. Over the years, this technique has been successfully combined with micropropagation to produce disease free potato seed. Plant tissue culture is a specialized technology used for plant propagation. It operates on the principle of growing disease-free plant tissues under sterile conditions in artificial plant growth medium (Shoyeb et al., 2017).

Tissue culture has been applied to improve production of potato by germplasm conservation, pathogen free potato plants and micropropagation (Khalafalla, 2001).

Previous studies show that micro propagation of seed potatoes depends on the biological value of cultivars, explant type (leaf, node, shoot tip, etc.), type of culture medium, season, temperature, photoperiod, and a balanced combination of plant growth regulators (PGRs) in the culture media (Akhtar et al., 2006; Dhital et al., 2010 quoted by Makau et al., 2022)

Addition of growth regulators in culture media has been reported to improve the number, growth and development of shoots (Ahmed et

al., 1993; Rabbani et al., 2001), though they are genotype dependant.

To establish tissue culture protocols for a plant species, exogenous growth regulators are used to evoke certain responses. Indole-3-acetic acid (IAA), a-naphthalene acetic acid (NAA), indole-3-butyric acid (IBA) are commonly used auxins to promote root initiation (Salem et al., 2022).

MATERIALS AND METHODS

In 2024, at National Institute of Research and Development for Potato and Sugar Beet Brasov, Romania through Research Laboratory of Vegetal Tissue Culture was undertaken a study with whose main objective was to follow the evolution of potato microplants development under the influence of various concentrations of auxins. Minicuttings obtained *in vitro* by uninodal multiplication were inoculated immediately after cutting on Murashige-Skoog medium (1962) to which combinations of hormonal treatments were added. Bifactorial experiment, of the type: 4*12 with 48 variants, divided into 3 repetitions included: the experimental factor a, variety with four gradations: a1 - Azaria, a2 - Braşovia, a3 - Cosiana, a4 - Cezarina (considered control

variety) and the factor *b* culture medium with different amounts of auxin, with 12 graduations (according to the treatment scheme from Table 1). All 4 potato varieties are Romanian genotypes created at NIRDPSB Brasov. The

purpose of this study was to establish for each genotype which hormonal treatment has a beneficial effect for the four analysed parameters: leaves number, plantlets height, root length, number of internodes.

Table 1. Treatment scheme: combination of naphthyl acetic acid (in 3 concentrations) and indole-3-butyric acid (in 4 concentrations)

Auxine	Concentration of auxine introduced into the culture medium (mg/l)											
Naphthyl acetic acid (NAA)	0				0.25				0.5			
Indole-3-butyric acid (IBA)	0 b ₁ (Ct)	0.25 b ₂	0.5 b ₃	1 b ₄	0 b ₁	0.25 b ₂	0.5 b ₃	1 b ₄	0 b ₁	0.25 b ₂	0.5 b ₃	1 b ₄

RESULTS AND DISCUSSIONS

Table 2 shows the calculated F values for the differences in leaves number, plantlets height, root length and number of internodes between hormonal treatment, cultivars and their combination. Significant differences existed among hormonal treatment, cultivars for all determinations. The differences in data across interaction between hormonal treatment and cultivar was not significant for internodes number.

Under the influence of treatment with different concentrations of auxins, Braşovia variety (Table 3) stands out with the highest average value of plant height (10.86 cm), followed by the Cosiana variety (10.39 cm). For this parameter there were no significant differences for the varieties Braşovia, Cosiana and Cezarina, instead they differed significantly from variety Azaria.

For the other analysed parameters (number of leaves, root length and number of internodes), Cosiana variety records the highest values (leaves: 8.36; root length: 5.14 cm; number of

internodes: 5.53), followed by variety Braşovia (leaves 7.50; root length: 4.61 cm; number of internodes: 5.11 cm). Varieties Cosiana and Braşovia formed a well-developed root system, the values of root differing very significantly, positively from the control variety.

Hormonal combinations had different effects on the studied elements (Table 4). Thus, the treatment composed of 0.5 mg/l NAA - 0 mg/l IBA was beneficial in obtaining a high number of leaves (9.00), followed by the combination 0.25 mg/l NAA - 0 mg/l IBA, which resulted in 8.42 leaves. The treatment 0.25 mg/l NAA - 0.5 mg/l IBA was favourable to increase in height of plantlets (11.46 cm), followed by the combination of the hormonal regulators NAA: IBA 0.5: 0.0 mg/l, which determined the height evolution of plantlets to 10.92 cm. Higher values of root length were recorded for NAA - IBA treatments of: 0.25 - 0.5 mg/l; 0.25 - 1 mg/l and 0.5 - 0.0 mg/l (5.29, 4.83 and 4.79 cm). The combination 0.5 - 0.0 mg/l NAA-IBA was conducive to the achievement of a high number of internodes (5.92 internodes), followed by the combination 0.5 - 0.5 mg/l (5.75 internodes).

Table 2. Analysis of variance in F values for determined parameters

Source of variation	df	Leaves number	Plantlets height	Root length	Number of internodes
Variety (a)	3	5.465 * (4.76; 9.78)	36.778 **	82.438 **	7.041 *
Hormonal treatment (b)	11	3.274 ** (1.95; 2.55)	7.739 **	4.946 **	2.796 **
Variety (a) * Hormonal treatment (b)	33	2.244 ** (1.60; 1.84)	2.319 **	1.778*	1.56 ns

df, degrees of freedom.
*Significant at the 0.05 probability level.
**Significant at the 0.01 probability level.
ns Not significant at the 0.05 probability level

Table 3. The variety influence on studied parameters under the effect of two auxins in culture medium

Variety	Leaves number	Diff. / Sign.	Plantlets height (cm)	Diff. (cm) / Sign.	Root length (cm)	Diff. (cm) / Sign.	Number of internodes	Diff. / Sign.
Azaria (a ₁)	7.22 A	0.11 ns	6.14 B	-3.58 ^{ooo}	2.86 C	0.09 ns	4.22 B	-0.75
Braşovia (a ₂)	7.50 A	0.39 ns	10.86 A	1.14 ns	4.61 B	1.85 ***	5.11 A	0.14
Cosiana (a ₃)	8.36 A	1.25 *	10.39 A	0.67 ns	5.14 A	2.38 ***	5.53 A	0.56
Cezarina (Ct) a ₄	7.11 A	-	9.72 A	-	2.76 C	-	4.97 A	-

LSD (p 5%) = 0.84; (p 1%) = 1.27; (p 0.1%) = 2.04.
 LSD (p 5%) = 1.23; (p 1%) = 1.86; (p 0.1%) = 2.99.
 LSD (p 5%) = 0.46; (p 1%) = 0.70; (p 0.1%) = 1.13.
 LSD (p 5%) = 0.71; (p 1%) = 1.08; (p 0.1%) = 1.73.

Table 4. The influence of hormonal treatment applied on the studied parameters

Hormonal treatment applied (mg/l)		Leaves number	Diff. / Sign.	Plantlets height (cm)	Diff. (cm) / Sign.	Root length (cm)	Diff. (cm) / Sign.	Number of internodes	Diff. / Sign.
NAA	IBA								
10	0 (Ct) b ₁	6.75 CD	-	6.33 G	-	2.53 F	-	4.08 CD	-
	0.25 b ₂	6.25 D	-0.50 ns	7.75 FG	1.42 ns	2.76 EF	0.23 ns	4.00 D	-0.08 ns
	0.5 b ₃	7.92 ABC	1.17 ns	9.00 CDEF	2.67 ***	3.83 BCDE	1.31 *	5.08 ABCD	1.00 *
	1 b ₄	7.17 BCD	0.42 ns	9.13 CDEF	2.79 ***	3.21 DEF	0.68 ns	5.00 ABCD	0.92 ns
00.25	0 b ₅	8.42 AB	1.67 **	9.71 BCDE	3.38 ***	4.08 BCD	1.56 **	5.00 ABCD	0.92 ns
	0.25 b ₆	7.42 BCD	0.67 ns	8.71 DEF	2.38 **	3.29 DEF	0.77 ns	4.58 CD	0.50 ns
	0.5 b ₇	8.00 ABC	1.25 *	11.46 A	5.13 ***	5.29 A	2.77 ***	5.17 ABC	1.08 *
	1 b ₈	7.08 BCD	0.33 ns	10.54 ABC	4.21 ***	4.83 AB	2.31 ***	5.17 ABC	1.08 *
00.5	0 b ₉	9.00 A	2.25 ***	10.92 AB	4.58 ***	4.79 ABC	2.27 ***	5.92 A	1.83 ***
	0.25 b ₁₀	6.92 CD	0.17 ns	8.08 EF	1.75 *	3.59 CDEF	1.07 ns	4.67 BCD	0.58 ns
	0.5 b ₁₁	8.00 ABC	1.25 *	10.33 ABCD	4.00 ***	4.17 ABCD	1.64 **	5.75 AB	1.67 ***
	1 b ₁₂	7.67 ABC	0.92 ns	9.38 BCDEF	3.04 ***	3.75 BCDE	1.23 *	5.08 ABCD	1.00 *

LSD (p 5%) = 1.20; (p 1%) = 1.58; (p 0.1%) = 2.05.
 LSD (p 5%) = 1.47; (p 1%) = 1.94; (p 0.1%) = 2.51.
 LSD (p 5%) = 1.07; (p 1%) = 1.41; (p 0.1%) = 1.83.
 LSD (p 5%) = 0.96; (p 1%) = 1.27; (p 0.1%) = 1.64.

Means of each parameter designated by the same letter are not significantly different at 5% level using Duncan's Multiple Range Test.

When examining the combined influence of variety and hormonal treatment, it can be seen that the difference of 6 leaves (Table 5) for the 0.5 mg NAA:0 mg IBA combination, compared to the control, is very significant and positive for Azaria variety. For Braşovia variety, there were no significant differences for the hormonal combinations compared to the hormonal variant considered as a control, regarding leaves number. For varieties Cosiana and Cezarina, combination 0.25 mg NAA:0 mg IBA and respectively 0.5 mg NAA:0.5 mg IBA led to obtaining positive, distinctly significant and significant differences in leaves number, compared to the control (4 and 2.67 leaves). For Azaria, Braşovia and Cezarina varieties, higher values (10.50, 14.17 and 14 cm) of microplants height (Table 6), with very significant positive differences compared to the control (7.83, 6.17 and 6.83 cm), were obtained for the following hormonal variants: 0.25 mg NAA:1 mg IBA, 0.25 mg NAA:0.5 mg IBA, 0.5

mg NAA:0 mg IBA. For Cosiana variety, 0.25 mg NAA:0 mg IBA combination showed a beneficial effect on microplants height (11.67 cm), with a distinctly significant positive difference (4.17 cm).

The growth regulators 0.25 mg NAA:0.5 mg IBA variant showed a strong beneficial effect on the root system (Table 7) for Cosiana and Braşovia varieties (7.17 and 6.83 cm) with distinctly significant and very significant differences compared to control (3 and 4.33 cm). For Azaria variety, the most beneficial hormonal treatment was 0.25 mg NAA: 1 mg IBA, determining the highest microplant root value (5.33 cm), with a highly significant positive difference compared to the control treatment (5.23 cm). For the Cezarina variety there were no significant differences, for treatments applied.

Regarding the internodes number (Table 8), the most pronounced effect for Azaria variety, in obtaining high values (5.67) showed the

combinations: 0 mg NAA-0.5 mg IBA and 0.25 mg NAA:1 mg IBA. For the Cezarina variety, the highest internodes number (7.33) was recorded for 0.5 mg NAA - 0.5 mg IBA.

Braşovia and Cosiana varieties did not show significant differences in the hormonal variants compared to the control variant.

Table 5. Combined influence of cultivar and hormone treatment on leaf number

Variety/Hormonal treatment applied (mg/l)		Azaria (a ₁)		Braşovia (a ₂)		Cosiana (a ₃)		Cezarina (a ₄) (Ct)		a ₁ -a ₄	a ₂ -a ₄	a ₃ -a ₄
NAA	IBA	Leaves number	Diff. / Sign.	Leaves number	Diff. / Sign.	Leaves number	Diff. / Sign.	Leaves number	Diff. / Sign.			
0	0 (Ct)	4.33	-	7.33	-	8.33	0.00	7.00	-	-2.67 o	0.33 ns	1.33 ns
	0.25	4.67	0.33 ns	6.00	-1.33 ns	7.67	-0.67 ns	6.67	0.33 ns	-2.00 ns	-0.67 ns	1.00 ns
	0.5	9.00	4.67 ***	8.00	0.67 ns	7.67	-0.67 ns	7.00	0.00 ns	2.00 ns	1.00 ns	0.67 ns
	1	7.00	2.67 *	8.00	0.67 ns	7.67	-0.67 ns	6.00	-1.00 ns	1.00 ns	2.00 ns	1.67 ns
0.25	0	6.67	2.33 ns	7.33	0.00 ns	12.33	4.00 **	7.33	0.33 ns	-0.67 ns	0.00 ns	5.00 ***
	0.25	6.67	2.33 ns	8.00	0.67 ns	8.33	0.00 ns	6.67	-0.33 ns	0.00 ns	1.33 ns	1.67 ns
	0.5	8.67	4.33 ***	8.67	1.33 ns	8.67	0.33 ns	6.00	-1.00 ns	2.67 *	2.67 *	2.67 *
	1	7.00	2.67 *	6.00	-1.33 ns	8.33	0.00 ns	7.00	0.00 ns	0.00 ns	-1.00 ns	1.33 ns
0.5	0	10.33	6.00 ***	7.33	0.00	9.00	0.67 ns	9.33	2.33 ns	1.00 ns	-2.00 ns	-0.33 ns
	0.25	6.33	2.00 ns	7.67	0.33 ns	7.00	-1.33 ns	6.67	-0.33 ns	-0.33 ns	1.00 ns	0.33 ns
	0.5	6.67	2.33 ns	7.67	0.33 ns	8.00	-0.33 ns	9.67	2.67 *	-3.00 o	-2.00 ns	-1.67 ns
	1	9.33	5.00 ***	8.00	0.67 ns	7.33	-1.00 ns	6.00	-1.00 ns	3.33 **	2.00 ns	1.33 ns

LSD (p 5%) = 2.39;
(p 1%) = 3.17;
(p 0.1%) = 4.09.

LSD (p 5%) = 2.44;
(p 1%) = 3.27;
(p 0.1%) = 4.34.

Table 6. Combined influence of cultivar and hormone treatment on plantlets height (cm)

Variety/Hormonal treatment applied (mg/l)		Azaria (a ₁)		Braşovia(a ₂)		Cosiana (a ₃)		Cezarina (a ₄) (Ct)		a ₁ -a ₄	a ₂ -a ₄	a ₃ -a ₄
NAA	IBA	Plantlets height (cm)	Diff. (cm) / Sign.	Plantlets height (cm)	Diff. (cm) / Sign.	Plantlets height (cm)	Diff. (cm) / Sign.	Plantlets height (cm)	Diff. (cm) / Sign.			
0	0 (Ct)	2.67	-	8.00	0.00	7.50	-	7.17	-	-4.50 ^{oo}	0.83 ns	0.33 ns
	0.25	2.33	-0.33 ns	9.50	1.50 ns	11.33	3.83 *	7.83	0.67 ns	-5.50 ^{oo}	1.67 ns	3.50 *
	0.5	6.00	3.33 *	11.33	3.33 *	9.67	2.17 ns	9.00	1.83 ns	-3.00 ns	2.33 ns	0.67 ns
	1	5.33	2.67 ns	11.17	3.17 *	10.67	3.17 *	9.33	2.17 ns	-4.00 ^o	1.83 ns	1.33 ns
0.25	0	4.83	2.17 ns	11.83	3.83 *	11.67	4.17 **	10.50	3.33 *	-5.67 ^{ooo}	1.33 ns	1.17 ns
	0.25	4.00	1.33 ns	11.50	3.50 *	9.33	1.83 ns	10.00	2.83 ns	-6.00 ^{ooo}	1.50 ns	-0.67 ns
	0.5	9.50	6.83 ***	14.17	6.17 ***	11.00	3.50	11.17	4.00**	-1.67 ns	3.00 ns	-0.17 ns
	1	10.50	7.83 ***	12.17	4.17 **	10.83	3.33 *	8.67	1.50 ns	3.50 *	2.17 ns	
0.5	0	7.83	5.17 ***	11.33	3.33 *	10.50	3.00*	14.00	6.83 ***	-6.17 ^{ooo}	-2.67 ns	-3.50 ^o
	0.25	5.00	2.33 ns	8.33	0.33 ns	10.67	3.17 *	8.33	1.17 ns	-3.33 ^o	0.00 ns	2.33 ns
	0.5	6.50	3.83 *	11.00	3.00 *	10.50	3.00 *	13.33	6.17 ***	-6.83 ^{ooo}	-2.33 ns	-2.873 ns
	1	9.17	6.50 ***	10.00	2.00 ns	11.00	3.50 *	7.33	0.17	1.83 ns	2.67 ns	3.67 *

LSD (p 5%) = 2.94;
LSD (p 1%) = 3.89;
LSD (p 0.1%) = 5.02.

LSD (p 5%) = 3.06;
LSD (p 1%) = 4.13,
LSD (p 0.1%) = 5.53.

Table 7. Combined influence of cultivar and hormone treatment on root length (cm)

Variety/Hormonal treatment applied (mg/l)		Azaria (a ₁)		Braşovia(a ₂)		Cosiana (a ₃)		Cezarina (a ₄) (Ct)		a ₁ -a ₄	a ₂ -a ₄	a ₃ -a ₄
		Root length (cm)	Diff. (cm) / Sign.	Root length (cm)	Diff. (cm) / Sign.	Root length (cm)	Diff. (cm) / Sign.	Root length (cm)	Diff. (cm) / Sign.			
NAA	IBA											
0	0 (Ct)	0.10	-	2.50	-	4.17	-	3.33	-	-3.23 oo	-0.83 ns	0.83 ns
	0.25	0.83	0.73 ns	3.53	1.03 ns	5.17	1.00 ns	1.50	-1.83 ns	-0.67 ns	2.03 ns	3.67 ***
	0.5	3.33	3.23 **	4.00	1.50 ns	4.00	-0.17 ns	4.00	0.67 ns	-0.67 ns	0.00 ns	0.00 ns
	1	3.17	3.07 **	3.67	1.17 ns	3.67	-0.50 ns	2.33	-1.00 ns	0.83 ns	1.33 ns	1.33 ns
0.25	0	2.17	2.07 ns	5.17	2.67 *	5.83	1.67 ns	3.17	-0.17 ns	-1.00 ns	2.00 ns	2.67 *
	0.25	1.50	1.40 ns	5.17	2.67 *	4.17	0.00 ns	2.33	-1.00 ns	-0.83 ns	2.83 **	1.83 ns
	0.5	4.67	4.57 ***	6.83	4.33 ***	7.17	3.00 **	2.50	-0.83 ns	2.17 *	4.33 ***	4.67 ***
	1	5.33	5.23 ***	4.17	1.67 ns	7.00	2.83 **	2.83	-0.50 ns	2.50 *	1.33 ns	4.17 ***
0.5	0	3.83	3.73 ***	5.33	2.83 **	6.67	2.50 *	3.33	0.00 ns	0.50 ns	2.00 ns	3.33 **
	0.25	1.70	1.60 ns	4.83	2.33 *	4.67	0.50 ns	3.17	-0.17 ns	-1.47 ns	1.67 ns	1.50 ns
	0.5	3.33	3.23 **	5.50	3.00 **	5.33	1.17 ns	2.50	-0.83 ns	0.83 ns	3.00 **	2.83 **
	1	4.33	4.23 ***	4.67	2.17 *	3.83	-0.33 ns	2.17	-1.17 ns	2.17 *	2.50 *	1.67 ns

LSD (p 5%) = 2.14;
LSD (p 1%) = 2.82;
LSD (p 0.1%) = 3.65.

LSD (p 5%) = 2.09;
LSD (p 1%) = 2.79;
LSD (p 0.1%) = 3.64.

Table 8. The combined influence of variety and hormone treatment on the number of internodes

Variety/Hormonal treatment applied (mg/l)		Azaria (a ₁)		Braşovia(a ₂)		Cosiana (a ₃)		Cezarina (a ₄) (Ct)		a ₁ -a ₄	a ₂ -a ₄	a ₃ -a ₄
		Number of internodes	Diff. / Sign.	Number of internodes	Diff. / Sign.	Number of internodes	Diff. / Sign.	Number of internodes	Diff. / Sign.			
NAA	IBA											
0	0 (Ct)	1.67	-	5.00	-	5.67	-	4.00	0.00	-2.33 o	1.00 ns	1.67 ns
	0.25	2.00	0.33 ns	3.67	-1.33 ns	5.33	-0.33 ns	5.00	1.00 ns	-3.00 oo	-1.33 ns	0.33 ns
	0.5	5.67	4.00 ***	5.33	0.33 ns	4.67	-1.00 ns	4.67	0.67 ns	1.00 ns	0.67 ns	0.00 ns
	1	4.33	2.67 **	5.67	0.67 ns	5.33	-0.33 ns	4.67	0.67 ns	-0.33 ns	1.00 ns	0.67 ns
0.25	0	3.67	2.00 *	5.00	0.00 ns	7.00	1.33 ns	4.33	0.33 ns	-0.67 ns	1.00 ns	2.67 **
	0.25	4.00	2.33 *	5.33	0.33 ns	4.67	-1.00 ns	4.33	0.33 ns	-0.33 ns	1.00 ns	0.33 ns
	0.5	5.00	3.33 ***	5.33	0.33 ns	6.00	0.33 ns	4.33	0.33 ns	0.67 ns	1.00 ns	1.67 ns
	1	5.67	4.00 ***	4.67	-0.33 ns	5.33	-0.33 ns	5.00	1.00 ns	0.67 ns	-0.33 ns	0.33 ns
0.5	0	5.33	3.67 ***	6.00	1.00 ns	5.67	0.00 ns	6.67	2.67 **	-1.33 ns	-0.67 ns	-1.00 ns
	0.25	3.67	2.00 *	5.00	0.00 ns	5.00	-0.67 ns	5.00	1.00 ns	-1.33 ns	0.00 ns	0.00 ns
	0.5	4.67	3.00 **	5.00	0.00 ns	6.00	0.33 ns	7.33	3.33 ***	-2.67 oo	-2.33 o	-1.33 ns
	1	5.00	3.33 ***	5.33	0.33 ns	5.67	0.00 ns	4.33	0.33 ns	0.67 ns	1.00 ns	1.33 ns

LSD (p 5%) = 1.92;
LSD (p 1%) = 2.54;
LSD (p 0.1%) = 3.28.

LSD (p 5%) = 1.97;
LSD (p 1%) = 2.64;
LSD (p 0.1%) = 3.52.

CONCLUSIONS

Each growth regulator and each of its concentrations presented its own effect on *in vitro* regeneration.

The development potential of the micropropagated plantlets was dependent on the genotype.

In this study, Braşovia variety stood out with the highest average value of plant height (10.86 cm), followed by Cosiana variety (10.39 cm); for the other analysed parameters (number of leaves, root length and number of internodes), Cosiana variety records the highest values (leaves: 8.36; root length: 5.14 cm; internodes

number: 5.53), followed by the Braşovia variety (leaves 7.50; root length: 4.61 cm; internodes number: 5.11 cm).

The treatment composed of 0.5 mg/l NAA:0 mg/l IBA was beneficial in obtaining a high number of leaves (9.00), followed by the combination 0.25 mg/l NAA:0 mg/l IBA, which resulted in 8.42 leaves.

The hormonal treatment applied with 0.25 mg/l NAA:0.5 mg/l IBA was favourable for plantlets growth (11.46 cm), followed by the combination of hormonal regulators NAA: IBA 0.5:0.0 mg/l, which determined the height evolution of microplants (10.92 cm).

NAA - IBA treatments of: 0.25-0.5 mg/l; 0.25-1 mg/l and 0.5-0.0 mg/l led to obtaining higher values of root length (5.29, 4.83 and 4.79 cm). The combination 0.5:0.0 mg/l NAA: IBA was conducive to achieving a high number of internodes (5.92 internodes), followed by the combination 0.5: 0.5 mg/l (5.75 internodes). The treatment composed of 0.5 mg/l NAA - 0 mg/l IBA was beneficial in obtaining a high number of leaves (9.00); the hormonal treatment applied with 0.25 mg/l NAA - 0.5 mg/l IBA was favourable for plantlets growth (11.46 cm); NAA - IBA treatments of: 0.25- 0.5 mg/l; 0.25-1 mg/l and 0.5-0.0 mg/l led to obtaining higher values of root length (5.29, 4.83 and 4.79 cm); combination 0.5 - 0.0 mg/l NAA - IBA was conducive to achieving a high number of internodes (5.92 internodes).

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