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The Effect of Vernalization and Sprayed Gibberellins and Humic Acid on the Growth and Production of Cabbage (*Brassica Oleracea* Var. Capitat)

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ABSTRACT

An experiment was conducted in Al-Haronia district of Al-Muqdadiyah city in Province of Diyala during the agricultural season of 2013-2014 to investigate the effect of vernalization by four application methods (unvernalized plants, vernalized plants by seeds, vernalized saplings and vernalized by seeds and saplings). It deals with effect of Gibberellins spraying with three rates of concentration 0, 75 and 150 mg/L as well as the effect of Humic acids spray with three rates of concentration 0, 100 and 200 mg/L in growth and harvest of cabbage (*Brassica oleracea* var. capitat). A factorial experiment was fulfilled by using a Split-split plot design and three blocks. The outcomes proved that Humic acids, Gibberellins and vernalization have statistically significant impact on the features of vegetative growth and certain effect on the product with significant varieties among the applications specifically that of comparison. The veranlized plants by seeds were of higher values in terms of (percentage of chlorophyll in outer leaves, the required duration for emergence of 50% of cabbage head, diameter of cabbage head). The values can be distributed respectively as follows (54.51 Spad, 43.96 day, 25.81 cm). The sprayed plants by Gibberellins proved higher values particularly with concentration of 150 mg/L in terms of the following features (space of outer leaves, content of chlorophyll in outer leaves). The values can be distributed respectively (1107.87 cm^2/plant, Spad 54.63, and 26.33 ton per donam (1000 sq.m). The sprayed plants by Gibberellins with concentration of 75 mg/L proved higher values in terms of the following features (the required duration for emergence and growth of 50% of cabbage heads and the diameter of cabbage heads) and their values were distributed respectively (42.16 day and 24.69 cm). The sprayed plants by of Humic acids with concentration of 200 mg/L proved higher levels in the following features (percentage of chlorophyll in outer leaves, the required duration for emergence of 50% of cabbage heads) and their values were listed respectively out of the following: 55.59 Spad ,44.00 day, 25.26 cm). In respect to triple interferences or three-way interactions, the vernalized plants by seeds and sprayed plants by Gibberellins with concentration of 75 mg/L and the sprayed plants by humic acids with concentration of 200 mg/L presented higher values in the following characteristics (the required duration for the emergence of 50% of the cabbage head, the diameter of the cabbage heads, and their values are presented respectively: (38.66 day, 30.66 cm). The vernalized plants by seeds and sprayed plants by Gibberellins with concentration of 150 mg/L along with sprayed plants by humic acids with concentration of 200 mg/L showed higher values in the following features (substance of chlorophyll in outer leaves successively as in (61.83 Spad). The unvernalized plants and sprayed plants by Gibberellins with concentration 150 mg/L and the sprayed plants by humic acids with concentration of 100 mg/L showed higher values in the following features (the size of outer leaves and their values are listed respectively as in (1355.72 cm^2/plant).

1. Introduction

Cabbage (*Brassica oleracea* var. capitata) is one of the main winter vegetable crops that cultivated in most areas of Iraq. The cabbage is from cruciferae and one of the most useful vegetables [1]. Cabbage is leafy vegetable wherever the cabbage head is edible, which contains wrapped leaves that cover the terminal bud. Moreover, the cabbage leaves can be utilized in making salads, pickles, cooked food and can be consumed and eaten when the leaves are stuffed and boiled [2]. Furthermore, Wang et al [3] found that spraying the cabbage plant with gibberellins would increase the size of leaves and the foliar area of the plant. However, Jamil et al [4] pointed out that spraying the cabbage plant with 100, 150 and 200 mg per 1 liter of gibberellins concentrations caused an increase in the foliar area and content of leaves particularly chlorophyll compared to the treatment of comparison. Additionally, Lendve et al [5] discovered that spraying the cabbage plant with 50 mg per 1 liter of gibberellins concentration led to an increase in the foliar area of the cabbage plant. Sang et al [6] stated that spraying the cabbage with 200 and 400 mg/L of gibberellins concentration had increased the chlorophyll content in leaves compared to the treatment of comparison.

In the same aspect, Yadav et al [7] referred to the point of spraying the cabbage plant with gibberellins has indeed shorten the time required for the emergence of 50% of cabbage heads. Furthermore, Lendve et al [5] found that spraying the cabbage vegetable with 75 mg per 1 litre of gibberellins concentration consumed fewer days than the days required for emergence of 50 of cabbage heads. While, Sawant et al [8] showed that spraying the cabbage with 75 mg per 1 litre of gibberellins concentration presented the best outcomes in decreasing the days needed for cabbage heads formation which reached to 37.3 days compared to treatment of comparison which lasted 59.3 days. To be precise, this process led to an increase in chlorophyll content of the outer leaves compared to treatment of comparison.

Atiyeh et al [9] showed hat addition of liquid humic acid to the soil leads to an increase of mineral elements readiness in the soil, which in turn causes a boost of leafy growth and make highest revenue in the production of cabbage plant. However, Kalalbandi [10] proved that addition of raw manure to the cabbage causes an increase in the foliar area of cabbage. Since the cabbage is one of biennial plants which cultivated vegetative in the first season wherever the flowering needs vernalization by exposing the seeds and saplings to usually low temperatures (slightly above zero)

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to motivate the cabbage plant to flower and sprout up. When the cabbage seeds are vernalized, it will accelerate the transition of the plant from the vegetative stage to flowering phase [11]. Grisana [12] noticed that spraying the vernalized cabbage with 100 mg per 1 litre of gibberellins concentration for 8 days increased the crops by 87% compared to controlled treatment. The experiment is fulfilled due to the importance of cabbage, the role of low temperatures, vernalization, gibberellins, and humic acid addition in improving the cabbage crops qualitatively and quantitatively.

2. Experimental Methods

An experiment has been conducted in one of private fields of Al-Muqdadiyah city in Province of Diyala during the agricultural season of 2013-2014 to examine the impact of following three major elements: firstly the vernalization by four application methods (without vernalization, vernalization of seeds, vernalization of saplings and vernalization of seeds and saplings altogether). Secondly it deals with effect of gibberellins spraying with three rates of concentration 0, 75 and 150 mg/L as well as the effect of Humic acids spray with three rates of concentration 0,100 and 200 mg per 1 litre in growth and harvest of cabbage (*Brassica oleracea* var. capital). In this context, gibberellins and humic acids have been sprayed twice; the first spray after 20 days of planting, while the second spray was after 20 days of the first spray. The vernalization treatments have been carried out on 8 degrees celcious along 12 days. An experiment has been conducted by using a Split-split plot design and three blocks. The humic acids application was placed in the main plots, whereas those of gibberellins were positioned in subplots and the applications of vernalization were put in sub-subplots. This is to produce 36 treatments in every block, thus the number of experimental units in every single experience reaches to 108 units. The outcomes have been analyzed statistically through using the above mentioned design and testing the significant differences among the averages by using Duncan's Multiple range test at range of 0.05 [13]. However, the following characteristics have been measured by the researcher.

2.1 The surface Area of the Leaf (cm^2/plant)

The leaf has been measured by using Leaf Area Meter and through measuring the foliar area of five leaves for every plant and measuring six plants in each experimental unit which had been chosen at random in order to draw the average.

2.2 The Relative Content of Chlorophyll in Outside Leaves (SPAD UNIT)

The content has been estimated by using chlorophyll Meter 502–SPAD. The sample was taken from five leaves of every plant, which included six plants in each experimental unit. The sample was drawn from different sites of these tested plants after 30 days of planting for every treatment and then it was washed thoroughly with water to get rid of stuck dust.

2.3 The Necessary Duration for Emerging 50% of the Cabbage Heads (Day)

It has been counted by the number of days from planting until the emergence of 50% of cabbage heads.

2.4 The Diameter of Cabbage Head (cm)

Ten plants of cabbage have been taken at random in an experimental unit and the diameter of cabbage head has been measured in the period of harvesting cabbage heads by using plastic tape to measure the diameter of the head and to then to draw the average.

2.5 The Percentage of Organic Substance in Inner Leaves of Cabbage

The dried up or and grinded samples by electric mill have been taken, only 0.5 mg were derived from every sample to estimate the organic substance. As the sample of 0.5 mg was placed in a weighted and ceramic desiccator, which in turn was set down in an oven at a temperature of 150 °C for 6 hours and kept in desiccator to cool the sample and dry it of any moisture. The sample was burned at an incinerator at a temperature of 600 °C for 6 hours and then has been weighted to calculate the organic material on the basis of the following equation : Organic Material OM % = the weight of container and the sample before burning (drying up) process – the weight after burning process (drying up) ÷ the weight of the sample.

3. Results and Discussion

3.1 The Surface Area of Leaf (cm^2/Leaf)

The results in Table 1 show that there is significant effect of non-vernalized seedlings treatment, as it outperformed by presenting higher value in external area of leaf; reaching to 1095.2 cm^2 compared to treatment of vernalized seeds, which gave lower value , reaching to 960.6 cm^2. There is neither significant effect in terms of saplings vernalization nor with vernalization of seeds and seedlings. It became clear that treated plants by 150 mg per 1 litre of gibberellins concentration has surpassed significantly by giving higher value, reaching to 1107.9 cm^2 compared to comparison treatment of treated plants by 75 mg per 1 litre of gibberellins, in which the value was lower since it reached to 975.8 cm^2. However, there was no significant effect by spraying of humic acid. Through the outcomes of Table 1, it became quite clear that there is significant effect in interpenetration among vernalization, gibberellins and humic acid in the surface area of the leaf. It demonstrated the highest value in treatment of non-vernalized plants, treated plants by 150 mg per 1 litre of gibberellins and treated plant by 100 mg per 1 litre of humic acid, as the value reached to1355.7 cm^2. While the value was lower in vernalized plant by seeds and saplings and unsprayed plants neither by gibberellins nor by humic acid, the value reached to 866.5 cm^2.

Table 1 The effect and interference of vernalization and spraying by gibberellins and humic acid in measuring external area of cabbage leaf (cm^2/Leaf)

Humic acid (A) mg/L	Gibberellin B (mg/L)	Element C (vernalization)				interpenetration A*B	Averages Humic acid (A)	Averages gibberellin (B)
		without vernalization C1	vernalization of seeds C2	vernalization of saplings C3	Vernalizetion of seeds and saplings C4			
A1 Control 0	B1 0 Control	1028.8 bcdef	981.8 cdef	1138.0 Bc	866.5 f	1003.8 bcde		
	B2 75	959.2 cdef	1021.7 bcdef	919.5 Cdef	928.6 cdef	957.2 e		
	B3 150	1126.7 bcd	944.6 Cdef	1058.0 bcdef	1138.5 bc	1066.9 bc		
A2 100	B1 Control 0	1131.5 bcd	909.1 Def	1007.3 bcdef	972.5 cdef	1005.1 bcde		
	B2 75	987.2 cdef	1062.2 bcdef	1008.9 bcdef	1040.8 bcdef	1024.8 Bcde		
	B3 150	1355.7 a	1038.4 bcdef	1044.2 bcdef	1218.7 ab	1164.3 A		
A3 200	B1 Control 0	1140.5 bc	918.1 cdef	1021.5 bcdef	981.8 cdef	1015.5 bcde		
	B2 75	1032.4 bcdef	882.5 ef	1017.7 bcdef	1044.2 bcdef	994.2 Cde		
	B3 150	1095.3 bcde	1082.6 bcdef	1097.5 bcde	1094.9 bcde	1092.6 ab		
Interpenetration A*C	A1 Control 0	1038.2 Abcd	982.7 bcd	1038.5 abcd	977.8 bcd		1009.3 A	
	A2 100	1058.1 abcd	1003.2 bcd	1020.2 bcd	1077.4 abc		1064.7 A	
	A3 200	1089.4 a	961.1 d	1045.6 abcd	1040.3 abcd		1034.1 A	
Interpenetration B*C	B1 Control 0	1100.3 abc	936.4 de	1055.6 bcd	940.2 de			1008.1 B
	B2 75	992.9 cde	923.6 e	982.07 cde	1004.5 cde			975.8 C
	B3 150	1192.6 a	1021.9 cde	1066.6 bc	1150.7 ab			1107.9 A
Element Averages C		1095.3 A	960,9 B	1031.8 A	1034.7 A			

**The averages that stand for various letters differ significantly from each other at probable range of 0.05*

Table 2 The effect and interference of vernalization and spraying by gibberellins and humic acid in measuring the chlorophyll in external content of leaves (spad)

Humic acid (A) mg/L	Gibberellin B (mg/L)	Element C (vernalization)				interpenetration A*B	Averages Humic acid (A)	Averages gibberellin (B)
		without vernalization C1	vernalization of seeds C2	vernalization of saplings C3	Vernalizetion of seeds and saplings C4			
A1 Control 0	B1 Control**0**	47.3 r	48.4 or	47.4 r	46.7 r	47.4 d		
	B2 75	53.2 fghi	54.2 defg	51.6 ijklmn	50.7 lmnop	52.4 bc		
	B3 150	49.8 nopq	52.4 hijkl	51.0 lmno	49.7 opq	50.7 cd		

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A2 100	B1 Control 0	50.7 lmnop	51.3 jklmno	50.4 mnop	49.1 pq	50.3 cd		
	B2 75	52.9 fghijk	55.1 Cde	53.0 fghijk	52.1 hijklm	53.2 bc		
	B3 150	54.2 defg	55.5 cd	54.1 defg	53.6 efgh	54.4 b		
A3 200	B1 Control 0	53.0 fghij	53.5 efghi	52.1 hijklm	51.1 klmno	52.4 bc		
	B2 75	56.4 c	58.1 b	54.3 def	53.4 efghi	55.5 ab		
	B3 150	59.1 b	61.8 a	58.3 b	55.6 cd	58.7 a		
interpenetration	A1 Control 0	50.1 H	51.7 fg	50.0 h	49.0 i		50.2 B	
A*C	A2 100	52.6 Ef	54.0 d	52.5 efg	51.6 g		52.6 Ab	
	A3 200	56.2 B	57.8 a	54.9 c	53.4 de		55.5 A	
interpenetration	B1 Control 0	50.3 de	51.0 d	49.9 e	49.0 f			50.1 B
B*C	B2 75	54.1 b	55.8 a	53.01 c	52.0 c			53.7 A
	B3 150	54.4 b	56.6 a	54.4 b	53.0 c			54.6 A
Element Averages C		52.9 B	54.5 A	52.4 B	51.3 C			

**The averages that stand for different letters differ significantly from each other at probable range of 0.05*

Table 3 The effect of vernalization and spraying by gibberellins and humic acid and their interference in the number of days required for emerging 50% of cabbage heads (in Days)

Humic acid (A) mg/L	Gibberellin B (mg/L)	Element C (vernalization) without vernalization C1	vernalization of seeds C2	vernalization of saplings C3	Vernalizetion of seeds and saplings C4	interpenetration A*B	Averages Humic acid (A)	Averages gibberellin (B)
A1 Control 0	B1 Control**0**	51.0 a	48.3 bcde	48.6 bcd	50.0 Ab	49.5 a		
	B2 75	45.6 hi	43.0 klm	44.0 Ijk	46.3 fgh	44.7 c		
	B3 150	47.3 cdefg	45.6 ghi	46.6 efgh	47.6 cdefg	46.8 b		
A2 100	B1 Control 0	49.0 bc	46.6 efgh	47.0 defg	48.0 cdef	47.6 B		
	B2 75	42.0 lmn	39.6 op	41.0 no	43.6 jkl	41.5 D		
	B3 150	46.0 gh	45.6 ghi	46.0 gh	47.0 defg	46.1 Bc		
A3 200	B1 Control 0	47.3 cdefg	44.0 Ijk	45.6 ghi	47.0 defg	46.0 Bc		
	B2 75	41.0 no	38.6 P	39.6 op	41.3 mno	40.1 D		
	B3 150	48.3 bcde	44.0 Ijk	45.0 hij	46.0 gh	45.8 bc		
interpenetration	A1 Control 0	48.0 a	45.6 bc	46.4 b	48.0 a		47.0 A	
A*C	A2 100	45.6 bc	34.9 de	44.6 cd	46.2 b		45.1 B	
	A3 200	45.5 bc	42.2 f	43.4 e	44.7 cd		44.0 C	
interpenetration	B1 Control 0	49.1 a	46.3 bc	47.1 b	48.3 a			47.7 A
B*C	B2 75	42.8 e	40.4 g	41.5 f	43.7 e			42.1 C
	B3 150	47.2 b	45.1 ce	45.8 c	46.8 bc			46.2 B
Element Averages C		46.4 A	43.9 C	44.8 B	46.3 A			

**The averages that stand for a variety of letters differ significantly from each other at probable range of 0.05*

Table 4 The effect of vernalization and spraying by gibberellins and humic acid and their interference in the diameter of cabbage heads (in centimeters)

Humic acid (A) mg/L	Gibberellin B (mg/L)	Element C (vernalization) without vernalization C1	vernalization of seeds C2	vernalization of saplings C3	Vernalizetion of seeds and saplings C4	interpenetration A*B	Averages Humic acid (A)	Averages gibberellin (B)
A1 Control 0	B1 Control 0	18.3 po	22.3 fghi	20.3 klmn	17.8 p	19.7 g		
	B2 75	22.0 ghij	26.3 bcd	24.0 Ef	20.6 jklmn	23.2 cd		
	B3 150	19.5 mno	24.0 ef	21.3 ijkl	19.0 nop	20.9 fg		
A2 100	B1 Control 0	20.0 lmn	23.3 efgh	22.5 fghi	21.6 hijkl	21.8 ef		
	B2 75	21.3 ijkl	27.3 bc	25.00 de	22.33 fghij	24.00 bc		
	B3 150	20.6 jklmn	24.6 de	24.0 ef	21.1 ijklm	22.6 de		
A3 200	B1 Control 0	22.3 fghi	26.0 bcd	25.0 de	22.66 fghi	24.0 bc		
	B2 75	23.5 efg	30.66 a	27.3 bc	25.8 cd	26.8 a		
	B3 150	22.6 fghi	27.6 b	26.1 bcd	23.3 efgh	24.9 b		
interpenetration	A1 Control 0	19.9 gh	24.2 d	21.8 f	19.1 h		21.3 C	
A*C	A2 100	20.6 g	25.1 c	23.8 d	21.7 f		22.8 B	
	A3 200	22.8 e	28.1 a	26.1 b	23.94 d		25.2 A	
interpenetration	B1 Control 0	20.2 e	23.8 c	22.6 d	20.72 e			21.8 C
B*C	B2 75	22.2 d	28.1 a	25.4 b	22.9 d			24.6 A
	B3 150	20.9 e	25.4 b	23.8 c	21.1 e			22.8 B
Element Averages C		21.1 C	25.8 A	23.9 B	21.6 C			

**The averages that stand for different letters differ significantly from each other at probable range of 0.05*

Table 5 The effect of vernalization and spraying by gibberellins and humic acid and their interference in the diameter of cabbage heads (in centimeters)

Humic acid (A) mg/L	Gibberellin B (mg/L)	Element C (vernalization) without vernalization C1	vernalization of seeds C2	vernalization of saplings C3	Vernalizetion of seeds and saplings C4	interpenetration A*B	Averages Humic acid (A)	Averages gibberellin (B)
A1 Control 0	B1 Control 0	10.6 abc	10.6 abc	10.3 bc	10.0 c	10.4 b		
	B2 75	10.9 abc	10.8 abc	11.2 abc	10.6 abc	10.9 ab		
	B3 150	11.1 abc	11.7 abc	12.0 ab	11.2 abc	11.5 a		
A2 100	B1 Control 0	12.1 a	11.0 abc	11.1 abc	10.9 abc	11.3 ab		
	B2 75	10.6 abc	10.6 abc	10.7 abc	10.7 abc	10.6 b		
	B3 150	10.8 abc	11.1 abc	10.6 abc	10.7 abc	10.2 b		
A3 200	B1 Control 0	10.9 abc	10.0 c	10.1 c	10.8 abc	10.4 b		
	B2 75	12.0 ab	10.8 abc	10.9 abc	11.0 abc	11.2 ab		
	B3 150	11.2 abc	10.6 abc	10.7 abc	10.2 c	10.7 ab		
interpenetration	A1 Control 0	10.9 a	11.0 a	11.2 a	10.6 a		10.9 A	
A*C	A2 100	11.2 a	10.9 a	10.8 a	10.7 a		10.9 A	
	A3 200	11.4 a	10.5 a	10.6 a	10.6 a		10.8 A	
interpenetration	B1 Control 0	10.2 a	10.5 a	10.5 a	10.6 a			10.4 A
B*C	B2 75	11.2 a	10.7 a	10.9 a	10.7 a			10.9 A
	B3 150	11.0 a	11.1 a	11.1 a	10.7 a			11.0 A
Element Averages C		11.1 A	10.8 A	10.8 A	10.7 A			

**The averages that stand for different letters differ significantly from each other at probable range of 0.05*

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3.2 The Chlorophyll in the Content of External Leaves (Spad)

It became clear through the outcomes of Table 2 that the vernalization has significant effect in the content of external leaves particularly the chlorophyll wherever the treated plants by vernalized seeds have proved superior in giving the highest value of chlorophyll content which reached to 54.5 Spad, while the compared plants presented the lowest value which reached to 51.3 Spad. It has been clearly shown that spraying plants with gibberellins has significant effect, wherever the treatment by 150 mg per 1 litre of gibberellins concentration proved highest value which reached to 54.6 Spad, in contrast to non-sprayed plants by gibberellins which gave only 50.1 Spad. Furthermore, it turned out that spraying plants with 75-150 mg per 1 litre of gibberellins concentrations has no significant effect. Additionally, it became obvious that spraying plants with humic acid has significant effect, wherever the treatment by 200 mg per 1 litre of humic acid gave highest value which reached to 55.5 spad, in comparison with non-sprayed plants which gave only 50.2 spad. Through the results of Table 2, it turns out that the vernalization, gibberellins and humic acid have significant effect in the chlorophyll content. It recorded highest value in terms of vernalized plants by seeds and sprayed plants with 150 mg/L of gibberellins concentration and sprayed plants with 200 mg/L of humic concentration. The value reached to 61.8 spad, compared to other treatments and comparison treatment which recorded lowest value; including the vernalization of seeds and saplings and with unsprayed plants by either gibberellins or humic, thus the value reached only to 46.7 spad.

The outcomes in Tables 1 and 2 proved that there is no significant effect between non-vernalized treatments and vernalized saplings. In Table 2, there is no significant effect between non-vernalized treatments and vernalized saplings and seeds. However, the results in Tables 1 and 2 demonstrated that treated plants by vernalization of seeds have significant effect in increasing the foliar area and chlorophyll content of leaves. The main reason may be due to vernalization and the role of low temperature in synthesis of gibberellins in embryonic cells of seeds and the gibberellins subsequently has an impact on decomposed enzymes of foodstuffs which could facilitate the process of transmitting these nutrients to embryos [14]. The gibberellins has a major role in cell division and in increasing its absorption of water and then in an enlargement of its size by increasing its protoplasmic content which is reflected in the surface area of the plant and its tissues and size [15]. The findings in Tables 1 and 2 explained that sprayed plants by 200 mg/L of humic concentration surpassed significantly by increasing the foliar area and chlorophyll content. This might be due to the role of humic acids in the compound in activating the growth and stimulating the metabolism, which increases CO_2 absorption and raises the production level of Adenosine Triphosphate (ATP), accelerating the respiration of mitochondria, which in turn stimulates photosynthesis [16].

Moreover, humic acids have positive impact in growth of plants by increasing the permeability of cell membranes, via stimulating the enzymatic interactions, through improving the cellular division and cell elongation and increasing the production of plant enzymes inside cells which can lead to raise the rate of plant growth [17]. The reason behind increasing the leaf area may be attributed to the role of humic acids which has a physiologic action in the plant similar to the role of cytokines and oxygen which affects the growth of plants and maximizes the leafy area [18]. The time required for the emergence of 50% of the cabbage heads (in days).

3.3 The Necessary Duration for the Emergence of 50% of Cabbage Heads (in Days)

The results of Table 3 demonstrated that vernalization has significant effect in the time required for the appearance of 50% of cabbage heads. The treatment of seeds vernalization has been made earlier than treatment of seeds and saplings vernalization by 2.3 days, which reached to 43.9 days. While the standard compared plants require necessarily 46.3 days for emerging the cabbage heads. Furthermore, there is no significant difference between the treatment of non-vernalized plants and the treatment of seeds and saplings vernalization. It also is clear that gibberellins has a significant effect in the period required for the appearance of 50% of the heads, as treated plants by 75 mg/L of gibberellins concentration has been made earlier than the compared plants in treatment of comparison by 5.5 days, which lasted for 42.1 days, whereas the emerging of cabbage heads in compared plants requires normally 47.7 days. It became clear that humic acid has a significant effect in the duration required for emerging 50% of the cabbage heads, as the treatment of 200 mg/L of humic acid concentration has been made earlier than treatment of comparison by 3.0 days in which the compared plants lasted 44.0 days, whereas the other plants took 47.0 days for emerging 50% of cabbage heads. Figures in Table 3 showed that the triple interferences among vernalization, humic acid and gibberellins have significant effect in the period required for emerging 50% of cabbage heads, as treated plants by vernalization of seeds , sprayed plants with 75 mg/L of gibberellins concentration and treated plants by 200 mg/L of humic acid concentration have been made earlier by 12.3 days, as the cabbage heads appeared by 38.6 days compared to treatment of comparison in which the non-vernalized plants, unsprayed plants by either gibberellins or humic acids, that require 51.0 days for emerging of cabbage heads.

3.4 The diameter of Cabbage Head (cm^2)

Through figures and results of Table 4, it became clear that vernalization has a significant effect in the diameter of cabbage heads, wherever treated plants by vernalization of seeds have surpassed by giving the highest value which reached to 25.8 cm, whereas the compared plants presented lower value 21.1 cm. Furthermore, it has been proved that there is no significant difference between treated plants by any vernalization and treated plants by vernalization of seeds and saplings. Besides that, treated plants by 75 mg/L of gibberellins concentration have significant effect by giving higher value (24.6 cm^2), compared to plants handled by treatment of comparison, that gave lower value (21.8 cm). It turns out obviously that plants treated by 200 mg/L of humic concentration have provided higher value (25.2 cm) compared to untreated plants which gave lower value (21.3).

Through figures and outcomes of Table 4, it shows clearly that triple interference among vernalization, gibberellins and humic acids had significant effect in measuring the diameter of cabbage heads. The treated plants by vernalization of seeds and 75 mg/L of gibberellins concentration along with 200 mg/L of humic concentration demonstrated highest value (30.6 cm). In comparison with other treatments of compared plants, particularly the vernalized plants by seeds and saplings altogether and unsprayed plants neither by gibberellins nor by humic acids, which gave lower value (17.8 cm).

The effect of these three elements in enlarging the diameter of heads and shortening the duration of emerging 50% of cabbage heads can be due to the role of gibberellins in organizing the growth in these plants and subsequently influencing the vegetative growth and accelerating the formation of crops as a result of an increase in cells division and an enlargement in its size and area [19, 20]. Secondly, it can be attributed to the role of humic acids in improving the cellular division and elongation of these cells; as the humic acid affect various biotic operations of plants such as respiration, Photosynthesis, proteins production and different enzymatic actions, The effect of humic acid is similar to the impact of plant hormones which causes considerable raising in the rate of plant growth and prepares the best possible conditions for cell division [21]. The reason of such increase can be attributed to the role played by humic acid in providing the necessary elements K,P,N which had essential role in strength of vegetative growth which made an increase in crops [22].

The average percentage of organic substance in the inner leaves of the cabbage head:

Through the results and figures in Table 5, it demonstrated obviously that the vernalization, gibberellins and humic acids have no significant effect in estimating the percentage of organic substance in inner leaves of the cabbage heads. However, the effect is significant in the triple interference among the above three mentioned elements m as the highest percentage (12.1%) was recorded by plants treated by vernalization of seeds, sprayed by 75 mg per 1 $litre^{-1}$ of gibberellins concentration and treated by 100 mg per 1 litre of humic acid concentration, compared to other treatments and application of comparison with other treated plants by vernalization of seeds and saplings, which presented lower percentage (10.0%) of organic substance.

4. Conclusion

From the results of this study we conclude that seeds vernalization and 150 mg/L gibberellins was increase the heads yield and reduce the time required onset of heads. Also sprayed plant with humic acid at 200 mgL^{-1} give the highest values in all characteristics. The interaction between seeds vernalization and 150 mg/L gibberellins and 200 mg/L humic acid recorded the highest values in most characteristics were studied

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