EFFECT OF PRUNING AND GROWTH REGULATORS ON ROSE GROWTH AND FLOWERING I – CYCOCEL APPLICATION

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ABSTRACT

Roses are perhaps the most famous flower in the world. They occupy the first position in the worldwide flower trade. Roses are used in the landscape as well as cut flowers. This study was carried out in order to enhance quality as well as quantity of the cut flower yield via pruning and cycocel application.

This experiment was laid out in a split plot design as one-year-old rose plants "*Rosa hybrida* cv. Mercedes" planted in a plastic house were divided into 2 main plots. Branches of the first main plot were pruned in mid October 2000 after the 4th mature leaf, while the second one was pruned after the 6th mature leaf. Each plot was divided into 4 subplots. Each subplot was sprayed with cycocel (CCC) at either 0, 150, 300 or 450 ppm. Three sprays were applied at monthly intervals, starting on November 20th, 2000. Treatments were repeated in the second season 2001-2002.

The effect of pruning was insignificant on most of studied characters. However, pruning at 6 leaves proved significantly better than pruning at 4 leaves in increasing number of mature leaves/plant (second flush 2001), number of bottom break/plant (first flush 2002), number of flowers/m^2 during summer (second flush 2001 and 2002) and in decreasing number of days to flowering (first flush 2002). Contents of chlorophyll a and b in leaves, and petal carotene

(first flush and second flush, 2002) were also greater when plants were pruned at 6 leaves.

Cycocel concentration exerted a significant influence on almost all the characters under investigation. Cycocel at 450 ppm scored the greatest number of significant effects on the following characters: number of immature leaves/plant, number of bottom break/plant, number of flowers/m^2 during summer (second flush 2001 and 2002), flower stem weight (in almost all cases), flower bud diameter and number of mature leaves/plant in the second flush. Chlorophyll a was also highest using cycocel at 450 ppm.

Cycocel at 300 ppm gained the highest significant record in increasing the number of mature leaves/plant in the first flush and flower stem length in 2001, while cycocel at 150 ppm gave the earliest flowering and the longest flower stem in 2002.

It is recommended to prune rose shrubs at the 6th leaf and to apply cycocel either at 450 ppm to get as many flowers as much or at 150 ppm if flowering precocity is sought.

Key words: rose, pruning, cycocel, cut flower.

INTRODUCTION

Roses are probably the most widely grown flowers and certainly among the most beautiful, cultivated practically everywhere that gardening is done. Greenhouse roses growing for cut flowers are now a very big commercial industry.

Imports of the European Union of fresh cut flowers has since 1993 been dominated by roses. Rose imports increased by about 47% between 1990 and 1994, amounting to EU 339 million (1.8 million tons) in 1994 and EU 348.3 million in 1996. Egypt rose exports in 1991 were 556 tons. This quantity decreased in 1992 to 382 tons to rise again in 1993 to 459 tons. **(El-Saied and Hossnei, 1998)**

Bush roses should be pruned in order to promote longer-stemmed blooms of superior qualities. However, the extent to which this procedure is carried out has a remarkable effect on the final

product. **Mortensen and Gislerod (1994)** showed that hard pruning of plants (6 months old) of the cut rose cultivars Baronesse and Kiss significantly decreased yield. **Paul *et al* (1995)** reported that the severity of pruning influenced yield parameters of *Rosa damascena*. Yield was negatively correlated with increasing intensity of pruning. **YounYol *et al* (1997)** indicated that total yield of cut flowers of roses (cultivars Mary Devor and Aalsmeer Gold), harvested in autumn and winter was increased by 33% for plants cut back and pinched out twice. The pruning treatments during summer dormancy (1 July-25 August) also increased the percentage of high quality cut flowers by 53% compared with the control.

On the contrary, **ZhaoFa *et al* (1998)** reported that pruning severity had little influence on bud development, flowering and cut flower quality. **Sarkka and Rita (1999)** found that in flush 1 the pruned 1.5-year-old rose plants of Mercedes produced more first grade blooms.

Using plant growth substances to improve cut flowers quality is an acknowledged practice now. Cycocel is famous for its ability to affect growth and development in an unlimited number of plants.

Atawia and Hassan (1995) showed that cycocel (chlormequat) at 1000 or 2000 ppm reduced growth parameters of pear cv. Le Conte trees and enhanced flowering in the following year. **Srivastava *et al* (2000)** mentioned that application of cycocel (CCC) promoted flowering in Eureka lemons. **Chen *et al* (2002)** found that *Gynura aurantiaca* plants treated by cycocel (as foliar sprays in two applications in March at two weeks interval) exhibited little improvement in their appearance compared to the control; some treatments were even detrimental. Regardless of application concentrations, subsequent growth of plants after pruning was not affected.

MATERIALS AND METHODS

This experiment was carried out in the ornamental nursery of the College of Agriculture, Ain Shams University in two successive years: 2000-2001 and 20001-2002.

Transplants of one-year-old rose plants "*Rosa hybrida* cv. Mercedes" budded onto *Rosa indica major* rootstocks were planted in mid February 2000 in a plastic house (41.50 m length x 8.00 m width x 3.20 m height). Plastic used was in the form of UV-proof sheets 20 mμ thick. Sheets of black saran were laid over the roof of the plastic house in summer only; to reduce heat inside the house as it allowed 63.5% shading. Average light intensity at plant top level was 14500 lux. Temperature in summer was about 10 degrees lower within the plastic house. Removing this shade in winter rendered it 10 degrees higher than without. Relative humidity inside the house was about 10-15% higher than outside. Meteorological records in the open air of the two seasons of this study are shown in Table (a).

Soil was hoed thoroughly and mixed with 2.5 m^3 of old decomposed organic manure (at the rate of 30 m^3/feddan). Chemical analysis of this manure is shown in Table (b).

One longitudinal central pathway (1.60 m wide) was outlined. Two ridges (1.00 m wide, 38 m long), 0.60 m apart were erected on each side of the pathway. Rose plants were planted on each side of the ridge at 0.30 m distance. Thus, each ridge had 126 plants on each side, leaving 2 longitudinal meters barren at each end. Total number of plants in the house was 1008 plants, of which 144 plants were chosen for this study. The chosen plants were as similar as possible in being 20-25 cm high, having 2-3 main branches. Each 10 plants occupied 1 m^2. All plants were fertilized by a 1:2:1 NPK fertilizer at 40g/m^2, at the first of each month from November to March in addition to the first of May. Plants received an extra nutrition through Kristalon solution at 2 g/l, sprayed twice in mid December and mid March.

The experiment was laid out in a split plot design as plants were divided into 2 main plots. Branches of the first main plot were pruned in mid October 2000 (when the experimental work of this study started) after the 4th mature leaf (the 5-leaflet leaf which subtended a flat dormant bud), while the second one received the same treatment after the 6th mature leaf (similar to that mentioned before). Each plot was divided into 4 subplots. Each subplot, represented in 3 replicates (with 6 plants in each replicate), was sprayed with cycocel (CCC) at either 0, 150, 300 or 450 ppm.

Three sprays were applied at monthly intervals, starting on November 20th, 2001. Treatments were repeated in the second season 2001-2002 and data were taken in both seasons.

Table (a) - Meteorological records in 2000 - 2002

	2000				2001				2002			
	Temp.			R.H.%	Temp.			R.H.%	Temp.			R.H.%
	max.	min.	ave.		max.	min.	ave.		max.	min.	ave.	
Jan	19.7	7.8	13.1	63	22.0	9.1	14.2	68	22.8	8.5	14.5	69
Feb	21.7	10.1	15.5	67	20.3	7.4	13.8	64	21.0	10.1	14.9	66
Mar	24.9	11.3	18.3	58	22.6	10.3	16.2	64	24.6	11.7	17.7	66
Apr	27.5	19.2	20.4	57	27.0	13.4	20.0	53	27.8	13.8	20.4	57
May	32.2	17.5	24.4	56	33.8	18.4	25.6	51	34.8	19.0	26.4	53
June	37.6	22.6	30.0	50	37.6	22.6	30.0	54	35.1	20.9	27.5	60
July	36.2	23.6	29.3	61	36.2	23.6	29.3	61	35.9	22.7	28.5	64
Aug	35.8	23.4	28.7	68	35.8	23.4	28.7	68	36.2	23.3	28.8	66
Sep	36.1	22.0	28.1	65	36.1	22.0	28.1	65	35.9	22.2	24.8	63
Oct	31.1	18.8	24.1	69	31.1	18.8	24.1	69	30.3	18.1	23.4	66
Nov	26.5	13.5	19.3	62	26.5	13.5	19.3	62	26.7	15.8	20.0	73
Dec	20.4	9.0	14.1	76	20.4	9.0	14.1	76	23.0	9.7	15.4	68

Table (b) - Chemical analysis of the organic manure

Component	%	Component	%	Component	%
moisture	8.84	ash	14.10	phosphorus	0.54
crude protein	6.70	nitrogen free ext.	32.70	potassium	1.07
crude fibre	33.60	calcium	2.45		

Data were obtained, unless otherwise mentioned, at the first flush of flowering and the second one for both years as follows:

1 - Number of immature leaves/plant
2 - Number of mature leaves/plant
3 - Number of bottom break/plant (in autumn and spring)
4 - Number of flowers/m^2 during summer (second flush)
5 - Number of days to flowering (first flush)
6 - Flowering earliness in days (first flush)
7 - Flower stem length (cm)
8 - Flower stem diameter (cm)
9 - Flower stem weight (g)
10 - Flower bud diameter (mm) (first flush)
11 - Leaf content of chlorophyll a (mg/g fresh weight) (Year 2002)
12 - Leaf content of chlorophyll b (mg/g fresh weight) (Year 2002)
13 - Petal content of carotene (mg/g fresh weight) (Year 2002)

First flush extended from December 21st to February 15th in 2000/2001 and from December 18th to February 1st in 2000/2001. Second flush started on March 28th or 15th and ended on June 15th or 20th in 2000/2001 and 2001/2002, respectively. The number of bottom break in the first flush represents the number of cut flowers with suitable parameters for foreign markets.

SAS computer program version 1995 was used to analyze these data. Means were compared by L.S.D. method according to **Snedecor and Cochran (1980)**.

RESULTS AND DISCUSSION

1 - Number of immature leaves/plant (Table, 1):

1 - a - There was no significant difference between the two pruning treatments (at the fourth or sixth leaf) on number of immature leaves/plant either in the first or second flush in both years of the experiment.

1 - b - Cycocel concentration had a significant effect on number of immature leaves/plant. In the first flush of 2001, this character rose significantly from 4 leaves/plant in the control treatment to 5.84 with CCC at 150 ppm. Although this number increased as CCC concentration increased from 150 to 300 and further to 450 ppm, the other significant difference was that between CCC at 150 and at 450 ppm treatments. In 2002, number of leaves/plant increased significantly as CCC concentration increased from 0 to 300 ppm. Increasing CCC concentration to 450 ppm did not add a significant increase in this concern.

At the second flush, a similar trend was observed as this character increased significantly in the first year with increasing CCC concentration from 0 ppm to 300 ppm. The last increase in CCC concentration to 450 ppm did not achieve any significant effect. In the second year, all CCC treatments had a positive effect on this character at the second flush compared to the control treatment. However, the difference between CCC at 300 ppm and 450 ppm was not significant.

1 - c - With the exception of the second flush in 2002, the interaction between the degree of pruning and CCC concentration

had in significant effect on the number of immature leaves. At this particular time the significantly highest number of immature leaves was found in plants undergoing pruning at 4 leaves (6.68 leaves/plant) and sprayed with CCC at 450 ppm. The significantly lowest number was that of the same pruning treatment without CCC application (4.69 leaves/plant).

Table (1) - Number of immature leaves/plant

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
first flush	0	3.58	4.41	4.00	0	4.02	4.45	4.23
	150	5.75	5.93	5.84	150	5.05	5.14	5.10
	300	6.31	6.37	6.34	300	5.73	5.90	5.82
	450	6.26	6.54	6.40	450	6.06	6.34	6.20
	Mean	5.48	5.81		Mean	5.22	5.46	
	LSD at 5% for pruning		NS		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		0.60		LSD at 5% for conc.		0.39	
	LSD at 5% for int.		NS		LSD at 5% for int.		NS	

	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
second flush	0	4.43	5.30	4.87	0	4.69	5.24	4.97
	150	5.27	5.67	5.47	150	5.45	6.14	5.80
	300	6.37	6.39	6.38	300	6.49	6.40	6.45
	450	6.36	6.67	6.52	450	6.68	6.57	6.62
	Mean	5.61	6.01		Mean	5.83	6.09	
	LSD at 5% for pruning		NS		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		0.31		LSD at 5% for conc.		0.33	
	LSD at 5% for int.		NS		LSD at 5% for int.		0.47	

2 - Number of mature leaves/plant (Table, 2):

2 - a - The effect of pruning on the number of mature leaves/plant proved insignificant in both years of this study except at the second flush in 2001,where this character increased significantly from 5.79 to 6.13 leaves/plant when plants were pruned at 4 and 6 leaves, respectively.

2 - b - CCC concentrations affected the number of mature leaves/plant significantly at the two flushes in both 2001 and 2002. At the first flush in 2001, using CCC in general, exerted a significant effect on number of mature leaves/plant when compared to the

control. Differences between all CCC levels were statistically insignificant.

2 - c - The interaction between pruning treatments and CCC concentrations did not exert any significant effect on the number of mature leaves/plant in both flushes in the two years of this study.

The effect of CCC in increasing leaf number was reported by some authors. Mostafa (2000) stated that CCC at 1500 ppm increased the number of leaves of *Senecio cruentus* cv. Alkmene. El-Maadawy *et al* (2001) mentioned that on *Begonia semperflorens* (*B. cucullata*), CCC spray-treatments at 1000-3000 ppm increased the number of leaves/plant.

Table (2) - Number of mature leaves/plant

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
first flush	0	4.61	4.82	4.72	0	8.19	5.82	6.01
	150	7.85	8.15	8.00	150	7.88	8.05	7.97
	300	8.70	8.33	8.52	300	8.61	8.42	8.52
	450	7.85	8.67	8.26	450	6.91	7.81	7.36
	Mean	7.25	7.49		Mean	7.40	7.53	
	LSD at 5% for pruning		NS		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		1.00		LSD at 5% for conc.		0.52	
	LSD at 5% for int.		NS		LSD at 5% for int.		NS	

	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
second flush	0	4.59	5.24	4.92	0	5.78	5.11	5.44
	150	5.72	6.07	5.90	150	5.63	5.83	5.73
	300	6.08	6.34	6.21	300	6.15	6.03	6.09
	450	6.77	6.85	6.80	450	6.52	6.07	6.29
	Mean	5.79	6.13		Mean	6.02	5.76	
	LSD at 5% for pruning		0.22		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		0.34		LSD at 5% for conc.		0.59	
	LSD at 5% for int.		NS		LSD at 5% for int.		NS	

3 - Number of bottom break/plant (Table, 3):

3 - a - This number was significantly affected by the degree of pruning in Autumn of 2001 and Spring of 2001 and 2002. The only significant effect was detected in Autumn 2002, where it increased

significantly from 2.10 to 2.57 for pruning at 4 and 6 leaves respectively.

3 - b - The number of bottom break/plant increased significantly in the Autumn and Spring of both years 2001 and 2002, as the CCC concentration increased from 0 ppm to 450 ppm.Untreated plants had the least significant numbers of bottom break/plant, in Autumn and Spring of both years. Highest significant numbers were a result of using CCC at 450 ppm, in Autumn and Spring of both 2001 and 2002.

3 - c - Although the only significant effect of the interaction between pruning degree and CCC concentration was that achieved in Autumn of 2002, trend was the same of other results obtained in Spring of 2001 and 2002, and that of Autumn of 2002. In Spring of 2001, the least significant characters were those of the untreated plants of both 4- and 6-leaves treatments. Significantly highest results were those of the CCC at 450 of both pruning treatments.

Table (3) - Number of bottom break/plant

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	Prune at 4 lvs.	pruning at 6 lvs.	Mean
Autumn	0	1.24	1.44	1.34	0	1.25	1.34	1.29
	150	1.35	1.89	1.62	150	1.62	2.31	1.97
	300	2.45	2.23	2.33	300	2.64	3.22	2.93
	450	2.66	2.75	2.71	450	2.89	3.40	3.15
	Mean	1.92	2.08		Mean	2.10	2.57	
	LSD at 5% for pruning		NS		LSD at 5% for pruning		0.30	
	LSD at 5% for conc.		0.24		LSD at 5% for conc.		0.39	
	LSD at 5% for int.		0.33		LSD at 5% for int.		NS	
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	Prune at 4 lvs.	pruning at 6 lvs.	Mean
Spring	0	1.55	1.44	1.50	0	1.52	1.36	1.44
	150	2.43	2.64	2.54	150	2.49	2.56	2.53
	300	3.2	3.28	3.25	300	3.35	3.06	3.20
	450	3.55	3.77	3.66	450	3.78	3.77	3.78
	Mean	2.69	2.78		Mean	2.79	2.69	
	LSD at 5% for pruning		NS		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		0.28		LSD at 5% for conc.		0.23	
	LSD at 5% for int.		NS		LSD at 5% for int.		NS	

4 - Number of flowers/m^2 during summer (second flush) (Table, 4):

4 - a - This number was significantly affected by pruning degree in the two seasons of 2001 and 2002. Pruning at 6 leaves gave significantly more flowers than pruning at 4 leaves.

4 - b - CCC concentrations proved to have a significant effect on the number of flowers/m^2 during summer (second flush). This number increased gradually from the untreated plants in 2001 and 2002, to the significantly highest records with CCC at 450 ppm in 2001 and 2002.

4 - c - Although the interaction between pruning and CCC concentration proved significant in 2002 only, the same trend could be observed in both years. The highest number of flowers was produced by plants pruned at 6 leaves and treated with CCC at 450 ppm in 2001 and 2002. However, the lowest number in the first year was produced by untreated plants pruned at 4 leaves, while the equivalent number in the second year (82.83 flowers) was produced by untreated plants pruned at 6 leaves.

A lot of workers investigated the influence of pruning on rose productivity. **Mortensen and Gislerod (1994)** showed that hard pruning of plants (6 months old) significantly decreased yield of the cut rose cultivars Baronesse and Kiss. **Paul *et al* (1995)** reported that the severity of pruning influenced yield parameters of *Rosa damascena*. Yield was negatively correlated with increasing intensity of pruning. **Bondt (1997)** stated that with young roses, cv.

Table (4) - Number of flowers/m^2 during summer (second flush)

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
second flush	0	78.65	81.77	80.21	0	84.22	82.83	83.53
	150	83.39	124.00	103.70	150	92.30	127.77	110.03
	300	92.57	123.11	107.84	300	93.63	141.93	117.78
	450	103.37	136.96	120.16	450	111.09	169.77	140.43
	Mean	89.50	116.46		Mean	95.31	130.58	
	LSD at 5% for pruning		9.93		LSD at 5% for pruning		10.67	
	LSD at 5% for conc.		13.66		LSD at 5% for conc.		8.87	
	LSD at 5% for int.		NS		LSD at 5% for int.		12.54	

First Red, flower numbers/m^2 were highest with the lightest pruning system, but average branch weight was the lowest with this system. On the other hand, **ZhaoFa *et al* (1998)** reported that pruning severity had little influence on flowering of cut roses.

Cycocel is well reputed in affecting flower number in a wide range of plants. **Mostafa (2000)** stated that using CCC at 750 ppm on *Senecio cruentus* cv. Alkmene increased number of inflorescences. **Srivastava *et al* (2000)** mentioned that application of cycocel (CCC) promoted flowering in Eureka lemons. **Al-Humaid (2001)** mentioned that spraying *Gladiolus gandavensis* cv. Rosesupreme plants with CCC at 50-800 ppm resulted in higher number of florets per spike compared with the control. However, **El-Maadawy *et al* (2001)** mentioned that on *Begonia semperflorens* (*B. cucullata*), CCC spray-treatments at 1000-3000 ppm reduced number of flowers/plant.

5 - Number of days to flowering (Table, 5):

5 - a - The same trend was kept in both years of this study of the effect of pruning degree on the number of days to flowering, although significance was obtained in the second year only. Pruning at 6 leaves induced earlier flowering than at 4 leaves in both years of study.

Table (5) - Number of days to flowering

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
first flush	0	104.44	105.03	104.73	0	105.52	102.72	104.12
	150	99.35	92.90	96.13	150	83.13	80.25	81.69
	300	103.00	99.35	101.17	300	86.54	83.40	84.97
	450	106.74	108.80	107.77	450	90.07	86.79	88.43
	Mean	103.38	101.52		Mean	91.32	88.29	
	LSD at 5% for pruning		NS		LSD at 5% for pruning		1.23	
	LSD at 5% for conc.		3.58		LSD at 5% for conc.		1.82	
	LSD at 5% for int.		NS		LSD at 5% for int.		NS	

5 - b - The effect of CCC concentration on this character was significant in both 2001 and 2002 seasons. Plants treated with CCC at 150 ppm were significantly earlier in flowering than other

treatments in both seasons. In 2001, plants treated with CCC at 450 ppm flowered significantly later than those treated with CCC at 150 ppm or 300 ppm. However, in 2002 the significantly latest plants to flower were those untreated with CCC at all.

5 - c - An insignificant effect was found for the effect of the interaction between pruning degree and CCC concentration on the number of days to flowering.

6 - Flowering earliness (days) (Table, 6):

This character was calculated to express how many days a given treatment
was earlier to flower compared to the CCC-untreated plants in both degrees of pruning. The negative sign means a delay in flowering.

6 - a - Flowering earliness in days compared to the control (CCC at 0 ppm treatment) was not significantly affected by the degree of pruning either in 2001 or 2002.

6 - b - Concentration of CCC significantly affected this character. Plants treated with CCC at 150 ppm were significantly the earliest in flowering compared to the control. The effect declined significantly as CCC concentration increased up to 450 ppm. In 2001, plants treated with CCC at 450 ppm flowered later than the untreated plants. In 2002, earliness in flowering of the CCC at 450 ppm-treatment was significantly the least.

6 - c - The interaction between pruning severity and CCC concentration had an insignificant effect on the earliness of flowering.

There is a great deal of contradictions in the literature about the effect of cycocel on flowering time. **Maharana and Pani (1982)** mentioned that cycocel at 5000 and 10000 ppm. applied to the hybrid rose cv. Celebration one month after pruning advanced flowering. However, **Mostafa (2000)** stated that using CCC at 750-3000 ppm on *Senecio cruentus* cv. Alkmene had no significant effect on flowering time. On the contrary, **Al-Humaid (2001)** mentioned that flowering time was increased (delayed) as CCC concentration increased from 50 to 800 ppm. *Gladiolus*

gandavensis cv. Rosesupreme plants sprayed with 800 ppm CCC flowered about 17-25 days later than did those of the control.

Table (6) - Flowering earliness (days)

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
first flush	0	0.00	0.00	0.00	0	0.00	0.00	0.00
	150	5.08	12.13	8.61	150	22.39	22.47	22.43
	300	1.44	5.68	3.56	300	18.98	19.32	19.15
	450	-2.31	-3.77	-3.04	450	15.46	15.93	15.69
	Mean	1.05	3.51		Mean	14.21	14.43	
	LSD at 5% for pruning		NS		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		3.58		LSD at 5% for conc.		1.82	
	LSD at 5% for int.		NS		LSD at 5% for int.		NS	

7 - Flower stem length (cm) (Table, 7):

7 - a - This character was not significantly affected by the degree of pruning either in the 1st or the 2nd flushes in both years of 2001 and 2002. However, it could be remarked that stem length in the first flush was approximately more than 1.5 times as mush as the corresponding values of the second flush.

7 - b - The effect of CCC concentration on flower stem length was significant. Untreated plants scored significantly the lowest records in the first and second flushes in 2001 and 2002, compared to other CCC-treated plants. The significantly longest stems in 2001 were the output of applying CCC at 300 ppm. Situation in 2002 was similar but not identical as the highest significant record was that of using CCC at 150 ppm.

7 - c - In 2001, the interaction between pruning and CCC treatments had no significant effect on flower stem length of both first and second flushes. However, significance was restored in the second year. The shortest stems were those of plants untreated with CCC and pruned at 6 leaves, while the longest stems belonged to plants pruned at 4 leaves and treated with 300 ppm CCC.

As cycocel belongs to the growth-retarding group of the plant growth substances, its effect is mainly the reduction of plant height or stem length. **Maharana and Pani (1982)** mentioned that cycocel

at 5000 and 10000 ppm. applied to the hybrid rose cv. Celebration one month after pruning decreased plant height. **Das *et al* (1999)** revealed that cycocel produced dwarf plants of *Salvia splendens*. **Prakesh *et al* (1999)** found that cycocel at 500 and 1000 ppm reduced potato plant (genotypes Kufri Chandramukhi and HPS-11/67) height significantly compared to the control. **Govindan *et al* (2000)** indicated that when soyabeans cv. CO 1, CO 2, JS 335 and PK 472 were sprayed with the growth regulator cycocel at 40 ppm on the 35th day after sowing, cycocel application reduced the plant height. **El-Maadawy *et al* (2001)** mentioned that on *Begonia semperflorens* (*B. cucullata*), CCC spray-treatments at 1000-3000 ppm reduced plant height.

Table (7) - Flower stem length (cm)

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
first flush	0	25.96	26.14	26.05	0	27.00	26.81	26.90
	150	32.77	31.92	32.34	150	34.58	35.16	34.87
	300	35.07	33.96	34.51	300	36.68	30.52	33.60
	450	32.65	32.17	32.41	450	31.02	30.70	30.86
	Mean	31.61	31.05		Mean	32.32	30.80	
	LSD at 5%	for pruning	NS		LSD at 5%	for pruning	NS	
	LSD at 5%	for conc.	3.93		LSD at 5%	for conc.	2.04	
	LSD at 5%	for int.	NS		LSD at 5%	for int.	2.88	
second flush	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
	0	16.67	16.67	16.67	0	13.97	13.61	13.79
	150	20.22	20.38	20.30	150	21.75	22.25	22.00
	300	21.32	21.83	21.57	300	23.19	19.82	21.51
	450	20.96	20.52	20.74	450	20.36	19.95	20.16
	Mean	19.79	19.85		Mean	19.82	18.91	
	LSD at 5%	for pruning	NS		LSD at 5%	for pruning	NS	
	LSD at 5%	for conc.	2.43		LSD at 5%	for conc.	1.16	
	LSD at 5%	for int.	NS		LSD at 5%	for int.	1.63	

However, the effect of cycocel is not always a reducing one. According to the cultivar or the concentration used the effect may be altered greatly. **Hossain *et al* (1999)** sprayed 10 cultivars of large flowering decorative dahlias (*Dahlia pinnata*) 3 times with

1000, 2000 or 4000 ppm cycocel. They noticed that cycocel at 4000 ppm reduced plant height only in cultivars Prime Minister and Thelma Davidson. It increased plant height in cv. Vigour, and had no significant effect on the height of the other cultivars or on flowering in any of the cultivars. **Chen *et al* (2002)** found that when *Gynura aurantiaca* plants were treated by cycocel (as foliar sprays), subsequent growth of plants was not affected.

8 - Flower stem diameter (cm) (Table, 8):

8 - a - Pruning degree effect on flower stem diameter was significant in the two flushes of the year 2001 only. In this year, plants pruned at 4 leaves were 0.39 cm thick, significantly thinner than those pruned at 6 leaves in the first flush. Situation was contradictory in the second flush, where the former plants were significantly thicker than the later ones.

8 - b - Apart from the second flush of 2001, the effect of CCC concentration on flower stem diameter was significant either in the first two flushes of the two years or the second one in the second year. The highest significant records in the same order of the previous categories were a result of applying CCC at 150 ppm, and higher concentration, i.e. 300 ppm.

8 - c - The only significant effect of the interaction between pruning degree and CCC concentration on flower stem diameter was observed in the first flush of 2002. The two extremes, significant highest and lowest records were confined to the pruning at 4 leaves-treatment, as stems of the untreated plants were 0.38 cm thick, while those treated with CCC at 150 ppm were 0.56 cm.

Guha (1993) said that 0.6% cycocel reduced trunk diameter of 5-year-old apple cv. Golden Delicious trees in the second year of application. On the contrary, **Das *et al* (1999)** revealed that cycocel produced plants of *Salvia splendens* with thick basal plant diameters. **Ram *et al* (2001)** working on three cultivars of gladiolus (American Beauty, Friendship and Oscar) reported that diameter of neck was highest with the application of cycocel at 250 ppm. **Al-Humaid (2001)** mentioned that flowering stem thickness was

increased by 45% when *Gladiolus gandavensis* cv. Rosesupreme plants were sprayed with 800 ppm CCC, compared to the control.

Table (8) - Flower stem diameter (cm)

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
first flush	0	0.39	0.41	0.40	0	0.38	0.41	0.39
	150	0.52	0.44	0.48	150	0.56	0.47	0.51
	300	0.47	0.46	0.47	300	0.52	0.47	0.50
	450	0.49	0.42	0.46	450	0.52	0.44	0.48
	Mean	0.47	0.43		Mean	0.49	0.44	
	LSD at 5% for pruning		0.01		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		0.05		LSD at 5% for conc.		0.04	
	LSD at 5% for int.		NS		LSD at 5% for int.		0.05	
second flush	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
	0	0.41	0.40	0.41	0	0.35	0.34	0.34
	150	0.40	0.34	0.37	150	0.39	0.38	0.38
	300	0.37	0.36	0.37	300	0.41	0.39	0.40
	450	0.36	0.37	0.37	450	0.33	0.37	0.35
	Mean	0.39	0.37		Mean	0.37	0.37	
	LSD at 5% for pruning		0.01		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		NS		LSD at 5% for conc.		0.03	
	LSD at 5% for int.		NS		LSD at 5% for int.		NS	

9 - Flower stem weight (g) (Table, 9):

9 - a - Insignificancy was the prevailing feature over the effect of pruning on flower stem weight in the two flushes of the two years of this study.

9 - b - Contrary to the effect of pruning on flower stem weight, CCC concentration was significantly influential on this character in the two flushes of both 2001 and 2002. Compared to the CCC-untreated stems, which were significantly the lightest in weight, heaviest stems were those of plants treated with CCC at 450 ppm for the first flushes of 2001, and 2002 and those of the second flush of 2001, and the 300 ppm treatment in the second flush of 2002,.

9 - c - There was no significant effect of the interaction between the two factors of pruning and CCC concentration on flower stem weight except for the first flush of 2002. Significantly lowest record

was that of the untreated plants in the 4-leaves pruned group, while the significant heaviest one was found in the 450 ppm treatment of the 6-leaves pruned group.

Table (9) - Flower stem weight (g)

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
first flush	0	8.65	9.00	8.83	0	8.30	9.13	8.71
	150	13.54	10.42	11.98	150	13.82	11.05	12.44
	300	14.37	12.79	13.58	300	14.73	14.16	14.44
	450	14.36	14.67	14.51	450	16.09	17.18	16.64
	Mean	12.73	11.72		Mean	13.23	12.88	
	LSD at 5%	for pruning	NS		LSD at 5%	for pruning	NS	
	LSD at 5%	of.	2.68		LSD at 5%	for conc.	1.05	
	LSD at 5%	for int.	NS		LSD at 5%	for int.	1.48	
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
second flush	0	4.60	4.16	4.38	0	5.05	5.33	5.19
	150	6.28	6.88	6.58	150	7.12	7.01	7.07
	300	6.96	7.22	7.09	300	8.21	9.54	8.87
	450	7.46	7.86	7.66	450	8.05	9.49	8.77
	Mean	6.33	6.53		Mean	7.11	7.84	
	LSD at 5%	for pruning	NS		LSD at 5%	for pruning	NS	
	LSD at 5%	for conc.	0.45		LSD at 5%	for conc.	1.26	
	LSD at 5%	for int.	NS		LSD at 5%	for int.	NS	

Cycocel affected weight of many plants. **Govindan *et al* (2000)** reported that when soyabeans cv. CO 1, CO 2, JS 335 and PK 472 were sprayed with cycocel at 40 ppm on the 35th day after sowing, cycocel application reduced the plant dry matter production. **Mostafa (2000)** stated that CCC at 750 ppm on *Senecio cruentus* cv. Alkmene increased number and dry matter of inflorescences. However, **El-Maadawy *et al* (2001)** working on *Begonia semperflorens* (*B. cucullata*), mentioned that CCC spray-treatments at 1000-3000 ppm reduced dry weight.

10 - Flower bud diameter (mm) (Table, 10):

10 - a - Flower bud diameter of plants pruned at 4 leaves did not differ significantly from that at 6 leaves.

10 - b - Flower bud diameter responded positively and significantly to CCC application compared to the untreated plants. The higher the concentration was, the wider the flower buds became. As CCC concentration increased progressively from 150 to 450 ppm, flower diameter increased, however, insignificantly.

10 - c - Interaction between pruning and CCC concentration failed to affect flower bud diameter significantly.

Table (10) - Flower bud diameter (mm)

	Year 2001				Year 2002			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
first flush	0	10.12	10.23	10.18	0	10.28	10.25	10.27
	150	10.37	10.49	10.43	150	10.47	10.48	10.48
	300	10.37	10.53	10.45	300	10.46	10.52	10.49
	450	10.39	10.53	10.46	450	10.43	10.58	10.51
	Mean	10.31	10.44		Mean	10.41	10.46	
	LSD at 5% for pruning		NS		LSD at 5% for pruning		NS	
	LSD at 5% for conc.		0.15		LSD at 5% for conc.		0.07	
	LSD at 5% for int.		NS		LSD at 5% for int.		NS	

Some authors did not find any significant effect of cycocel on flower diameter. **Beal and Fiens (1997)** mentioned that when cycocel at 2.5 ml/litre (2500 ppm) was applied to azaleas, flower and crown diameters did not differ significantly. **Mostafa (2000)** stated that using CCC at 750-3000 ppm on *Senecio cruentus* cv. Alkmene had no significant effect on inflorescence width. On the contrary, **Rana *et al* (2001)** working on three cultivars of gladiolus (American Beauty, Friendship and Oscar) reported that diameter of neck was highest with the application of cycocel at 250 ppm.

11 - Leaf content of chlorophyll a (mg/g fresh weight) (Table, 11):

11 - a - Pruning degree affected content of chlorophyll a. In both first and second flushes this content was lower in leaves of plants pruned at 4 leaves than in those pruned at 6 leaves.

11 - b - The leaf content of chlorophyll a increased progressively as the CCC concentration increased from 0 ppm to 450 ppm.

11 - c - Curves representing effect of the interaction between pruning degree and CCC concentration on leaf content of

chlorophyll a had the same trend for plants pruned at 4 or 6 leaves, either in the first flush or the second one.

Table (11) - Leaf content of chlorophyll a (mg/g fresh weight)

	First Flush				Second Flush			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean		pruning at 4 lvs.	pruning at 6 lvs.	Mean
2002	0	35.40	59.50	47.45	0 ppm	32.50	39.20	35.85
	150	39.90	61.20	50.55	150 ppm	33.40	40.50	36.95
	300	40.40	61.60	51.00	300 ppm	35.60	40.90	38.25
	450	43.60	65.20	54.40	450 ppm	37.10	46.70	41.90
	Mean	39.38	61.88		Mean	34.65	41.83	

12 - Leaf content of chlorophyll b (mg/g fresh weight) (Table, 12):

12 - a - The effect of pruning on leaf content of chlorophyll b simulated that on leaf content of chlorophyll a, although contents were much lower. Pruning at 6 leaves resulted in higher contents compared to those of plants pruned at 4 leaves.

12 - b - The stimulating effect of CCC concentration on leaf content of chlorophyll b could not be generalized to all concentrations used. In the first flush of 2002, this content rose from 17.35 for the untreated plants to 19.20 and further to 19.95 mg/g fresh weight for plants treated with CCC at 150 and 300 ppm respectively. However, this effect turned negative as the content dropped to 19.60 mg/g fresh weight with CCC at 450 ppm. Situation with the second flush of 2002 was not the same. As this content increased from 13.35 mg/g fresh weight in the untreated plants to 15.95 and 15.90 mg/g fresh weight in plants treated with CCC at 150 and 300 ppm. Another rise in chlorophyll b content occurred by using CCC at 300 ppm (17.05 mg/g).

12 - c - Lowest leaf contents of chlorophyll b were found in the untreated plants pruned at 4 leaves in the first and second flushes of 2002, while the highest records were those of the same pruning treatment, i.e. 6 leaves, but at different CCC concentrations, i.e. 300 and 450 ppm.

Table (12) - Leaf content of chlorophyll b (mg/g fresh weight)

	First Flush				Second Flush			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
2002	0	12.70	22.00	17.35	0	12.10	14.60	13.35
	150	16.80	21.60	19.20	150	14.90	17.00	15.95
	300	17.40	22.50	19.95	300	14.40	17.40	15.90
	450	17.80	21.40	19.60	450	14.30	19.80	17.05
	Mean	16.18	21.88		Mean	13.93	17.20	

13 - b - The CCC concentration effect on petal content of carotene in the first flush was persistently promotive as this character increased progressively with the increase in CCC concentration from 0 to 450 ppm.

13 - c - Untreated plants pruned at 4 leaves had the lowest content of carotene in both first and second flushes of 2002, while the highest records were those of plants pruned at 6 leaves and sprayed with CCC at 450 ppm.

Table (13) - Petal content of carotene (mg/g fresh weight)

	First Flush				Second Flush			
	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean	CCC conc. (ppm)	pruning at 4 lvs.	pruning at 6 lvs.	Mean
2002	0	30.00	49.30	39.65	0	30.70	38.10	34.40
	150	30.20	50.10	40.15	150	29.50	41.30	35.40
	300	35.80	50.70	43.25	300	30.60	48.50	39.55
	450	36.70	52.40	44.55	450	33.50	43.70	38.60
	Mean	33.18	50.63		Mean	31.08	42.90	

Pruning had a certain effect on plant pigments. Zieslin and Mor (1981) indicated that in various experiments on rose cvs. Baccara, Lovita, Forever Yours and Cara Mia, continuous lateral shoot removal increased the chlorophyll content of the remaining leaves by approximately 25% each compared with the intact control plants. However, Mahanta and Baruah (1992) reported that all the pigment contents, except chlorophyll, were higher in pruned tea than in unpruned tea leaf.

Cycocel also proved to have an influence on major plant pigments. **Mostafa (2000)** stated that CCC at 750 ppm increased the total chlorophyll content (a + b) of *Senecio cruentus* cv. Alkmene. **Prakash *et al* (2000)** mentioned that the foliar application of cycocel on potato cultivars Kufri Chandramukhi and HPS-II/67 at 45 days after planting increased the chlorophyll a, chlorophyll b, and total chlorophyll contents, with 1000 ppm cycocel being the most effective. **El-Maadawy *et al* (2001)** reported that on *Begonia semperflorens* (*B. cucullata*), CCC spray-treatments at 1000-3000 ppm increased chlorophyll a and b content.

However, **Arvin and Banakar (2002)** found that when cycocel (500, 1000 mg/l) was sprayed on onion plants (*Allium cepa*) cv. Texas Early Grano prior to vernalization, cycocel had no effect on leaf chlorophyll.

In some cases, the effect of cycocel was a negative one. **El-Maadawy *et al* (2001)** found that on *Begonia semperflorens* (*B. cucullata*), CCC spray-treatments at 1000-3000 ppm reduced carotenoids. **Sagta and Nautiyal (2002)** reported that the increasing level of cycocel concentration decreases the chlorophyll contents (a, b and total) of four-month-old seedlings of *Dalbergia sissoo*. The maximum chlorophyll contents in leaves were observed in plants untreated by CCC. Higher concentration of CCC decreases chlorophyll contents more adversely as compared to lower concentration.

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الملخص العربى

تأثير التقليم ومنظمات النمو على نمو وإزهار الورد
١ – إستعمال السيكوسيل

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يعد الورد أشهر الأزهار المعروفة في العالم. وتحتل أزهار الورد المكانة الأولى فى تجارة الزهور العالمية. وتستعمل نباتات الورد في أغراض التنسيق فى الحدائق، كما تصلح الأزهار للقطف. وقد أجريت هذه الدراسة لزيادة صفات الجودة ومحصول الأزهار باستعمال التقليم والرش بالسيكوسيل .

صممت هذه التجربة بنظام القطع المنشقة وذلك بزراعة نباتات ورد صنف مرسيدس عمر سنة فى صوبة بلاستيكية حيث وزعت النباتات على قطعتين رئيسيتين . وعند بدء هذه التجربة فى منتصف أكتوبر ٢٠٠٠ تم تقليم نباتات القطعة الرئيسية الأولى بعد الورقة الرابعة المكتملة النمو ، بينما قلمت نباتات القطعة الرئيسية الثانية بعد الورقة السادسة المكتملة النمو . ثم قسمت كل قطعة رئيسية إلى أربع قطع فرعية تم رشها كل على

حدة بالسيكوسيل بتركيز صفر ، ١٥٠ ، ٣٠٠ ، أو ٤٥٠ جزء فى المليون. وقد تكرر الرش ثلاث مرات بين المرة والأخرى شهر واحد بدءا من ٢٠ نوفمبر ٢٠٠٠. وكررت المعاملات فى الموسم الثانى ٢٠٠١-٢٠٠٢

أوضحت النتائج أنه لم يكن لمعاملات التقليم تأثيرا معنويا على معظم الصفات التى درست. وعلى كل ، فقد كان التقليم بعد الورقة السادسة أفضل معنويا من التقليم بعد الورقة الرابعة من حيث زيادة عدد الأوراق المكتملة النمو لكل النبات (موسم الإزهار الثانى عام ٢٠٠١) ، وعدد الشماريخ القاعدية لكل النبات (موسم الإزهار الأول عام ٢٠٠٢) ، وعدد الأزهار لكل متر مربع أثناء الصيف (موسم الإزهار الأول والثانى عام ٢٠٠٢) ، وفى تقليل عدد الأيام اللازمة للإزهار (موسم الإزهار الأول عام ٢٠٠٢) . كما كان محتوى الأوراق من كلوروفيل أ ، ب ومحتوى البتلات من الكاروتين (موسم الإزهار الأول والثانى عام ٢٠٠٢) أكبر فى حالة التقليم بعد الورقة السادسة.

كان للسيكوسيل تأثيرا معنويا على معظم الصفات التى درست. وقد سجل السيكوسيل بتركيز ٤٥٠ جزء فى المليون أفضل النتائج ذات التأثير المعنوى فى الصفات التالية : عدد الأوراق الغير مكتملة النمو لكل نبات ، وعدد الشماريخ القاعدية لكل نبات ، وعدد الأزهار لكل متر مربع أثناء الصيف (موسم الإزهار الأول والثانى عام ٢٠٠٢) ، ووزن الساق الزهرية (فى معظم الحالات تقريبا) ، وقطر البرعم الزهرى ، وعدد الأوراق المكتملة النمو لكل نبات (موسم الإزهار الثانى) . كما كان محتوى كلوروفيل أ أعلى باستعمال السيكوسيل بتركيز ٤٥٠ جزء فى المليون . وحقق استعمال السيكوسيل بتركيز ٣٠٠ جزء فى المليون أعلى النتائج بالنسبة لعدد الأوراق المكتملة النمو لكل نبات (موسم الإزهار الأول) ، وطول الساق الزهرية عام ٢٠٠١. كما تسبب السيكوسيل بتركيز ١٥٠ جزء فى المليون فى تبكير فى الإزهار وفى إنتاج أكثر السيقان الزهرية طولا عام ٢٠٠٢.

لذا ينصح أن يتم تقليم شجيرات الورد بعد الورقة السادسة ، وأن تجرى المعاملة بالسيكوسيل (الرش ثلاث مرات بفاصل شهر بين المرة والأخرى بدءا من ٢٠ نوفمبر) بتركيز ٤٥٠ جزء فى المليون للحصول على أكبر عدد من الأزهار ، أو تركيز ١٥٠ جزء فى المليون إذا كان المطلوب تبكير الإزهار.