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A comparative study of the effect of plant part source and growth regulator in tissue culture propagation of date palm (*Phoenix dactylifera* L.) cultivar Barhi

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I. Abstract:

This research was conducted in the Tissue Culture Laboratory, College of Science, University of Basrah, from March 2024 to October 2025, to investigate the effect of plant part source (apical bud, flower bud) and treatment with the growth regulator dimethylallylamino purine (2ip) at four concentrations (0.5, 1, 2, and 3 mg L^{-1}) added to the medium of both the terminal bud and the flower parts cultured separately. The results showed that the treatment with the plant part source (flower bud) and the cytokinin (2ip) treatment at concentrations of 0.5 and 1 mg L^{-1} were significantly superior in recording the highest values for the studied traits (percentage of initial callus induction, time required for embryonic callus appearance, fresh and dry weight of embryonic callus, time required for embryo emergence, and number of embryos), the embryos (as measured by treatment with the terminal bud and cytokinin (2ip) at a concentration of 3 $mg.L^{-1}$) showed the lowest values for the traits studied above. The interaction between the two study factors had a significant effect on most of the studied traits.

Keywords: callus, embryos, dry weight, cytokinin, flower bud

II. Introduction

Date palms grow in various tropical and subtropical regions, particularly in North Africa, the Middle East, and South Asia. Intensive cultivation is concentrated between latitudes 10° and 35° north of the equator, extending from the Indus River basin in Pakistan to the Canary Islands, climatic factors significantly influence palm growth and date production. Palms achieve good yields in environments with high temperatures, low humidity, and no rainfall during the fruiting period (Fernandez-Lopez et al., 2022). In Iraq, date palm cultivation is limited to the area between Mandali and Tikrit districts at latitude 35° north and the city of Faw at latitude 30° south. It is widely cultivated in most Iraqi governorates (Ibrahim, 2019). Date palms are tolerant of arid and semi-arid environmental conditions, including high temperatures, limited water resources, and soil salinity.

The concept of plant tissue culture is the growth of different plant cells or tissues in glass or plastic containers containing artificial nutrient media consisting of the nutrients needed by the plant under completely sterile conditions in controlled environmental conditions (Qabil, 2015). Micropropagation (tissue culture) is defined as the process of taking a section of living plant tissue and culturing it on an artificial medium containing a group of chemicals that promote growth by increasing the number of cells until the various plant parts are formed (Al-Mayahi, 2019a). Others define it as the science concerned with cultivating plant cells, tissues, or organs separated from the parent plant under pathogen-free conditions, sterilizing them, and culturing them in sterile

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artificial nutrient media. The cultured part is then incubated under controlled conditions of temperature, light, and humidity, followed by the development of the cultured part towards the desired outcome (Smith, 2013). Tissue culture technology has proven its efficiency in terms of the large number and uniformity of plants produced within a short period, as well as their genetic compatibility with the parent plant from which they were taken and their freedom from pathogens and insects. Furthermore, it allows for year-round plant propagation. For these reasons, the focus is on tissue culture propagation techniques (Alwael *et al*., 2017 , Ribeiro *et al*., 2020). Plant tissue culture has become increasingly important as one of the most important techniques used in plant propagation and improvement, both quantitatively and qualitatively, because it is considered a tool for the large-scale cultivation of plant cells. It is used in plant propagation and improvement, both quantitatively and qualitatively, because it is a tool for large-scale, year-round plant cell culture. Furthermore, it has provided multiple opportunities for the continuous production of secondary metabolites without being restricted to a specific season (AL-Amery *et al*., 2023). The propagation of date palms through tissue culture offers numerous advantages, particularly for high-quality varieties characterized by a low number of offshoots and high prices. It also provides suitable plant parts for propagation, regardless of the propagation method used, whether somatic embryogenesis or direct organogenesis (Zayed, 2017). Offshoot production from the mother palm is limited to a specific period representing the vegetative stage, not exceeding the first 15 years of its life. Therefore, some rare and unique varieties may exceed the age limit for offshoot production, and there is no method to propagate and preserve them from extinction (Zayed & Wet, 2002). Based on this, some researchers have considered utilizing other plant parts that do not harm the mother palm. Attention has turned to cultivating flower stalks as a more suitable and preferable method, since using these parts does not harm the palm or the offshoot, which is a significant advantage. This is of paramount importance from an applied and practical standpoint (Khairallah, 2007). Furthermore, flower buds contain high concentrations of natural plant hormones such as auxins, cytokinins, and gibberellins.

This group of organic compounds is termed natural hormone regulators. It includes compounds naturally produced in plants and compounds synthesized in laboratories outside the plant, known as synthetic growth regulators. These synthetic growth regulators are present in very low concentrations to stimulate, inhibit, or modify the physiological, vital, and morphological processes necessary for plant growth, development, and production (Al-Khafaji, 2014). They are classified into auxins, cytokinins, gibberellins, ethylene, and abscessic acid. Growth regulators play a role in promoting the growth, emergence, differentiation, and organogenesis of plant cells in plant tissue cultures (Al-Sumaida'i, 2017). Izabela *et al*. (2020) explained that plant hormones play an important role in physiological and biological processes, as well as in secondary and therapeutic compounds. They also noted that media containing cytokinins are considered alternative sources of biologically active compounds. This is a multi-step process largely controlled by the balance between auxins and cytokinins, and that plant growth regulators may play antagonistic or synergistic roles (Bharati *et al*., 2022; Zhao *et al*., 2021). Mohsen (2007) found that, using different apical parts (apical bud, axillary bud, subapical tissue, primary leaves, and flower bud) of the Sharifi date palm cultivar, the flower buds were superior in the time required for callus formation and the percentage of plant parts that formed callus. The flower buds also had the superior time required for the emergence of cylindrical embryos. In a study by Ta'imah (2025) using callus produced from the inflorescences of the Barhi date palm cultivar grown on three different nutrient media supplemented with two types of cytokinins, zeatin and 2iP, each at four concentrations (0, 0.5, 1, and 2 $mg.L^{-1}$), the results showed that the highest fresh and dry weight of the embryonic callus was obtained in MS medium supplemented with the cytokinin 2iP at a concentration of 0.5 $mg.L^{-1}$, achieving the shortest period for inducing embryonic callus and embryo emergence. Given that the Barhi variety is a local and desirable variety, and due to the low production of offshoots, and in order to preserve the number of offshoots due to their scarcity, its flowering parts were

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taken and cultured, and to compare them with the terminal buds and to show the best results for the studied traits, and due to the scarcity of studies on those comparisons of plant parts, in order to obtain the plant part and the optimal concentration of the growth regulator cytokinin for the purpose of using them and continuing their use by way of tissue propagation, this research was conducted.

III. Materials and Methods

This research was conducted in the Tissue Culture Laboratory, College of Science, University of Basrah, from March 2024 to October 2025.

1 - Removal and Sterilization of Plant Parts:

Date palm offshoots of the Barhi cultivar, aged (4-5) years, were obtained from orchards in Abu Al-Khasib district, Basrah Governorate, the offshoots were dissected progressively by gradually removing their leaves, upon reaching the area near the growing tip, the flower buds were removed. Upon reaching the growing tip, the apical bud and subapical tissue were removed. After pruning the plant parts (apical bud and flower buds), and dividing the apical bud into four equal sections (Matar, 1986), they were placed in an antioxidant solution consisting of 150 mg,L^{-1} citric acid and 100 mg.L^{-1} ascorbic acid.

it was kept in the refrigerator at a temperature of 4°C until the surface sterilization process was carried out. For the purpose of carrying out the sterilization process, the plant parts were extracted and washed with sterile distilled water, then placed in the sterilization solution consisting of sodium hypochlorite, concentration 20% v:v, with the addition of one drop of the surfactant (Tween20) per 100 cm^3 of the solution, with shaking and stirring for (15) minutes. The plant parts were then extracted and washed three times with sterile distilled water, this process was carried out inside a culture booth, the plant parts were then cultured on the surface of the nutrient medium in 2.5 x 18 cm tubes and incubated in a dark growth chamber at ± °C.

Preparation of the Specific Nutrient Medium for the Research:

The nutrient medium consisted of a group of inorganic salts (Murashige and Skoog, 1962), known as MS, modified by Jasim, 2000 (Table 1), with the following additives (Table 2). The addition of naphthaleneacetic acid (NAA) remained constant at a concentration of 5 mg.L^{-1} Dimethylallylamino purine (2ip) was added at four concentrations (0.5, 1, 2, and 3 mg.L^{-1}) to the medium of both the apical bud and the plant parts. Each culture was individually cultured and re-cultured every four weeks on the same MS medium with the same additives and cytokanin IP2 concentrations until initial callus induction. After 12 weeks, the percentage of callus induction was calculated using the following equation:

$$percentage\ of\ callus\ induction = \frac{\text{number of tubes in which callus appeared}}{\text{total number of tubes}} * 100$$

The Stage of Embryonic Callus Production

To induce embryonic callus from primary callus culture and subsequent embryo production, the following experiments were conducted:

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A- Effect of Plant Part Source and Cytokinin on Induction and Growth of Embryonic Callus

Primary callus formed after 12 weeks from the apical bud and flower parts was cultured on MS medium with the additives listed in Table 2, supplemented with auxin NAA at a concentration of 5 mg/L and cytokinin 2ip at four concentrations (0.5, 1, 2, and 3 mg.L^{-1}) separately in a factorial experiment to determine the appropriate plant part source and cytokinin concentration for inducing and growing embryonic callus in Barhi date palms. Culture was carried out in the laboratory's culture room within a laminar air flow cabinet sterilized by ultraviolet radiation and 70% ethanol, all culture instruments, including forceps and scalpels, were also sterilized using ethanol. At a concentration of 70%, the experiment involved culturing 100 mg of primary callus, five replicates were used for each treatment, and the cultures were incubated at a temperature of 27 ± 1°C and a light intensity of 1000 lux, with an average of 16 hours of light followed by 8 hours of darkness daily. Re-cultivation was performed every 4-6 weeks. The following characteristics were estimated in this experiment:

1 - Time required for embryonic callus formation (days):

The time required for embryonic callus formation (days) was calculated from daily observations.

2- Fresh weight of embryonic callus (g):

The fresh weight of embryonic callus was calculated after 60 days for each treatment

Using a small, sterile, sensitive balance inside a culture cabinet, model SF-400C, manufactured by HIGHTOP-IRAQ, at a rate of 5 tubes per concentration in the experiment.

3 - Dry weight of embryonic callus (g)

Embryonic callus samples were dried 60 days after the experiment for each of the four concentrations, using the plant part source (apical bud, flowering parts) and cytokine, in an electric oven at 70°C for 72 hours. The dry weight was then calculated at rest using a small, sensitive balance, model SF-400C, manufactured by HIGHTOP-IRAQ, at a rate of 5 tubes per concentration in the experiment.

B- Effect of Plant Part Source and Cytokinin on Stimulating Vegetative Embryo Formation:

After obtaining the embryonic callus in the previous experiment, the effect of the plant part source on MS medium and the additives listed in Table (2) was studied, as well as the use of the plant growth regulator cytokinin (2ip) at concentrations of (0.5, 1, 2, and 3) mg L^{-1} for each, in independent experiments supplemented with auxin (NAA) at a concentration of 5 mg L^{-1} in all treatments. Five replicates were used for each treatment, with a mass of embryonic callus being planted in each neighbor. The cultures were incubated at a temperature of 27 ± 1°C and a light intensity of 1000 lux, with an average of 16 hours of light followed by 8 hours of darkness daily, controlled by a timer. The culture was then repeated for 4-6 weeks. The most important characteristics studied during this experiment were:

1 - Calculating the Time Required for Vegetative Embryo Formation

The average time period for embryo formation was calculated by visually observing the embryos daily

2- Counting the number of vegetative embryos

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A random sample was taken and placed in a Petri dish, and the number of vegetative embryos was counted.

Table (1) Composition of MS culture medium on the basis of ($mg.L^{-1}$)

Name of the materia	**The concentration $mg.L^{-1}$**	**Name of the materia**	**The concentration $mg.L^{-1}$**
Ammonium nitrate NH_4NO_3	165	Copper sulfate $CuSO_4.5H_2O$	0.025
Calcium nitrate $Ca(No_3)4H_2O$		Sodium molybdate $NaMoO_4.2H_2O$	0.25
Potassium nitrate KNO_3	1900	Potassium iodide KI	0.83
Ammonium sulfate So_4NH_4		Zinc sulfate $ZnSO_4.7H_2O$	8.60
Potassium sulfate K_2SO4		Ferrous sulfate hydrate $FeSO_4.7H_2O$	27.84
Magnesium sulfate $MgSO_4.7H_2O$	370	Chelating agent in the form of disodium salt Na_2EDTA	36.7
Calcium chloride $CaCl_2.2H_2O$	440	Thiamin hydrochloric acid	0.5
Potassium phosphate KH_2PO4	170	Nicotinic acid	0.5
Sodium phosphate $NaH_2PO_4.H_2O$		Pyridoxine	0.5
Boric acid H_3BO_3	6.25	Glycine	2
Cobalt chloride $CoCl_2.6H_2O$	0.025	Myoinositol	100
Manganese sulfate $MnSO_4.H_2O$	22.30		

Table (2) Concentrations of materials added to the MS culture medium

Name of the material	Quantity $mg.L^{-1}$
Sucrose	3000
Sodium hydrogen ortho phosphates	170
Adenine sulphates	40
Riboflavin	1
amino acid glutamine	100
Activated charcoal	1000
Agar	6000

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Statistical Design:

The experiment was conducted as a two-factor factorial experiment using a completely randomized design (CRD). The first factor represented the type of plant part source (apical bud, flower bud), and the second factor was the growth regulator cytokinin 2ip at four concentrations (0.5, 1, 2, 3) mg L^{-1} with five replicates. The results were analyzed using the Genstat program, and the means were compared using the Least Significant Difference Test (LSD) at a probability level of 0.05 (Al-Rawi and Khalaf Allah, 2000).

IV. Results and Discussion:

Table (3) shows the effect of plant part type, cytokine 2ip, and their interactions on the percentage of callus induction, the results showed that the plant part (flower bud) significantly outperformed the callus induction percentage, reaching 50.95%, compared to the apical bud, which recorded 47.65%, the growth regulator cytokine 2ip at a concentration of 0.5 mg.L^{-1} also significantly outperformed the callus induction percentage, reaching 57.73%, which was not significantly different from the cytokine at a concentration of 1 mg.L^{-1}, which recorded 57.27%, the lowest percentage of callus induction was observed with the cytokine at a concentration of 3 mg.L^{-1}, reaching 37.08%. The interaction between the two study factors had a significant effect, with the treatment using the flower bud and the cytokine at a concentration of 0.5 mg/L being the most effective. The highest percentages were recorded at 59.63% compared to the treatment of apical bud interference with cytokinin at a concentration of 3 mg L^{-1}, where the lowest percentages were recorded at 36.04%.

Table (3) shows the effect of the plant part source and the growth regulator cytokinin on the percentage of callus induction of Barhi date palm cultivar %

Source of the plant part	Cytokinin concentrations 2ip(mg.L^{-1})				**Average effect of plant part**
	0.5	**1**	**2**	**3**	
Apical bud	55.83	55.65	43.08	36.04	47.65
flower bud	59.63	58.90	47.17	38.12	50.95
Average effect of cytokinin	57.73	57.27	45.12	37.08	
L.S.D	**Cytokinin**		**for interventions**		**plant part**
	2.91		**4.12**		**2.06**

Table (4) shows the effect of the plant part source and the growth regulator cytokinin 2ip, and the interactions between them, on the average time required for embryonic callus formation, the results showed that the treatment of the plant part source (flower bud) significantly reduced the number of days for embryonic callus formation to 42.30 days, while the treatment of the plant part source (apical bud) recorded the longest period for embryonic callus formation at 44 days. Treatment with the growth regulator cytokinin at a concentration of 1 mg.L^{-1} significantly reduced the number of days for embryonic callus formation to 39.43 days, compared to the treatment with cytokinin at a concentration of 3 mg.L^{-1}, which recorded a period of 47.09 days for embryonic callus formation. The interaction between the two study factors had a significant effect, the interaction treatment of the flower bud with cytokinin at a concentration of 1 mg.L^{-1} resulted in the shortest number of days for embryonic callus formation, at 38.41 days, while the highest number of days for embryonic callus formation was observed with the interaction treatment of the apical bud with cytokinin at a concentration of 3 mg.L^{-1}, at

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48.07 days. Tables 3 and 4 show that lower concentrations of the growth regulator cytokinin were more responsive in inducing primary and embryonic callus, this may be because higher concentrations lead to a decrease in the rate of cell division and development, it was also observed that adding growth regulators at concentrations higher than the optimum concentration to the culture medium affects the activity of enzymes responsible for cell wall synthesis and degradation, thus affecting the mechanical properties of the cell wall and influencing cell division and embryonic callus formation (Taiz and Zeiger, 2006).

Table (4) shows the effect of the source of the plant part and the growth regulator cytokinin on the period required for the appearance of embryonic callus in the date palm of the Barhi cultivar (day)

Source of the plant part	Cytokinin concentrations 2ip(mg.L^{-1})				**Average effect of plant part**
	0.5	**1**	**2**	**3**	
Apical bud	41.61	40.46	45.86	48.07	44.00
flower bud	40.35	38.41	44.32	46.11	42.30
Average effect of cytokinin	40.98	39.43	45.09	47.09	
L.S.D	**Cytokinin**		**for interventions**		**plant part**
	0.77		**1.09**		**0.54**

Table (5) shows a significant advantage for the plant part source (flower bud) in the callus fresh weight, recording the highest values of 1.72 g, compared to the plant part source (apical bud), which recorded 1.51 g, the cytokinin 2ip treatment at a concentration of 1 mg.L^{-1} was significantly superior, recording the highest callus fresh weight of 1.78 g, which did not differ significantly from the cytokinin treatment at a concentration of 0.5 mg.L^{-1}, compared to the cytokinin treatment at a concentration of 3 mg.L^{-1}, which recorded the lowest callus fresh weight of 1.44 g. The interaction between the two study factors had a significant effect, with the interaction treatment of the flower bud with cytokinin at a concentration of 1 mg.L^{-1} yielding the highest values at 1.93 g, while the lowest soft callus weight was recorded in the interaction treatment of the apical bud with cytokinin at a concentration of 3 mg/L, reaching 1.43 g.

Table (5) shows the effect of the plant part source and the growth regulator cytokinin on the fresh weight of embryonic callus of the Barhi date palm cultivar (gm).

Source of the plant part	Cytokinin concentrations 2ip(mg.L^{-1})				**Average effect of plant part**
	0.5	**1**	**2**	**3**	
Apical bud	1.49	1.64	1.51	1.43	1.51
flower bud	1.86	1.93	1.65	1.49	1.72
Average effect of cytokinin	1.67	1.78	1.58	1.44	
L.S.D	**Cytokinin**		**for interventions**		**plant part**
	0.185		**0.262**		**0.131**

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Table (6) indicates the effect of treatment with the plant part source and the growth regulator cytokinin 2ip, and the interactions between them, on the dry weight of the embryonic callus,the results in the table showed a significant advantage for the plant part source (flower bud) in the dry weight of the embryonic callus, recording the highest value of 0.074 g, compared to the apical bud treatment, which recorded 0.060 g, the cytokinin treatment at a concentration of 1 mg.L^{-1} was significantly superior, recording the highest dry weight of the embryonic callus at 0.074 g, while the cytokinin treatment at a concentration of 3 mg.L^{-1} recorded the lowest dry weight of the embryonic callus at 0.054 g, the cytokinin treatment at a concentration of 1 mg/L did not differ significantly from the treatments of 0.5 and 2 mg.L^{-1} in this characteristic. The interaction between the two factors had a significant effect, with the treatment of the flower bud with cytokinin at a concentration of 1 mg.L^{-1} significantly outperforming, recording the highest dry weight of the embryonic callus at 0.083 g, while the lowest dry weight of the embryonic callus was recorded from the interaction treatment of the apical bud with cytokinin at a concentration of 3 mg.L^{-1}, reaching 0.053 g. Therefore, the increase in the fresh and dry weight of the callus in Tables 5 and 6 reflects changes in the various contents of its cells, depending on its growth in the type of nutrient medium used and the type and concentration of added growth regulators. in general the process of callus cell division is accompanied by an increase in its important components for sustaining division and growth, such as proteins and amino acids, along with internal changes that lead to division, growth, and then specialization (Ta'ima, 2025)

Table (6) shows the effect of the plant part source and the growth regulator cytokinin on the dry weight of the embryonic callus of the date palm, Barhi cultivar (g)

Source of the plant part	Cytokinin concentrations 2ip(mg.L^{-1})				**Average effect of plant part**
	0.5	**1**	**2**	**3**	
Apical bud	0.060	0.066	0.063	0.053	0.60
flower bud	0.080	0.083	0.076	0.056	0.074
Average effect of cytokinin	0.070	0.074	0.069	0.054	
L.S.D	**Cytokinin**		**for interventions**		**plant part**
	0.012		**0.018**		**0.009**

Table (7) shows that the plant part source significantly reduces the number of days required for embryo emergence from the embryonic callus, the treatment with the plant part source (flower bud) significantly reduced the number of days required for vegetative embryo emergence to 33.69 days, compared to the treatment with the plant part source (apical bud), which recorded 35.07 days. Similarly, the treatment with the growth regulator cytokinin at a concentration of 0.5 mg.L^{-1} significantly reduced the number of days required for embryo emergence to 31.71 days, which did not differ significantly from the treatment with cytokinin at a concentration of 1 mg.L^{-1}, which recorded 32.11 days, compared to the treatment with cytokinin at a concentration of 3 mg/L, which recorded the highest number of days required for embryo emergence at 38.89 days. The interaction between the two factors had a significant effect, such that the treatment with the plant part source (flower bud) with cytokinin at a concentration of 0.5 mg.L^{-1} significantly reduced the embryo emergence period to 31.03 days, while the longest embryo emergence period was with the treatment with the plant part source (apical bud) and cytokinin at a concentration of 3 mg.L^{-1}, which reached 40.33 days.

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Table (7) shows the effect of the source of the plant part and the growth regulator cytokinin on the period required for the emergence of embryos in the date palm of the Barhi cultivar (day).

Source of the plant part	Cytokinin concentrations 2ip(mg.L^{-1})				**Average effect of plant part**
	0.5	**1**	**2**	**3**	
Apical bud	32.40	32.40	35.16	40.33	35.07
flower bud	31.03	31.83	34.46	37.46	33.69
Average effect of cytokinin	31.71	32.11	34.81	38.89	
L.S.D	**Cytokinin**		**for interventions**		**plant part**
	1.07		**1.52**		**0.76**

Table (8) shows the effect of the plant part source and the growth regulator cytokinin and the interactions between them on the number of embryos formed from the embryonic callus, the results showed that the plant part source (flower bud) was significantly superior in the number of embryos formed, reaching 7.09 embryos, compared to the apical bud, which recorded 6.67 embryos. Cytokinin at a concentration of 0.5 mg.L^{-1} was significantly superior, recording the highest number of embryos, reaching 7.48 embryos, which in turn did not differ significantly with the concentration of 1 mg.L^{-1}, which recorded 7.35 embryos, compared to the cytokinin treatment at a concentration of 3 mg.L^{-1}, which recorded the lowest number of embryos, reaching 5.88 embryos. The interaction between the two study factors had a significant effect, with the interaction treatment of the flower bud with cytokinin at a concentration of 0.5 mg.L^{-1} resulting in the highest number of embryos (7.86 embryos), while the interaction treatment of the apical bud with cytokinin at a concentration of 3 mg.L^{-1} resulted in the lowest number of embryos (5.66 embryos). The development of vegetative embryos occurs as a result of the reduction in cytokinin concentration due to the long culture period, or as a result of its consumption and diffusion in the cells of the growing tissue, or its adsorption by activated charcoal, after the growth regulator in the nutrient medium is exhausted, the development of spherical embryos occurs, with the cessation of division, their meristematic pole begins to divide and grow, accompanied by the rupture of the hard shell of the spherical embryo. Thus, the cotyledon elongates, and the cylindrical shape of the embryo appears (Mohsen, 2004). We conclude from this research that using the plant part source, the flowering parts or flower buds, and using growth regulators, especially cytokinins, at low concentrations, led to positive results, especially reducing the period required for the appearance of embryos and the number of vegetative embryos. This, in turn, positively impacts the production of plants with good characteristics.

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Table (8) shows the effect of the source of the plant part and the growth regulator cytokinin on the number of embryos of the Barhi date palm cultivar

Source of the plant part	Cytokinin concentrations 2ip(mg.L^{-1})				**Average effect of plant part**
	0.5	**1**	**2**	**3**	
Apical bud	7.10	7.16	6.76	5.66	**6.67**
flower bud	7.86	7.53	6.90	6.10	**7.09**
Average effect of cytokinin	7.48	7.35	6.83	5.88	
L.S.D	**Cytokinin**		**for interventions**		**plant part**
	0.553		**0.782**		**0.391**

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