P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating (2025): 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 8; Issue 10; October 2025; Page No. 109-115

Received: 18-08-2025
Accepted: 19-09-2025

Indexed Journal
Peer Reviewed Journal

The Effect of different concentrations of Indole Butyric Acid IBA on some growth and rooting characteristics of cuttings taken from the stem of the *thymus vulgaris* plant spread in Iraq.

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DOI: https://www.doi.org/10.33545/26180723.2025.v8.i10b.2519

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Abstract

The study was conducted during 2024 to determine the effect of Indole Butyric Acid (IBA) on rooting of three types of thyme spread naturally in Iraq, Kirkuk Governoratem, Hawija District, Suleiman Al-Gharb Village.

A stem cuttings of *Thymus vulgaris*, Thymus *citriodorus* and Thymus *serpyllum* were collected and treated with different concentrations of IBA (0, 250, 500, 750 and 1000 ppm) then they were planted under controlled conditions at the greenhouse. The root traits (rooting%, number of roots and length of roots), and shoot traits (length of main stem cm, number of shoots and length of shoots) were measured after two months of planting. The results were analyzed according to Randomized Completely Block Design with three replicates.

The treatments of IBA showed positive effect on all the studied trait as compared with the control, according to the concentration of IBA and the species studied. The concentration 500 ppm showed the best results over the studied species of thyme in terms of rooting percentage (83.67%), number of roots (141.86) and number of shoots (8.97), while the concentration of 250 ppm gave the highest root length (18.83 cm) and the main stem length (11.5 cm).

In general, these concentrations significantly surpassed the other concentrations. *T. serpyllum* showed the best root characteristics, while T. *vulgaris* had better shoot characteristics whereas *T. citriodourus* showed intermediate values between the two previous species.

Keywords: Iraq ,Thymus spp., IBA, Stem cutting ,Rooting percentage.

Introduction

Thymus is a small herbaceous plant with narrow leaves and small, fragrant flowers. It is found in many countries, including Iraq. Thyme is known for its pleasant taste and aroma, and has multiple uses in cooking and herbal medicine due to the active ingredients contained in it .(Al-Zubaidy, A. I. M., *et., al*., 2012) [3]. The thyme is a plant widespread in Iraq from the northern parts of Kurdistan to even central and southern regions. It is commonly found in pastures, and alpine-area growing conditions on Montagne (Saleh, N. A*. et., al*., 2019) [17].

The importance of thyme

1. Thyme Its use: Thyme dried leaves and flowers are firesses in traditional Iraqi spices and condiments. Thyme provides a robust and savory aromatic flavor to all types of food, while adding delicious taste to dishes (Al-Zubaidy, A. I. M., *et., al*., 2012) [3].
2. Medicinal use: Thyme is used as ancient medicinal plant for its potential benefit. It's thought that thyme is full of antioxidants and natural anti-inflammatory compounds, which may help promote a healthier immune system and aid in fighting off certain illnesses. It traditionally was used for digestive disturbances and against respiratory congestion, coughs and sore throat. (Al-Fatlawi, M. T., and Al-Bayati, A. S., 2012) [2].
3. Agriculture and economy: Thyme planting is able to provide an income source to improve the living conditions of Iraqi farmers. Native thyme can be sold or even exported outside the country, helping to revive local economies in regions surrounding where it is produced). Al-Fatlawi, M. T., and Al-Bayati, A. S., 2012) [2].

Types of Thymus can vary depending on various factors, including the specific species of thyme, environmental conditions, and the concentration of the hormone used (Zaller JG, *et al*., 2019) [19].

Indole butyric acid (IBA) is a plant hormone that is used to stimulate the root growth and increase the rate of successful rooting in many plants, including thyme. Applied to stem cuttings, IBA can promote the development of adventitious roots its presence is a requirement for the growth and propagation of thyme plant (Carús L, *et al*., 2015) [4].

Powder The standard method of applying IBA is to dip the base of a stem cutting into an IBA rooting solution at various concentrations. Some plants may require higher amounts of IBA, especially those that are difficult to root (Lucini L, *et al*., 2013) [11]. The influence of IBA on rooting and growth of thyme stem cuttings can be seen from the

analysis of parameters like percentage rooted cuttings, root length and shoot growth. Increased level of IBA may increase the success of rooting and increase the number of cuttings developing roots. But too high IBA concentration may bring negative influences, such as hormone toxic effect or impediment of root generation (Gonçalves S, *et al*., 2017) [6]. It should be mentioned that the most efficient concentration of IBA for Thymus spp. may differ depending on the species promoted. Experiments can be perfor- med and/or the scientific literature consulted to establish the correct concentration of IBA for individual Thymus spp. plants, and proper practices of hormone application and plant propagation principles (Esmaeili A, *et al*., 2011) [5].

The optimal concentration of indole butyric acid (IBA) for rooting thyme (*Thymus* spp.) plants can vary according to many factors such as the specific type of thyme, environmental conditions and rooting techniques used (Tahi, H. S., *et al*., 2013) [18].

Normally, different concentrations of IBA are applied for rooting thyme plants depending on the root ability of a particular cultivar and the results obtained in previous experiments. Concentrations vary from lower concentrations employed for easy rootable thyme to higher ones for difficult to root varieties (Mahajan, Y., *et al*., 2016) [12]. Some experiments suggest that IBA levels between 100 and 2,000 ppm can be used to root thyme plants. However, it is usually preferable to use concentrations in the range of 100 to 500 ppm (Mnayer, D., *et al.*, 2019) [14]. But the right concentration of IBA in IBA root stimulator for thyme may depend on many factors, such as cultivar, and growing and rooting conditions when it comes to a specific type of thyme. And it is suggested that the reasonable IBA concentra tion for Thymus spp. rooting should be determined from both experiments and published sci entific reports in future research. your.

The species studied are

In Iraq, there are different types of thyme plants that are widespread. Some common types in Iraq include:

1. **Common thyme (*Thymus vulgaris*):** This is the most common and well-known type of thyme herb used in cooking and herbal medicine. It is characterized by its small, opposite, erect leaves that release a distinctive aromatic scent when crushed (Al-Douri, N.A.N., 2010) [1].
2. **Lemon thyme (Thymus *citriodorus*):** Also known as lemon thyme or lemon thyme, it has an aromatic lemon scent. It is used in multiple fields such as cooking, herbal tea and perfumery (Al-Douri, N.A.N., 2010) [1].
3. **Wild thyme (Thymus *serpyllum*):** Also known as pink thyme, this is a small perennial with attractive pink flowers and small, reddish leaves. It is sometimes used in cooking and is preferred as an ornamental plant in gardens (Al-Douri, N.A.N., 2010) [1].

The effect of treating stem cuttings of was tested on three types of thyme; T. *serpyllum*, T. *capitatus* and T. *vulgaris* with a concentration (500 ppm) of the hormone indole butyric acid (IBA) in rooting and increasing vegetative growth rates compared to untreated cuttings. The study showed that IBA generally succeeded in increasing rooting rates and thus vegetative growth in cuttings of species treated with the hormone compared to the control. (Lapichino *et al*., 2006) [10].

Some scientists studied the effect of several concentrations of hormone) IBA and IAA)as follows: (0, 100, 200, 300, 1000, 2000,3000 ppm) on rooting cuttings of thyme type T. kotschyanus under greenhouse conditions, where he took readings related to the rooting rate, the length and number of roots, the dry weight of the root system, in addition to the number of vegetative buds formed on The stem, where the two concentrations of 100-300 ppm gave the best results compared to the other concentrations and the control, indicating a relative preference for IAA over IBA in the indicators studied (Henrique A., *et., al*., 2017) [8].

Karimi, *et al*. (2014) [9] studied the vegetative propagation of the thyme type T .satureioides ,using cuttings from different parts of the plant (basal cuttings and apical cuttings). The cuttings were collected at the height of the plant's growth period and cut to a length of 5-7 cm. The base of the cuttings was immersed for two minutes at three concentrations (100-250-500 ppm) of The hormone indole butyric acid (IBA) was added to the control, and it was planted in a specific soil mixture of turf and sand in a ratio of one-third to two-thirds, and at a temperature that ranged between 21-26 degrees, which is considered ideal for rooting. The final results were taken eight weeks after planting. It was found that there were low rooting rates in the basal cuttings, ranging between (11-26%) according to the concentration of the hormone used, compared to the rooting rate that ranged between (48-91%) for the apical cuttings, noting that the highest concentration of the hormone used was (500 ppm). It gave the best results for both types of users.

Objective and importance of the study

The research aims to compare different concentrations of the rooting hormone IBA and reach the best concentration for three types of thyme widespread in Iraq, which is Common thyme (*Thymus vulgaris*), Lemon thyme (Thymus *citriodorus*), Wild thyme (Thymus *serpyllum*). Thus to benefit from the results of the study whether in preserving the types of thyme studied or in producing seedlings for farmers with good qualities and in large numbers.

Research materials and methods

Plant material and the place where the research was carried out: Young stem cuttings were collected during the vegetative growth stage (before the plants entered the flowering stage) for three types of thyme spread in Iraq, Kirkuk Governoratem, Hawija District, Suleiman Al-Gharb Village. A stem cuttings of *Thymus vulgaris*, Tymus *citriodorus*, and Thymus *serpyllum*.

The research was carried out in 2024 during the months of (March, April and May), where the cuttings were collected from several plants belonging to each type of the mentioned sites at the end of the month of March and transported in wet burlap bags directly to the glass greenhouse, where the cuttings were prepared. They were planted immediately after being treated with the tested hormone concentration under controlled conditions (heat, humidity, and irrigation) .

Method of preparing the cuttings and treating them with hormones and cultivation: I took the terminal cuttings from the studied species with lengths that ranged between (5-7

cm), so that they contained 3 to 5 buds. The lower leaves were removed from the cuttings and the bases of the cuttings (1-2 cm) were immersed in the tested concentration of The hormone indole butyric acid, respectively (0, 250, 500, 750, 1000 ppm) for 5 seconds, then I planted the cuttings in a medium consisting of one-third of turf and two-thirds of sand in addition to a small amount of perlite in rows so that the distance between one plant and the other was 10 cm and between the rows. 20 cm in a glass greenhouse under controlled conditions with temperature (22-27°C) and humidity (72-75%) and regular irrigation .

3-Measurements taken: Observations about the growth and development of the cuttings were recorded on a weekly basis, and after eight weeks had passed since the start of the experiment, measurements related to the root and vegetative systems were recorded as follows:

- Total root: percentage of rooting (%), average number of roots (root/plant), and average root length (cm).
- Vegetative total: average number of vegetative branches, average length of vegetative branches (cm), and average length of the main stem (cm).

The factorial experiment was carried out using completely randomized blocks with 3 types and 5 concentrations of the IBA hormone, 3 replicates, and 15 cuttings per replicate, meaning 675 cuttings. The results were analyzed using the NTSYS statistical program and the averages were compared at a 5% significance level.

Results

The results showed a variation in the rooting rates of cuttings of the studied thyme species, in addition to the characteristics of the root and vegetative systems, according to the concentration of the hormone used on the one hand and the studied type of thyme on the other hand .

The effect of treatment with the IBA hormone on the rooting rate of cuttings of the studied thyme species:

The effect of treatment with the rooting hormone appeared clearly and positively in all the tested treatments of the thyme species studied, as it gave high percentages of rooting compared to the control (Table 1). With regard to the concentration of the rooting hormone used, the highest percentage of rooting appeared in cuttings of the type T. *serpyllum* for concccentration 500, and 750, 250, 1000 ppm, respectively (83.67%, 77.8, 73.9, 63.4%).

The results of the statistical analysis showed that at a value (LSD5%= 3.587) the tested concentrations exceed The 500 ppm concentration was significantly superior to the rest of the concentrations, followed by the 250, 750 and 1000 concentrations, respectively, noting that they all outperformed the control treatment (0 ppm). As for the rooting rates of the cuttings of the studied species, it was found that the highest values for the rooting rates and in all the tested concentrations appeared.

The *T.* species was followed by the *T. citriodorus* species, while the lowest values were in the T. vulgaris species. The difference in rooting rates between the three thyme species also appeared in the results of the statistical analysis, where the *T. serpyllum* species excelled at a value of (LSD 5%= 2.877). It was significantly superior to the other two types, and the *citriodorus* thyme was significantly superior to the T type. Vulgaris.

Table 1: Rooting percentage of cuttings of the studied Thyme species when treated with different concentrations of the growth regulator IBA

Average (Type)	concentrations of the hormonal solution					
	1000	**750**	**500**	**250**	**0**	**Type**
23.03 c	29.5 f	30.40 f	28.33 f	14.1 g	12.8 g	*T. vulgaris*
41.3 b	26.9 f	38.13 e	50.77 d	60.9 c	29.8 f	*T. citriodorus*
65.55 a	63.4 c	77.80 ab	83.67 a	73.9 b	28.7 f	*T. serpyllum*
43.29a	39.93 d	48.77 bc	54.256 a	49.63 b	23.7 e	Average (Concentration)
	2.877			Type		LSD 5%
	3.59			Concentration		
	6.21			Type and Concentration		

2-The effect of treatment with the IBA hormone on the average number of adventitious roots formed on the cuttings of the studied thyme species:

The average number of adventitious roots formed on the cuttings in the studied treatments varied according to the rooting hormone concentration and for the species studied (Table 2). The highest average number of roots (141.86) appeared in the 500 ppm concentration treatment for T. *serpyllum* cuttings, followed by the 250 ppm concentration for *T. citriodorus* (134.5).

While the lowest average number of roots on cuttings appeared in the control cuttings for the two species T. vulgaris and *T. citriodorus*, respectively (8.11 and 8.35).

The results of the statistical analysis showed that there were clear significant differences between all the tested concentrations with regard to the number of adventitious roots formed on the stem, where the 500 ppm treatment at a value of (LSD 5% = 12.66) outperformed the rest of the treatments that It also outperformed the control treatment by (250, 750, 1000 ppm).

As for the species studied, the cuttings of the T. *serpyllum* type gave the highest values for the average number of roots on the cutting at all the hormone concentrations tested compared to the cuttings of the other two species, with the exception of the concentration of 250 ppm for the *T. citriodorus* type, and the T type also excelled.

T citriodorus over *T. vulgaris* in the number of adventitious roots and for all concentrations tested except for focus 1000 ppm. Statistically, *T. serpyllum* outperformed the other two types at a value of (LSD5%= 9.81). *citriodorus* thyme also outperformed, significantly, over *T. vulgaris.*

Table 2: The Effect of Treatment with the hormone IBA on the average number of adventitious roots formed on the cuttings of the studied Thyme species:

Average (Type)	concentrations of the hormonal solution					
	1000	750	500 b	250	0	**Type**
36.00 c	40.50 ef	41.92 ef	70.85 cd	18.75 fg	8.11 g	T. *vulgaris*
62.5 b	28.83 efg	44.85 e	96.10 a	134.50 a	8.35 g	*T. citriodorus*
83.6 a	67.33 d	93.75 b	141.86 a	87.51 bcd	27.51 efg	T. *serpyllum*
60.7	45.553 d	60.173 c	102.93 a	80.25 b	14.65 e	Average (Concentration)
	9.81			Type		LSD 5%
	12.66			Concentration		
	21.93			Type and Concentration		

3- The effect of treatment with the IBA hormone on the average length of adventitious roots formed on the cuttings of the studied thyme species*:*

According to the results shown in Table (3), the average length of the roots formed on the cuttings in all treatments ranged between (3.6-18.8 cm). The lowest values were recorded for the average length of adventitious roots in the control plants compared to the cuttings treated with the rooting hormone, while the highest value was recorded for the average number of roots.

Transverse (18.8 and 16.2 cm), respectively, for cuttings of *citriodorus* thyme and Thyme *serpyllum* treated with a concentration of 250 ppm of indole butyric acid. As for cuttings of the species T. *vulgaris*, the average root length reached the highest value (15.1 cm) for cuttings treated with a concentration of 500 ppm. Statistically, at a value of (LSD 5%=1.47) The two concentrations 500 and 250 ppm outperformed the rest of the concentrations studied in addition to the control, while no significant differences were recorded between them. The results of the statistical analysis also did not show any significant difference between the two concentrations of 750 and 1000 ppm, but they in turn outperformed the control.

As for the variation in the values of the average length of the adventitious roots in the cuttings of the studied species, the highest values were recorded in the cuttings of the T type *.*

serpyllum at the tested concentrations (except for the concentration of 250 ppm), while the remaining two species varied in the average length of the adventitious roots formed, such that the values for cuttings of T. vulgaris were higher for the concentrations of 500 and 750and 1000 ppm and lower for the concentrations of 0 and 250 ppm than the values recorded for the cuttings of *citriodorus* thyme. Statistically at the value (LSD = 114%) The T. *serpyllum* species outperformed the two *T. citriodorus* species In high spirits. *vulgaris* over *T. citriodorus*, and it also outperforms *T. citriodorus*. *Vulgaris*.

Table 3: Average number of roots from cuttings of the studied thyme species when treated with different concentrations of growth regulator (IBA:

Average (Type)		concentrations of the hormonal solution				
	1000	750	500 b	250	0	**Type**
7.5 c	7.1 cd	7.3 c	15.1 b	4.0 e	3.60 e	T. *vulgaris*
9.9 b	4.6 de	7.4 c	14.7 b	18.8 a	3.9 e	*T. citriodorus*
13.2 a	14.6 b	14.5 c	15.4 a	16.2 b	5.2 cde	T. *serpyllum*
10.2	8.76 bc	9.73 b	15.06 a	13.0 a	4.233 d	Average (Concentration)
	1.14			Type		LSD 5%
	1.47			Concentration		
	2.55			Type and Concentration		

The effect of treatment with the IBA hormone on the average number of vegetative branches formed on the cuttings of the studied thyme species:

Although the resulting values for the average number of vegetative branches formed on the cuttings in most of the studied treatments are higher than their values for the control for each species, no clear superiority was observed for any of the tested concentrations for the three species combined (Table 4), as the two concentrations gave 250 and 500 ppm. The highest value for the average number of roots was found in cuttings of T. *serpyllum* (8.63 and 8.43), respectively, while the highest values appeared for *T. citriodorus* when treated with the two concentrations of 250 and 500 ppm. As for *T. citriodorus*, the highest values appeared for the two concentrations of 500-750 ppm statistically at The value of (5% LSD=0.81) for the two concentrations of 500 and 250 ppm is superior to the other two concentrations and the control, and the two concentrations of 750-1000 ppm are also superior to the concentration (0) ppm (the control)*.*

As for the species studied, the average number of vegetative branches formed in T. vulgaris was higher than in T. *serpyllum* and *T. citriodorus* in most of the treatments studied. However, no significant differences were recorded according to the results of the statistical analysis (5% LSD = 0.63) between the values of the average number of vegetative branches formed on the cuttings of the two species T. *serpyllum* and T. vulgaris*.*but they were significantly superior to *T. citriodorus.*

Table 4: Average number of vegetative branches of cutting of the studied Thyme species when trated with differtent concentrations of the growth regulator IBA:

Average (Type)	concentrations of the hormonal solution					
	1000	750	500 b	250	0	**Type**
6.28 a	6.02 cdef	6.67 cd	8.97 a	5.27 defg	4.5 fg	T. *vulgaris*
5.36 b	4.57 fg	4.77 efg	5.83 cdef	7.13 bc	4.5 fg	*T. citriodorus*
6.74a	6.2 cde	6.5 cd	8.43 ab	8.63 a	2.93 g	T. *serpyllum*
6.126	5.59 b	5.98 b	7.74 a	7.01 a	3.97 c	Average (Concentration)
	0.63			Type		LSD 5%
	0.81			Concentration		
	1.41			Type and Concentration		

The effect of treatment with the IBA hormone on the average length of vegetative branches formed on the cuttings of the studied thyme species:

Similarly to the average number of branches, none of the tested concentrations was distinguished in giving the highest values for the average length of the vegetative branches formed in the cuttings of the three studied thyme species in culture (Table 5), as the highest value (9.1 and 8.97 cm) appeared for the two concentrations 500-750 ppm. In cuttings of T. vulgaris, the highest value in T. *serpyllum* (7.67 cm) resulted from a concentration of 500 ppm, while the highest value for the average length of vegetative branches of *T. citriodorus* (6.53 cm) appeared in cuttings treated with a concentration of 250 ppm. According to the results Statistical analysis (5% LSD = 0.5423) The 500 ppm concentration significantly outperformed all other concentrations except 750 ppm.

While no significant differences were recorded between the concentrations of 250, 750, and 1000 ppm, all of which were superior to the control treatment of 0ppm. T. *capitatus* showed the highest values for the average length of vegetative branches, as it was significantly superior according to the results of statistical analysis (5%LSD= 0.42) to the other two species. *T. citriodorus* also significantly superior to *citriodorus* thyme in terms of the average length of vegetative branches formed on the stem**.**

Table 5: Average length of vegetative branches of cutting of the studied Thyme species when treated with different concentrations of the growth regulator IBA:

Average (Type)	concentrations of the hormonal solution					
	1000	750	500 b	250	0	**Type**
7.81 a	8.77 a	9.1 a	8.97 a	7.13 bc	5.07 f	T. *vulgaris*
6.11 c	5.63 ef	6.07 cdef	6.47 cde	6.53 cde	5.87 def	*T. citriodorus*
6.82 b	6.29 cde	6.33 cde	7.67 b	7.03 be	6.77 bcd	T. *serpyllum*
6.913	6.89 b	7.166 ab	7.703 a	6.89 b	5.9 c	Average (Concentration)
	0.42			Type		LSD 5%
	0.5423			Concentration		
	0.92			Type and Concentration		

6- The effect of treatment with the IBA hormone on the average length of the main stem of cuttings of the studied thyme species*:*

The results (Table 6) did not show a clear effect of any of the concentrations used on the average length of the main stem compared to the control, as the results of the statistical analysis (%LSD = 0.751) showed only a significant superiority of the 250 ppm concentration over the 500 ppm concentration and the control, while no results were recorded. Significant differences between the rest of the coefficients **.**The same applies to comparing species among themselves. Although the highest value for the average length of the main stem (11.5 cm) resulted from *citriodorus* thyme cuttings treated with a concentration of 250 ppm, it was not significantly different from other species, and this also appeared in the results of the statistical analysis at a value of (250 ppm). (%LSD 5= 0.97) as no significant differences were recorded between types of thyme according to this trait **.**

Table 6: Average main leg length of vegetative branches of cutting of the studied Thyme species when treated with different concentrations of the growth regulator IBA:

Average (Type)	concentrations of the hormonal solution					
	1000	750	500 b	250	0	**Type**
9.9 a	9.63 ab	9.38 b	10.2 ab	10.2 ab	10.13 ab	T. *vulgaris*
9.86 a	9.27 b	9.1 b	9.6 ab	11.5 a	9.9 ab	*T. citriodorus*
10.26 a	9.67 ab	9.67 ab	10.46 ab	10.8 ab	10.6 ab	T. *serpyllum*
10.006	9.52 bc	9.37 bc	10.086 ab	10.83 a	10.21 ab	Average (Concentration)
	0.751			Type		LSD 5%
	0.97			Concentration		
	1.68			Type and Concentration		

Discussion

From the previous results, we find that treatment with the rooting hormone IBA positively affected the rooting rates of cuttings of different types of thyme, namely (T. *serpyllum*, T. *vulgaris and T. citriodorus*). and this can be explained by the stimulating effect of the hormone IBA on the formation of adventitious roots and increasing their number, especially in the cutting areas (Hartman *et al*., 1990) [7].

In addition to its role in accelerating the formation of these roots (Mateja *et al.,* 2005) [13], and thus the results of our current study agreed with the results of many researchers in this field, including (Karimi *et al.*, 2014) [9], when they propagated the thyme species T. *satureioids* using basal cuttings.

The apical cuttings showed the ability to root without using IBA, but the percentage of rooting increased significantly when the cuttings were treated with the aforementioned hormone from 48% to 91% .

Cuttings treated with a rooting hormone also showed a noticeable increase in the number of roots formed and the average length of those roots as a result of the positive effect of the IBA hormone on this. This is also consistent with the results of many previous studies that dealt with vegetative propagation by stem cuttings of many plants, both thyme species (Lapichino *et al*., 2006.) [10], or other plant species such as *Salvia officinalis* and dairy pebbles (Paradikovic *et al.,* 2000) [16] *Rosmarinus officinalis* Regarding the vegetative growths formed on the thyme cuttings of the studied treatments, there was somewhat similarity in the average number and length of growths in many of the treatments, with some of them clearly superior to the control plants. This is mainly due to the hormone indole butyric acid stimulating early root formation, which helps The vegetative shoots are able to benefit from the nutritional reserves present in the cuttings more quickly, in addition to the nutrients that the cuttings obtain through the formed roots, and thus obtain better vegetative growth in less time, and this is consistent with the results of (Nicola *et al*., 2005) [15] They indicated the positive effect of treatment with the IBA hormone on root system formation and its positive impact on the vegetative system .

Despite the convergence in the general trend in terms of the superiority of the three thyme species in all the indicators studied over the control plants, a clear discrepancy was observed between the species studied in those indicators, and this is mainly due to genetic variation between these species in addition to the difference in environmental and soil conditions that It also affects, in one way or another, the nutritional reserves of the brain, and thus its impact on the indicators studied, as the species T. *serpyllum* showed the best indicators related to the total

rooting, while T. *vulgaris* was superior in vegetative growth indicators, and this is what was concluded by (Lpichinpo *et al.,* 2006) in their study of vegetative propagation of three types of thyme, where they obtained good rooting rates for the species studied, in addition to strong vegetative growth rate and length. The flowering period significantly increased in T. *vulgaris*.

Conclusion

Despite the success of propagating the studied types of thyme using terminal cuttings and without the use of the rooting hormone IBA, the current study has proven its positive effect in increasing the rooting rate in addition to improving the characteristics of the root and vegetative systems in general, and despite the fact that a clearly superior concentration did not appear in all the indicators studied except The two concentrations, 250-500 ppm, gave the best results according to the current study .

Recommendations

1. Propagation of varieties that are distinguished in their vegetative production, in addition to their content of essential oil in quantity and quality, with the aim of multiplying and spreading the cultivation of distinguished ones.
2. Continuing the study on all types of thyme spread in Iraq in its natural areas of distribution .
3. Preserving the studied species within heirloom complexes due to the great economic importance of thyme and for fear of the extinction of these species.

References :

1. Al-Douri NAN. Flora of Iraq. Vol. 4, Part 1. Ministry of Agriculture, Iraq; 2010.
2. Al-Fatlawi MT, Al-Bayati AS. Isolation and identification of essential oil components of *Thymus vulgaris*. J Al-Nahrain Univ Sci. 2012;15(3):28–32.
3. Al-Zubaidy AIM, Al-Fakhri SD, Al-Ansari NA. The effect of *Thymus vulgaris* leaves extract on the pathogenic bacteria isolated from urinary tract infection. Tikrit J Pure Sci. 2012;17(1):51–54.
4. Carús L, *et al*. Thyme as a novel source of bioactive compounds: the phenolic profile of Thymus spp. extracts. Food Chem. 2015;167:202–210.
5. Esmaeili A, *et al*. The usage of plant hormones as treatments for the improvement of rooting and quality conservation of apple leafy cuttings. Afr J Biotechnol. 2011;10(12):2296–2304.
6. Gonçalves S, *et al*. Plant hormone signaling in flower patterning and development: an integrated view. Antioxidants. 2017;6(2):29.
7. Hartman AH, Davies FT. Plant propagation: principles and practices. Englewood Cliffs, New Jersey; 1990. p. 234–237.
8. Henrique A, Campinhos EN, Oono EO, Pinho SZD. Effect of plant growth regulators in the rooting of Pinus cuttings. Braz Arch Biol Technol. 2006;49(2):189–196.
9. Karimi S, Yadollahi A. Using putrescine to increase the rooting ability of hardwood cutting of peach almond hybrid GF677. J Agrobiol. 2014;29(2):63–69.
10. Lapichino G, Amico Roxas U, Betrolino M, Accardo-Palumbo S, Moncada A. Propagation techniques for three Mediterranean native shrubs with potential as ornamental outdoor plants. Acta Hortic. 2006;723:433–436.
11. Lucini L, *et al.* Antioxidant activity of selected wild plant species and their phenolic compounds. J Agric Food Chem. 2013;61(35):8134–8141.
12. Mahajan Y, *et al*. Influence of rooting hormone on root induction in *Thymus vulgaris* L. J Pharmacogn Phytochem. 2016;5(5):1–7.
13. Mateja S, Franci S, Gregor O. Influence of IAA and

IBA on root development and quality of Prunus 'Gisel A5' leafy cuttings. HortScience. 2005;40:20–52.
14. Mnayer D, *et al*. Application of phytoalgorithms techniques to optimize the effects of indole-3-butyric acid (IBA) concentrations: a case study of Lavandula officinalis L. and *Rosmarinus officinalis* L. Jornada Paulista de Plantas Medicinais, Aromáticas e Condimentares. 2019;7(1):39–48.
15. Nicola S, Fontana E, Hoeberenchts J, Saglietti D. Rooting products and cuttings timing on sage (*Salvia officinalis* L.) propagation. Acta Hortic. 2005;676:135.
16. Paradikovic N, Svjetlna Z, Monika T, Vinkovic T, Imra D, Milica M. Influence of rooting powder on propagation of sage (*Salvia officinalis* L.) and rosemary (*Rosmarinus officinalis* L.) with green cuttings. Poljoprivreda. 2000;10.
17. Saleh NA, Thejel MA, Al Hussaini TI. Flora of Iraq: Labiatae. Sulaymaniah University Press; 2019.
18. Tahi HS, *et al*. Effects of different types and concentrations of indole-butyric acid hormone on rooting of *Thymus vulgaris* L. stem cuttings. Adv Environ Biol. 2013;10(2):309–315.
19. Zaller JG, *et al*. Evaluation of different methods for propagation of Thymus *serpyllum* L. cv. 'Coccineus' for organic plant production. Org Agric. 2019;9(2):175–184.