Effect of Gibberellic Acid and Cycocel on Majorana hortensis Mnch[1]

I. The Plant Growth

M. Y. EL-GHITANY[2], FAWZY T. HUSSEIN[3], AND
ABD-EL-MAGEID SALEEM[4]

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 growth regulators comprised plant height, plant diameter, number of branches and the time of blooming.

The results of the study showed that the plant height was significantly increased due to GA treatments while it was significantly reduced due to CCC treatments in comparison with the control plants. Plant diameter showed a significant increase due to GA treatments and significant decrease due to CCC treatments. The number of branches was more in the GA treatments than the control and the CCC treatments. The time of blooming was not affected by the different treatments.

INTRODUCTION

Sweet marjoram (*Majorana hortensis* Mnch.) is a perennial plant grown in Egypt for foreign markets since 1952, and it has become one of the most commercially important medicinal plants. It has a peculiar sweet minty taste and flavour. The leaves are used fresh or dry as a condiment for seasoning food and poultry. The dried leaves combined with some other herbs are used in sweets, soups, sausages and also in fish and sauce recipes. Sweet marjoram oil is reputed for its use in medicine as a carminative and expectorant.

Sastri (6) mentioned that the oil is used in the treatment of bruises, constipation, paralytic limbs, tooth ache and acute diarrhoea. The oil is used in manufacturing perfumes, soups and some liquors.

Sweet marjoram oil can be obtained by the steam distillation of the leaves and flowering tops of the plants. The percentage of the essential oil in the plant varies according to different factors. It generally ranges from 0.3 to 0.4% referred to the

[1] *This work was undertaken in Egypt.*

[2] *Faculty of Agriculture, Alexandria University, Alexandria, Egypt.*

[3] *Faculty of Pharmacy, University of Tripoli, Tripoli, Libya.*

[4] *Faculty of Agriculture, Alexandria University, Alexandria, Egypt.*

fresh weight, and 0.7 to 3.5% referred to the dry weight. It has been found that the oil content of the plant is at its highest level when the plant is harvested just before the seed formation. The oil is pale yellow to yellowish-green, having a pungent odour.

The increasing importance of sweet marjoram because of economic value in the world market, drew the attention of many research workers towards the improvement of the plant qualities as well as its oil contents and properties.

Therefore, sweet marjoram was chosen to be the focus of this work with the aim of studying the effect of the two growth regulators Gibberellic acid (GA) and Cycocel (CCC) on the vegetative growth of the plant in order to find out the most favourable conditions to improve the properties of the plant and consequently the essential oil quantity and quality.

MATERIALS AND METHODS

Majorana hortensis Mnch. (sweet marjoram) plants subjected to this experiment were grown from seedlings obtained from the Medicinal and Aromatic Experimental Station, Ministry of Agriculture at El-Kanater El-Khieria, Cairo, Egypt.

The two growth regulators used in this work were:

A) Gibberellic Acid (GA), known commercially as 'Berelex' which was obtained in the form of tablets from Plant Production Limited Co., England.

B) 2-Chloroethyl trimethyl ammonium chloride, known commercially as Cycocel (CCC) which was obtained in the form of a solution from the National Research Centre, Doki, Cairo, Egypt.

The two compounds were utilized as solutions in the concentrations 25, 50, and 100 ppm for GA and 500, 1,000, 1,5000, 2,000, and 4,000 ppm for CCC.

The statistical set-up of the experiment was a complete randomized block-design of nine treatments with four blocks. The nine treatments consisted of three different concentrations of GA and five different concentrations of CCC in addition to a control treatment.

The chemical treatments were represented by one plot within each block, in addition to the control treatment. Each block comprised nine separate plants. Data was based on the analysis of each of the nine plant treatments for all studies. Analysis of variance was calculated for the mean of each block.

The experimental work started on March 3rd, 1971, by potting the seedlings in 8 cm pots. The seedlings were transplanted to 30 cm pots on April 6, 1971 when they were 10 to 12 cm high, and having 4 to 5 branches. The same experiment was repeated in the same season of the year 1972. The plants were first treated with the chemical solutions fifteen days after transplanting. For the second harvest the plants were treated fifteen days after harvesting.

The treated plants were sprayed three times at ten day intervals. Plant height, plant diameter, number of branches and date of blooming were recorded after each spray and at the end of each growing season.

RESULTS AND DISCUSSION

I. Effect of GA and CCC on plant height

From the two-year experiment, it has been found (Table 1) that GA and CCC induced a highly statistically significant increase in the plant height in comparison with the control treatment for every cut each year. The best treatment was obtained when using

Table 1 Analysis of variance for the average plant height of sweet marjoram plants treated with GA and CCC

Source of variation	Degree of freedom	Mean squares			
		1971 Experiment		1972 Experiment	
		1st cut	2nd cut	1st cut	2nd cut
Blocks	3	2.68	6.68	1.77	5.21
Treatments	8	603.90[a]	561.07[a]	385.88[a]	660.64[a]
Error	24	2.23	2.44	3.49	4.15

[a]Significant at 0.01 level.

GA in the concentration 100 ppm followed by 50, then 25 ppm. CCC concentrations on the contrary reduced the plant height as compared with the control. The lowest treatment with CCC was when using the concentration 4,000 ppm (Table 2). Figures 1 and 2 indicate remarkable differences between the heights of the treated plants as compared with the control plants.

The increased height of the plants induced by GA treatment is due to the elongation of cells produced by GA. It is known that cell elongation in the stems leads to elongation of the enternodes and this was reported by Brain *et al.* (1).

Dwarfism was induced in plants treated with CCC. This induced effect increased with the increase in CCC concentrations. In this work 4,000 ppm concentration showed the shortest plants in all treatments. The effect of CCC on plants is not only due to preventing cell elongation but also it stops cell division specially in the apical tops. This leads consequently to dwarfism as reported by Wittwer and Tolbert (9) and Van Elyen *et al.* (8).

Table 2 Effect of GA and CCC on average plant height (in cm) of sweet marjoram

Treatments	Average length			
	1971 Experiment		1972 Experiment	
	1st cut	2nd cut	1st cut	2nd cut
GA ppm				
25	55.50c	40.42c	55.89c	42.78c
50	61.50b	45.98b	61.94b	47.86b
100	72.36a	55.39a	66.69a	57.92a
CCC ppm				
500	45.11e	25.11e	46.86e	26.19e
1,000	42.89f	25.48ef	45.97ef	25.67e
1,500	42.47 f	25.48e	45.42ef	26.39e
2,000	40.75f	24.33e	43.33f	24.00e
4,000	31.75g	21.03f	34.03g	20.17f
Control	50.78d	33.72d	49.78d	34.53d
L.S.D.				
0.05	2.23	2.31	2.76	2.97
0.01	3.02	2.13	3.75	4.03

Means with common letter are equal at 0.05 level.

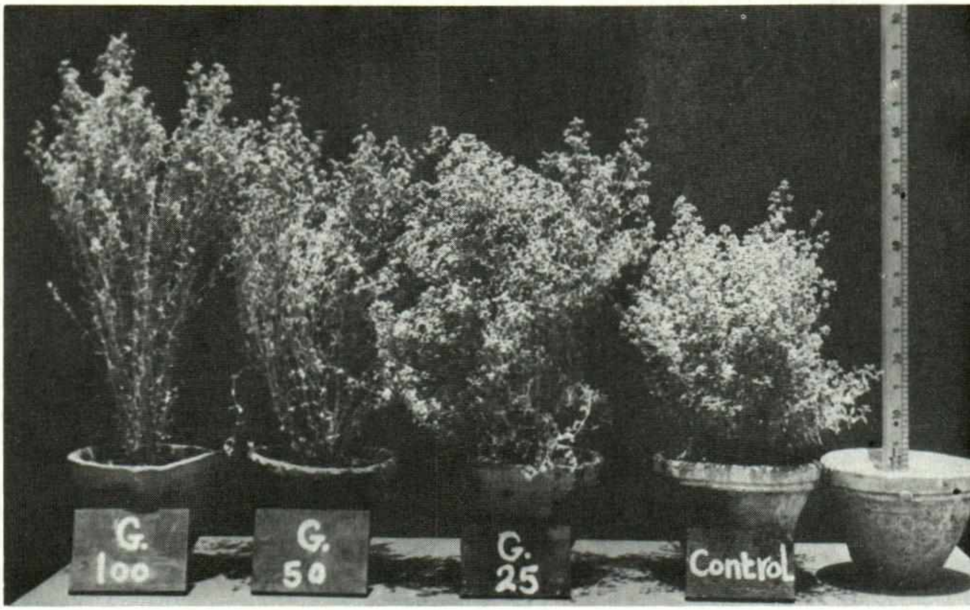

Fig. 1. Effect of GA on the height of sweet marjoram plants.

It has been found that the height of the plants of the first cuts were in general taller than the corresponding plants of the second cuts. This can be explained by two reasons:

1. The rate of growth is faster in young plants than when they get old.
2. The increase in temperature at the time of the second cut inhibits the growth activity rate of the plants which in turn gives plants shorter than those of the first cut.

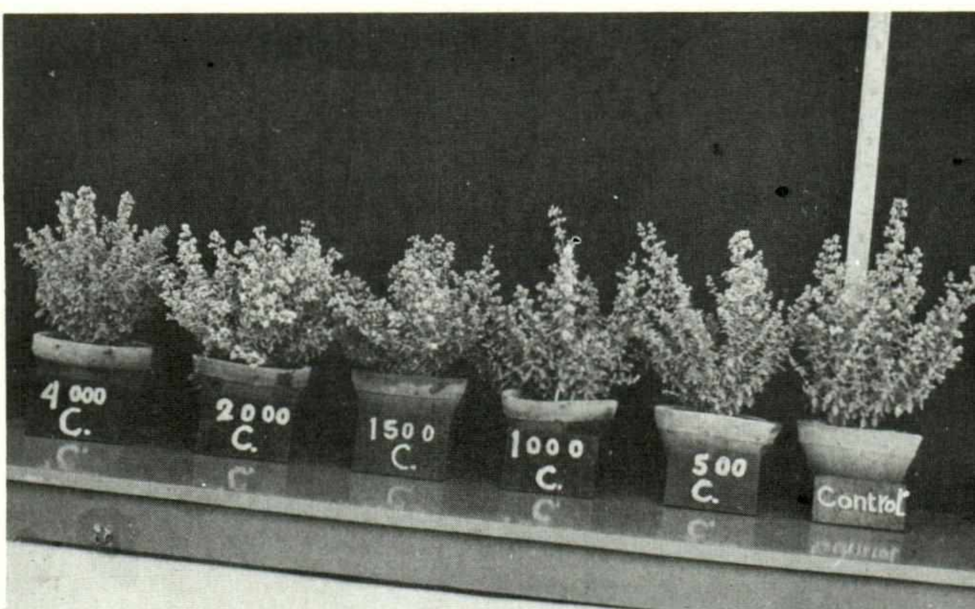

Fig. 2. Effect of CCC on the height of sweet marjoram plants.

Table 3 Analysis of variance of the average plant size (in cm) of sweet marjoram plants treated with GA and CCC

Source of variance	Degree of freedom	Mean Squares			
		1971 Experiment		1972 Experiment	
		1st cut	2nd cut	1st cut	2nd cut
Blocks	3	1.38	4.54	2.99	1.06
Treatments	8	2.42[a]	3.91 N.S.	5.47[b]	5.49[b]
Error	24	0.71	2.43	0.49	1.55

[a]Significant at 0.05 level.
[b]Significant at 0.01 level.
N.S. Not significant.

The sensitivity of sweet marjoram to environmental conditions was previously reported by Rudorf *et al.* (5) and Schroeder (7).

II. Effect of GA and CCC on plant diameter

Concerning the effect of GA and CCC on the diameter of the plant, Table 3, indicates a statistically significant effect in the second cut of the first season. The plants treated with GA did not show any differences from the control plants except when using GA concentration of 50 ppm, which gave plants with increased diameter, while CCC concentrations 1,000 and 4,000 ppm were the least concentrations of CCC which produced plants with decreased diameters (Table 4).

Statistically significant effects on plant diameter were observed due to the induced effect of GA and CCC treated plants. The greatest effect appeared in GA treated plants, while the least effect appeared in the CCC treated plants. This is due to the

Table 4 Effect of GA and CCC on average plant diameter (in cm) of sweet marjoram plants

Treatments	Average diameter			
	1971 Experiment		1972 Experiment	
	1st cut	2nd cut	1st cut	2nd cut
GA (ppm)				
25	27.39ab	25.47a	26.14a	26.94a
50	28.00a	24.14a	26.25a	25.42abc
100	27.06abc	25.28a	26.06ab	26.72ab
CCC (ppm)				
500	26.36bcd	24.78a	24.25cd	25.24abc
1000	26.08cd	24.45a	24.61cd	24.89bcd
1500	26.72bcd	24.17a	24.98c	25.61abc
2000	26.25bcd	24.14a	23.61de	24.53cd
4000	25.56d	22.28a	22.89e	23.14d
Control	27.47ab	25.45a	25.09bc	26.22abc
L.S.D.				
0.05	1.24	2.31	1.03	1.94
0.01	1.68	3.13	1.40	2.63

Means with common letter are equal at 0.05 level.

Table 5 Analysis of variance for the average number of branches of sweet marjoram plants treated with GA and CCC

Source of variation	Degree of freedom	Mean Squares			
		1971 Experiment		1972 Experiment	
		1st cut	2nd cut	1st cut	2nd cut
Blocks	3	573.80	46.30	83.73	76.20
Treatments	8	554.95[a]	1607.75[a]	412.00	1394.29[a]
Error	24	74.41	48.03	55.65	54.27

[a] Significant at 0.01 level.

well-known effect of GA and CCC on the rates of growth activity of plants either longitudinally or horizontally which consequently induced a variable effect on the number of branches, their distribution and the plant diameter.

III. Effect of GA and CCC on the number of branches

From (Table 5) it seems obvious that both GA and CCC induced a highly statistically significant effect on the number of branches of the plant.

Concerning the effect of GA and CCC on the number of branches of the plant, both experiments in the two seasons gave the same results as shown in Table 6.

Plants treated with GA showed an increased number of branches in comparison with control plants. The concentration 100 ppm gave the highest number of branches.

Contrary to the effect of GA on the number of branches CCC decreased the number of branches of the treated plants.

Table 6 Effect of GA and CCC on average number of branches of sweet marjoram plants

Treatments	Average number of branches			
	1971 Experiment		1972 Experiment	
	1st cut	2nd cut	1st cut	2nd cut
GA(ppm)				
25	94.89ab	126.64ab	98.67bc	128.47ab
50	106.73a	120.36bc	106.78ab	123.72bc
100	106.86a	136.05a	117.42a	136.56a
CCC(ppm)				
500	78.31c	85.92de	97.92bcd	96.45d
1,000	90.06bc	95.89d	90.36cde	97.42d
1,500	108.89a	84.14e	87.39de	88.06d
2,000	89.59bc	89.69de	85.67e	93.59d
4,000	78.83c	86.03de	90.25cde	87.89d
Control	101.72ab	113.67c	95.36cde	115.31c
L.S.D.				
0.05	12.78	10.40	11.17	11.00
0.01	17.31	14.10	15.13	14.91

Means with common letter are equal to 0.05 level.

The increase in number of branches is due to GA which induced activity on lateral branches producing buds. The more concentrations, the more effective the solution. This was previously reported by Brain and Hemming (1) and Greulach and Haesloop (2).

It has been reported that CCC inhibits bud activity and prevents branching in plants. It increases only the thickness of branches as mentioned by Wittwer and Tolbert (9) and Van Eylen and De Doncher (8). The second cuts in the two experiments gave more branched plants compared with the first cuts. This was due to two reasons:

1. The cut branches usually develop newer branches in greater numbers than before.
2. A high temperature helps the plant more in developing branches than in growing in height.

IV. Effect of GA and CCC on the time of blooming

It has been found that both GA and CCC treatments did not show any effect on either the blooming or the full blooming time of the treated plants as compared with control plants (Table 7). The blooming stage is considered the period which starts from the time of the formation of the flower bud to the time of complete formation of the white petals of the flower.

Table 7 Effect of GA and CCC on the time of blooming of sweet marjoram plants

Experiment	Cut	Date of blooming
1971	1st cut	1–18 June
	2nd cut	20 July–1st August
1972	1st cut	20 June–7 July
	2nd cut	15–30 August

The end of the blooming stage i.e. the complete formation of the flowers is known as the full blooming stage. This can be explained by the fact that GA directs the plant growth activity towards cell elongation and not towards the formation of flowers. This theory is reported by Kljuka (3) and Kuraiska and Muir (4).

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تأثير حمض الجبريليك والسيكوسيل على نبات البردقوش

١ – النمــو الخضري للنبات

محمد يسرى الغيطاني – فوزي طه حسين – وعبد المجيد سليم

المستخلص

يعتبر نبات البردقوش من النباتات العطرية والطبية الهامة ولزيادة الاهتمام به اجري هذا البحث لدراسة تأثير اثنين من منظمات النمــو النباتية هما حمض الجبريليك والسيكوسيل على النمو الخضرى للنبات بقصد الوصول إلى أفضل الطرق لتحسين صفات النبات وبالتالى جودة زيت البردقوش الطيار وزيادة كميته .

وقد شملت الدراسة في هــذا البحث تأثير المنظمين المذكورين على طول النبات وسمكه وعدد الأفرع ووقت الأزهار .

وبمعاملة النبات بتركيزات مختلفة من محاليل المنظمين المذكورين وجد ان حمض الجبريليك بتركيزات معينة يؤثر بالزيادة على كل منطول النبات وسمكه وعدد الأفرع الناتجة منه وليس له تأثير واضح على وقت الأزهار .

كما وجد ان السيكوسيل يؤثر بالنقص على كل من الطول والسمك وعدد الأفرع الناتجة وليس له تأثير واضح على وقت الأزهار .