UDC: 06:582.711.713:628.93

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INFLUENCE OF LIGHT ON THE DETERMINATION OF RHIZOGENESIS OF ALMOND PLANTS *IN VITRO*

An evolutionary connection has developed between the quantity and quality of light and plant ontogenesis. It has been established that for the determination of rhizogenesis in almond regenerants (Georgia variety), the optimal light intensity is 3.7 and 4.4 kLux under increased hormone levels (BAP 0.25 + IBA 1.0). An increase in the duration of illumination delayed the initiation of root formation. The optimal photoperiod is 16 hours per day.

Key words: hormonal background, light intensity, callus, root formation, photoperiod.

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ВПЛИВ СВІТЛА НА ДЕТЕРМІНАЦІЮ РИЗОГЕНЕЗУ РОСЛИН МИГДАЛЮ *IN VITRO*

Еволюційно сформувався зв'язок між кількістю, якістю світла та онтогенезом рослини. Встановлено, що для детермінації ризогенезу регенерантів мигдалю (сорт Джорджія) оптимально застосовувати інтенсивність освітлення 3,7 та 4,4 kLux за підвищеного вмісту гормонів (БАП 0,25 + ІМК 1,0). Збільшення тривалості освітлення затримувало старт формування коренів. Оптимальним фотоперіодом є 16 годин на добу.

Ключові слова: гормональний фон, інтенсивність освітлення, калюс, формування коренів, фотоперіод.

Most of their life cycle, plants function as autotrophs, synthesizing the biomolecules of their bodies from inorganic compounds using light energy. Evolutionarily, a relationship has been established between the quantity and quality of light and plant ontogenesis [1-3].

In in vitro culture with mixotrophic nutrition, where the heterotrophic mode of nutrition predominates, the role of light as an energy source for biosynthesis is insignificant. However, light acts as a determinant fixed at the genomic level. It regulates both metabolic processes (synthesis of primary and secondary metabolites) and morphological changes [4, 5]. Specifically, the light spectrum can influence processes similarly to phytohormones. For example, a predominance of the red spectrum over the blue in a 4:1 ratio enhances apical dominance, similar to the effect of auxins [6].

Regenerants were grown under standard conditions [7]. We studied the features of rhizogenesis determination in almond regenerants (Georgia variety) under varying lighting parameters:

1. Light intensity;
2. Duration of illumination (photoperiod);
3. Ratio of red and blue spectra.

Light intensity influenced both the quantitative and qualitative nature of biochemical reactions and morphogenesis [1-3, 8]. The study of plant regeneration determination at the rhizogenesis stage was conducted at light intensities of 1.2, 1.8, 2.4, 2.9, 3.7, and 4.4 kLux with an allowable deviation of ±0.2 kLux, determined by the positioning of culture containers relative to the light sources. Different numbers of LEDs per unit area were used to create varying light intensity levels.

On the 45th day of cultivation, differences in the biometric parameters of regenerants were observed under two hormone combinations (BAP 0.1 + IBA 0.25; BAP 0.25 + IBA 1.0) at a lighting duration of 16 hours per day (Table 1).

Table 1 – **Morphogenesis features of almond (cv. Georgia) explants at the rhizogenesis stage under different light intensities on the 45th day of observations**

Parameter	Hormone Combination	Light Intensity, kLux					
		.2	.8	.4	.9	.7	4
Height of regenerants, mm	BAP 0.1 + IBA 0.25	6.4	9.0	01.6	23.2	36.6	7.2
	BAP 0.25 + IBA 1.0	9.1	7.4	4.6	78.6	85.3	6.4
Regenerants with roots, %	BAP 0.1 + IBA 0.25		1.4	3.1	8.6	3.4	.6
	BAP 0.25 + IBA 1.0		1.7	1.7	1.6	9.6	.1
Number of internodes, pcs	BAP 0.1 + IBA 0.25	.1	.3	.7	.9	.1	0
	BAP 0.25 + IBA 1.0	.6	.0	.2	.7	.1	2
Root length, mm	BAP 0.1 + IBA 0.25		4.7	9.2	7.4	1.2	.1
	BAP 0.25 + IBA 1.0			7.8	1.6	7.6	.4
Number of roots, pcs	BAP 0.1 + IBA 0.25		.9	.3	.7	.7	7
	BAP 0.25 + IBA 1.0		.1	.6	.1	.4	4
Callus formation at the base of shoots, %	BAP 0.1 + IBA 0.25	6	1	1	4	-	-
	BAP 0.25 + IBA 1.0	6	6	4	9	3	-

The height of in vitro regenerated plants, despite the presence of sucrose in the nutrient medium, depended on light intensity. As light intensity increased from 1.2 to 3.7 kLux, the height of regenerants also increased. The difference between the 3.7 and 4.4 kLux variants was within the error range (~5%). A similar trend was observed for the biometric parameter "number of internodes."

The best rhizogenesis results (in terms of root number and length) were obtained at light intensities of 3.7 and 4.4 kLux.

An analysis of the interaction between "hormone combination and light intensity" revealed the following pattern: at lower light intensities, higher biometric indicators were observed at lower hormone concentrations. At the same time, at 2.8, 3.7, and 4.4 kLux, greater shoot height and a more developed root system were observed with increased hormone content. High hormone concentrations at low light intensity led to callus formation at the basal part of the shoots.

The duration of the light day is associated with seasonal changes in nature, i.e., the alternation of warm and cold periods of the year [9]. This has led to the genetic fixation of plant ontogenesis features, including morphogenesis, which involves the formation of vegetative and generative organs and their tissues [8].

With a shorter photoperiod, developmental processes are activated in contrast to growth processes. Accumulation of reserve substances occurs, protective tissues develop more intensively, and the formation of organs and buds accelerates, although they remain smaller in

size [6].

We studied the morphogenesis features, including root formation, under illumination conditions with an intensity of 2.9 ± 0.2 kLux at different photoperiod durations: 8, 12, 16, 20, and 24 hours per day with BAP 0.100 and IBA 0.250 mg/L (Table 2).

Table 2 – **Morphogenesis features of almond regenerants (cv. Georgia) in vitro under different photoperiod durations on the 45th day of observations**

Parameter	Photoperiod, hours per day				
	8	12	16	20	24
Regenerant mass, g	0.347	0.562	1.237	1.611	1.892
Root mass, g	0.094	0.117	0.413	0.502	0.519
Onset of rhizogenesis, days	27.2	20.2	20.4	23.6	36.4

The ratio of regenerant mass to root system mass remained close to 3:1 regardless of photoperiod duration. The onset of rhizogenesis at photoperiods from 12 to 24 hours slowed down from 20.2 to 36.4 days, meaning that increasing light duration delayed root formation. In other words, growth processes prevailed over development, as evidenced by the increase in regenerant mass.

Meanwhile, at the shortest photoperiod of 8 hours per day, root formation began later (on the 27.2nd day) compared to variants with lighting durations of 12, 16, and 20 hours per day. We believe that the optimal photoperiod is 16 hours per day.

Therefore, for the determination of rhizogenesis in vitro of almond regenerants (Georgia variety) on a medium with an increased content of hormones (BAP 0.25 + IMC 1.0), it is optimal to use lighting with an intensity of 3.7 and 4.4 kLux with a photoperiod of 16 hours per day.

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