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Effect of Gibberillic Acid and Cycocel on Majorana Hortensis Mnch[1]

II. The essential oil

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ABSTRACT

Two growth regulators GA and CCC were used in this experiment to study their effect on sweet marjoram plants. The concentrations, used were 25, 50, and 100 ppm for GA and 500, 1,000, 1,500, 2,000 and 4,000 for CCC. The study of the effect of the growth regulators comprised the total fresh weight, the fresh weight of the plant organs, the total dry weight, the dry weight of the plant organs, percentage of essential oil in fresh plant organs, percentage of essential oil in dry plant organs and the physical and chemical properties of fresh leaves and racemes essential oils.

The results of the study showed that the total fresh weight was significantly increased with GA treatments, while it was significantly decreased with CCC treatments. The same result was obtained with the fresh weight of the plant organs except that the racemes were not affected. The total dry weight of the plant as well as that of the plant organs were higher in GA treatments than the control and CCC treatments in all cases. Percentage of essential oil of fresh plant organs was higher in GA 25 ppm and CCC 1500 ppm than the other treatments while in GA 100 ppm it was the lowest. No essential oil was found in the stems. Percentage of essential oil of dry plant organs was almost the same in all treatments. Physical and chemical properties of leaves and raceme oil were almost similar to those reported except the ester number of the raceme oil which was found to be higher than that of the leaf oil.

INTRODUCTION

In a previous publication by El-Ghitany *et al.* (4), the effect of GA and CCC on Majorana hortensis plants was studied. The study comprised the plant weight, plant diameter, number of branches and the time of blooming.

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As a continuation of our previous study, this part of our work is concerned with the study of the effect of both the two growth regulators GA and CCC on the quantity and quality of the essential oil of sweet marjoram. The aim was to find out a new method of treatment by which to increase the amount of the oil or to improve its quality.

MATERIALS AND METHODS

The plant material and the chemical used were those used in the previous study on the effect of the two growth regulators on the plant growth (4).

After getting the data for the plant height, the plant diameter, number of branches and the time of blooming of the treated plants, total fresh weight, total dry weight, percentage of the essential oil and its properties were estimated.

RESULTS AND DISCUSSION

1. Effect of GA and CCC on the total fresh weight

Regarding the total fresh weight, highly significant differences were observed between GA and CCC treatments in all cases. The highest increase was due to GA 25 ppm application Table 1. This concentration induced moderate cell elongation and consequently an increase in food assimilation occured which in turn increased the total fresh weight. The increase in the total fresh weight of plants induced by GA was reported by Wittwer and Bukova (13) and Sciuchetti (11).

Table 1 Effect of GA and CCC on average total fresh weight (in g) of sweet marjoram plants

	Average total fresh weight			
	1971 Experiment		1972 Experiment	
Treatments	1st cut	2nd cut	1st cut	2nd cut
GA (ppm)				
25	101.72a	128.06a	111.19a	126.30a
50	96.14ab	111.81b	94.42b	114.14ab
100	96.86ab	103.37bc	94.72b	109.47bc
CCC (ppm)				
500	75.94cd	90.36de	86.86bc	94.95de
1,000	83.81bc	101.50c	87.70bc	97.81cd
1,500	95.00ab	97.34cd	91.42b	104.67bcd
2,000	80.67c	87.98e	76.78cd	83.61ef
4,000	64.47d	71.00f	68.36d	75.25f
Control	97.28a	103.34bc	93.56b	105.98bcd
L.S.D.				
0.05	13.08	8.59	13.53	13.97
0.01	17.72	11.68	18.40	18.94

Means with common letter are equal at 0.05 level.

Contrary to the effect of GA it has been found that total fresh weight of the plant was increased with the decrease in CCC concentrations. CCC in low concentration increased chlorophyll formation in leaves and stem diameter and therefore gives rise to increased total fresh weight. High CCC concentrations induced dwarfism in plants resulting in smaller plants with reduced total fresh weight. The effect of CCC was studied by Anderson (1).

2. Effect of GA and CCC on the fresh weight of the plant organs

Significant differences between GA and CCC treatments in all cases were observed concerning the fresh weights of the plant organs. GA 25 ppm treatment showed the highest weights of leaves as shown in Tables 2 and 3. The increase in the leaf fresh weight when using GA 25 ppm was mentioned by Wittwer and Bukova (13) and Scott (12).

Treatment with CCC gave average leaf fresh weight more or less around the average of the control treatment except in the case of CCC 4,000 ppm treatment which gave remarkable decrease in the leaf fresh weight. The decrease was due to loss of easily dropped leaves and dwarfism of plants as described by Wittwer and Tolbert (14) and Humphries (8). The increase in the fresh weight of the racemes was also observed which was also highest with GA 25 ppm concentration.

Treatment with CCC 4,000 gave the lowest fresh weight. The effect of plant growth regulators on the flowers was previously studied by Marth *et al.* (10) and Kuraiski and Muir (9).

As shown before, GA 100 ppm concentration induced moderate cell elongation, this could be due to the fact that this concentration gave the highest fresh weight in

Table 2 Effect of GA and CCC on average fresh weight of the plant organs (in g) of sweet marjoram in 1971

	Average fresh weight of plant parts in 1971 experiment					
	1st cut			2nd cut		
Treatments	Leaves	Racemes	Stem	Leaves	Racemes	Stems
GA (ppm)						
25	56.72a	42.16ab	16.09bc	73.25a	28.56a	20.22bc
50	51.81ab	38.50b	19.03b	58.90b	28.50a	21.03b
100	33.72ab	31.42c	28.70c	25.17bc	25.20a	28.45a
CCC (ppm)						
500	20.75c	37.61b	11.64cd	47.22bc	22.45a	15.00d
1,000	26.33c	38.39b	11.28cd	52.95b	23.33a	17.73bcd
1,500	26.50c	40.72ab	14.12c	46.56bc	28.75a	16.44bcd
2,000	21.86c	38.50b	9.86d	55.64b	22.39a	14.94d
4,000	20.64c	32.06c	9.61d	33.50c	19.97a	14.40d
Control	31.14bc	45.03a	14.03c	55.61b	26.78a	16.00cd
L.S.D.						
0.05	24.85	5.49	3.54	15.31	8.30	4.68
0.01	33.68	7.44	4.82	20.75	11.24	6.36

Means with common letter are equal at 0.05 level.

Table 3 Effect of GA and CCC on average fresh weight of plant organs (in g) of sweet marjoram plants in 1972

	Average fresh weight of plant parts in 1972 exp.					
	1st cut			2nd cut		
Treatments	Leaves	Racemes	Stems	Leaves	Racemes	Stems
GA(ppm)						
25	42.22a	42.89ab	19.47cde	67.92a	33.50a	21.14bcd
50	33.75b	37.61b	23.33b	54.31b	34.33a	21.81bc
100	22.89cd	33.64c	33.91a	39.50a	39.50cd	30.28a
CCC (ppm)						
500	24.00c	39.78bc	18.08cde	43.64cd	29.48a	19.20bcd
1,000	20.67cd	41.70ab	18.50ab	42.59cd	30.33a	19.36bcd
1,500	43.00a	46.64a	20.19bcd	30.61bc	30.45a	18.78cd
2,000	23.28c	38.00bc	17.42de	36.11de	27.06a	17.92cd
4,000	20.36c	35.00c	16.42e	25.75e	26.61a	16.50d
Control	27.58bc	42.81ab	21.17bc	46.70bc	32.67a	23.78b
L.S.D.						
0.05	8.03	6.69	3.56	10.40	7.14	4.99
0.01	10.88	9.06	4.84	14.10	9.68	6.78

Means with common letter are equal at 0.05 level.

stems than other treatment. It would be also explained that CCC 4,000 ppm concentration gave the lowest average in stems due to induced dwarfism as mentioned by Humphries (8) and Halevy and Wittwer (7).

3. Effect of GA and CCC on the total dry weight of the plant

Analysis of variance for dry weight showed highly significant differences among the treatments of both the two cuts of the two years. The total dry weight increases with the increase in GA concentration. (Table 4). The corrilation existing between the total fresh weight and the different treatments is almost similar to that between the total dry weight and the different treatments. The obtained results coincide with those reported by Brian *et al.* (2) and Cabler (3).

4. Effect of GA and CCC on the dry weight of the plant organs (leaves, racemes and stems)

Concerning the dry weight of the plant organs, GA 25 ppm treatment showed an increase in the average dry weight of the leaves but a decrease in the average dry weight of the stems (Table 5 and 6), while GA 100 ppm treatment showed opposite results i.e. decrease in the average dry weight of the leaves and an increase in that of the stem. This result was reported by Cabler (3).

5. Effect of GA and CCC on the percentage of essential oil in the fresh plant organs (leaves, racemes and stems)

In comparison with the control plants, an increase in the percentage of the essential oil both in the leaves and racemes in this work was reported (Table 7). As far as we

Table 4 Effect of GA and CCC on average total dry weight (in g) sweet marjoram plants

	Average total dry weight		
	1971 Experiment	1972 Experiment	
Treatments	1st cut and 2nd cut	1st cut	2nd cut
GA (ppm)			
25	38.44a	47.33ab	41.00a
50	37.06a	49.11ab	35.67ab
100	37.44a	44.33bc	40.00d
CCC (ppm)			
500	23.44cd	44.00bc	22.89c
1,000	20.11d	51.33a	18.44c
1,500	24.11bc	39.67cd	22.00c
2,000	24.00bc	37.00de	20.33c
4,000	21.56cd	30.89e	18.22c
Control	26.89b	37.33d	29.89b
L.S.D.			
0.05	3.25	6.15	
0.01	4.28	8.10	

know this is the first time to report an increase in sweet marjoram oil to be achieved in plants treated with GA.

According to Sciuchetti (11), GA has no effect on the essential oil percentage of sweet marjoram plant. However, this experiment showed that low concentrations of GA (25 ppm) induce light increase in the oil content comparing with the control plants

Table 5 Effect of GA and CCC on average dry weight of the plant organs (in g) of sweet marjoram plants in 1971

	Average dry weight of the plant organs of 1971 exp.					
	1st cut			2nd cut		
Treatments	Leaves	Racemes	Stems	Leaves	Racemes	Stems
GA (ppm)						
25	16.67a	17.56a	7.44bc	16.67a	12.22b	7.44bc
50	14.11a	18.00a	8.61b	14.11a	10.78bc	8.61b
100	10.06b	13.67b	13.22a	10.06b	16.22a	13.22a
CCC (ppm)						
500	7.61bc	13.00b	5.50de	7.61bc	7.67cd	5.50de
1,000	7.56bc	11.67bc	3.72f	7.56bc	6.00d	3.72f
1,500	7.50bc	13.56b	4.28ef	7.50bc	11.00bc	4.28ef
2,000	8.06bc	11.56bc	4.61ef	8.06bc	11.00bc	4.61ef
4,000	6.72c	9.44c	6.44cd	6.72c	7.22d	6.44cd
Control	10.17b	14.67ab	5.55de	10.17b	7.33d	5.55de
L.S.D.						
0.05	2.69	3.38	1.50	2.69	3.38	1.50
0.01	3.43	4.46	1.99	3.43	4.46	1.99

Means with common letter are equal at 0.05 level.

Table 6 Effect of GA and CCC on average dry weight of the plant organs (in g) of sweet marjoram plants in 1972.

	Average dry weight of the plant organs of 1972 exp.					
	1st cut			2nd cut		
Treatments	Leaves	Racemes	Stems	Leaves	Racemes	Stems
GA (ppm)						
25	13.44a	21.44bc	10.61b	19.00a	13.22ab	10.61b
50	10.56bc	15.00d	9.22bc	16.00b	10.67bcd	9.22bc
100	7.11de	16.33d	17.83a	11.22c	14.56a	17.83a
CCC (ppm)						
500	8.89bcd	23.78ab	8.72bc	9.11d	8.00cde	8.72bc
1,000	10.67b	25.89a	9.00bc	7.67de	6.44e	9.00bc
1,500	6.78e	22.78ab	7.89c	6.11e	10.22bcde	7.89c
2,000	6.89de	16.33d	8.89d	7.22de	11.00abc	8.89bc
4,000	4.44f	17.67cd	6.78c	6.78c	7.11de	6.78c
Control	8.56de	17.22d	8.94bc	15.00b	8.56cde	8.94bc
L.S.D.						
0.05	2.02	3.80	2.74	2.02	3.80	2.74
0.01	3.92	5.01	3.61	3.92	5.01	3.61

Means with common letter are equal at 0.05 level.

which did not appear statistically. This increase is due to moderate growth of the plant associated with an increase in essential oil assimilation. In case of using high concentrations of GA (100 ppm) oil assimilation became slow.

Treatments with CCC apparently increased the oil percentages in the plant. The increase was not directly due to CCC effect but it was due to the formation of chlorophyl which helps in food assimilation and indirectly increase the percentage of the oil.

The percentage of the oil in general differs from one organ to another but it was found to be higher in the flowers than in the other organs of the plant (Table 7). The stems are almost free from the oil.

6. Effect of GA and CCC on the percentage of essential oil in the dry plant organs (Leaves, racemes, and stems)

The results obtained from analysis for the essential oil percentage of the dry plant organs (Table 8) showed the following:

No essential oil was found in the dry stems.

GA 25 and CCC 500 ppm treatments gave the highest oil percentage while GA 100 ppm gave the lowest percentage in the leaves.

GA 25, CCC 500, 1,000 and 4,000 ppm applications gave the same results given in the control treatment.

GA 100 ppm treatment gave the lowest essential oil percentage.

7. Effect of GA and CCC on oil properties

Regarding the physical and chemical properties of the essential oil of sweet marjoram, treated plants with both GA and CCC, the obtained results were found to be fluctuating (Table 9), but within the range of those reported for untreated sweet

Table 7 Effect of GA and CCC on average percentage of essential oil of the fresh plant organs (in % weight)

	Average percentage of essential oil							
	1971 Experiment				1972 Experiment			
	1st cut		2nd cut		1st cut		2nd cut	
Treatments	Leaves	Racemes	Leaves	Racemes	Leaves	Racemes	Leaves	Racemes
GA (ppm)								
25	0.68ab	0.83bc	0.67b	0.77abc	0.72a	0.84bc	0.67a	0.78a
50	0.64c	0.76c	0.63cd	0.65d	0.63e	0.80e	0.58cde	0.67c
100	0.55de	0.68c	0.42g	0.52e	0.57f	0.70d	0.35f	0.50d
CCC (ppm)								
500	0.65bc	0.92ab	0.66bc	0.82a	0.69bc	1.02a	0.62abc	0.76a
1,000	0.64c	0.79bc	0.48f	0.66cd	0.67cd	0.78d	0.53de	0.69bc
1,500	0.69a	1.04a	0.61d	0.80ab	0.66d	0.82bc	0.66ab	0.73ab
2,000	0.54e	0.83bc	0.55e	0.69bcd	0.56g	0.79cd	0.59bcd	0.74ab
4,000	0.58d	1.00a	0.75a	0.69bcd	0.63e	0.85bc	0.65abc	0.69bc
Control	0.67abc	0.82bc	0.55e	0.75abcd	0.70ab	0.89b	0.51e	0.75a
L.S.D.								
0.05	0.041	0.164	0.041	0.123	0.062	0.103	0.080	0.061
0.01	0.056	0.221	0.056	0.160	0.080	0.130	0.110	0.083

Means with common letter are equal at 0.05 level.
N.B. No essential oil was found in the fresh stems.

Table 8 Effect of GA and CCC on average percentage of essential oil of the dry plant organs (in % weight)

	Average percentage of essential oil	
	1971 and 1972 Experiments	
	First and second cuts	
Treatments	Leaves	Racemes
GA (ppm)		
25	1.93a	2.09a
50	1.77ab	1.83b
100	1.33c	1.53c
CCC (ppm)		
500	1.95a	2.14a
1,000	1.83ab	2.05a
1,500	1.79ab	1.82b
2,000	1.72ab	1.80b
4,000	1.62b	2.12a
Control	1.86ab	2.23a
L.S.D.		
0.05	0.29	0.21
0.01	0.39	0.28

Means with common letter are equal at 0.05 level.
N.B. No essential oil was found in the dry stems.

marjoram plants as reported by Guenther 1960 (6) and Gildemeister and Hoffmann (5).

The only difference observed was that of the ester value which was higher in case of oil in the leaves.

Table 9 Effect of GA and CCC on average physical and chemical properties of sweet marjoram fresh leaf oil

	Average physical & chemical properties				
Treatments	Specific gravity	Refractive index	Optical rotation	Ester value	Colour
GA (ppm)					Yellow to yellowish-green
25	0.8893	1.475	+16° 0	53.96	
50	0.8764	1.474	+15° 50	41.46	
100	0.8860	1.479	+15° 25	48.00	
CCC (ppm)					
500	0.8891	1.480	+15° 0	51.12	
1,000	0.8915	1.482	+18° 0	51.79	
1,500	0.8897	1.476	+15° 50	49.17	
2,000	0,8913	1.477	+15° 75	49.76	
4,000	0.8900	1.477	+18° 25	42.32	
Control	0.8900	1.480	+18° 50	54.62	

N.B. No variations were found in the fresh leaves essential oil properties between 1971 and 1972 experiments.

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تأثير حمض الجبريليك والسيكوسيل على نبات البردقوش

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٢ – الزيت الطيـــار

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المستخلص

في بحث سابق تم دراسة تأثير كل من حمض الجبريليك والسيكوسيل على نمو نبات البردقوش . واتماما لما سبق دراسته اجري هذا البحث لدراسة تأثير كل من المنظمين المذكورين على نبات البردقوش متناولين النقاط الآتية :-

١ - الوزن الكلي الطازج للنبات .

٢ - الوزن الطازج لاجزاء النبات المختلفة (الازهار - الاوراق - السيقان)

٣ - الوزن الكلى الجاف للنبات .

٤ - الوزن الجاف لاجزاء النبات المختلفة (الازهار - الاوراق - السيقان)

٥ - نسبة الزيت الطيار باجزاء النبات الطازجة (الازهار - الاوراق - السيقان) .

٦ - نسبة الزيت الطيار باجزاء النبات الجافة (الازهار - الاوراق - السيقان) .

٧ - المواصفات الطبيعية والكيميائية لزيت البردقوش (زيت الاوراق وزيت الازهار) .

وقد اثبتت التجارب ان حمض الجبريليك يؤثر بالزيادة وان السيكوسيل مؤثر بالنقص على كل من الوزن الكلى الطازج للنبات والوزن الطازج لاجزاء مختلفة والوزن الكلي الجاف للنبات والوزن الجاف لاجزاء مختلفة وان حمض الجبريليك بتركيز ٢٥ جزء في المليون والسيكوسيل بتركيز ١٥٠٠ جزء في المليون يؤثر كل منهما بالزيادة في نسبة الزيت الطيار في اجزاء النبات الطازجة . ولم يظهر أى تأثير لتركيزات المنظمين المختلفة على المواصفات الطبيعية والكيميائية لزيت البردقوش .