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CYCOCEL AFFECTS VEGETATIVE GROWTH AND KEEPING QUALITY OF *Moluccella laevis* L.

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ABSTRACT

Two experiments were conducted in the Floriculture and Ornamental Horticulture Research Garden, at El-Shatby, during the seasons of 2001/2002 and 2002/2003, to study the effect of cycocel on the vegetative growth and the keeping quality of a local cultivar of *Moluccella laevis* L. plants. Each experiment included two application methods of cycocel, as a foliar spray or as a soil drench, using the rates at 0,500,1000,2000,3000 and 4000 ppm. Generally, all cycocel treatments were significantly effective in controlling the plant height, compared with the control, but the effect of the soil drench was significantly more than that of the foliar spray in reducing the plant height. The minimum plant height was recorded at the highest cycocel concentration of the soil drench (4000 ppm) followed by the same concentration of foliar spray in the first and second seasons respectively. The control plants significantly had the maximum mean of the leaf area, compared with cycocel treated plants. The leaf area decreased with increasing cycocel concentrations. Cycocel significantly decreased the shoot dry weight, compared with the control. The lowest mean was recorded at the highest cycocel concentration applied as a soil drench. The leaf chlorophyll contents were significantly increased in the treated plants, compared with the untreated ones in both application methods. Cycocel significantly increased the vase life compared with the control. The maximum vase life (12.8, 12.2 days) were recorded by the treatments at (4000 ppm) as foliar spray followed by the treatment of the same concentration as soil drench in the first and second seasons respectively. Water uptake of plants were improved by all cycocel treatments, however, the differences among treatments were not significant. The maximum water uptake was obtained by the treatments of 3000 ppm followed by 2000 ppm cycocel as foliar spray, in the first and second seasons respectively.

INTRODUCTION

Many floricultural crops, tend to grow taller than desired and require height control measures. The floriculture market requires that plant heights including the pot range from 2.7 to 3.5 times the pot diameter. The most common growth regulators used in greenhouse crop production are the plant growth retardants. Quality standards dictate that most container-grown greenhouse crops must be compact, have short internodes, have a height consistent with the container they are grown in and have strong stems. Although short or dwarf cultivars exist for many crop species, chemicals that further reduce plant height and increase the compactness and strength of the plant are often required. The growth retardants function by inhibiting gibberellin synthesis. If gibberellins are applied to a plant, it will become tall and spindly. In contrast, if gibberellin production in the plant is reduced, it will be shorter and stronger with thicker stems and darker foliage (Wasfy, 1995). Cycocel is the commercial name for chlormequat chloride. It is one of the most widely used plant growth regulators in agriculture. In floricultural crops, it is most commonly used on *Hibiscus* (Abdel-Maksoud, 1992), *Begonia* (Yoon and Lang, 1998), *Salvia splendens* (Das *et al.*, 1999), *Senecio cruentus* (Mostafa, 2000), *Chrysunthemum* (Sharad *et al.*, 2000) and roses (Porwal *et al.*, 2002). Cycocel is usually applied as a foliar spray and it is also effective as a substrate drench, but foliar sprays are most common. Foliar Cycocel applications often result in a phytotoxic response (chlorosis), but the symptoms usually disappear after several days. Three categories of control methods are available to producers. When deciding the best method, consider the cost (including equipment, labor, and other expenses such as fuel); the effect on crop scheduling; and the effect on plant quality. Applying a growth retardant in a drench form is fairly easy. Drenches use larger volumes of solution per plant or pot, but usually at lower concentrations than a spray or dip. Drenches can take more time to apply than sprays, and require exact metering of volume delivered per pot. However, phytotoxicity is less likely with a soil drench. Spray applications can be more difficult to apply evenly. Some chemical labels recommend "spray to run-off"; that is, spray each plant until spray visibly just begins to drip off of the foliage. Otherwise if the solution drips into pots, those plants may receive both a spray and a drench (2x treatment). The consequence would be severely stunted plants. Depending on the size of the plant, the sprayer's objectivity, and other factors, varying amounts of chemical will be applied to each plant. It is much safer and more accurate to base spray application on areas, not plants, regardless of how many containers are in the area (Cramer and Bridgen, 1998).

Moluccella laevis L. or Bells of Ireland (Family Labiatae) is considered one of the most important florist green worlds wide. It is a lightly scented plant that grows 60 to 80 cm tall. The 2- to 5-cm, white-veined green bells that cling closely to stems are not really flowers but enlarged calyxes--the outer leaves that appear at the base of most flowers. Leaves are long-petioled, rounded-subcordate with coarse rounded teeth. The true flowers, tiny, fragrant and white, are deep within the bells. The popular names alluding to Ireland have been applied to this plant only because of the green color of the bells, not because the plant comes from Ireland; it is native to the eastern Mediterranean region. Bells-of-Ireland makes interesting and long-lasting cut flowers, and have additional value as dried flowers for winter arrangements. The plants are used in borders, in flowerbeds and in pots. They need staking to obtain erect straight stems.

The main objective of the present study was to find out the best application methods and rates of cycocel to obtain *Molucella laevis* plants with more compact growth, have a height consistent with the container they are grown in , have strong straight stems without staking and will have good keeping quality after stem harvesting.

MATERIALS AND METHODS

Two experiments were conducted in the Floriculture and Ornamental Horticulture Research Garden, at El-Shatby, during the seasons of 2001/2002 and 2002/2003, to study the effect of cycocel on the vegetative growth and the keeping quality of a local cultivar of *Moluccella laevis* L. plants. On Oct. 9, 2001 and Oct. 11, 2002 for the first and second seasons respectively, seeds were sown in seed-pans containing a mixture of clay, sand and peat moss at 1:1:1 (by volume) and watered thoroughly. After six weeks, the seedlings were transplanted into 30 cm. diameter clay pots (one plant per pot) containing the same soil mixture. cycocel rates of 0 (tap water), 500, 1000, 2000, 3000 and 4000 ppm were prepared and applied using two methods; the foliar spray or the soil drench. Cycocel aqueous solutions were applied three times at 14 days intervals in both methods. The first application was applied three weeks after the final transplanting. For the foliar spray, the pot surface was covered with polyethylene to avoid falling of spray drips on the growing medium and pots were sprayed at 40 cm centers. All rates were applied using a hand sprayer and the wetting agent tween twenty was added to each test solution (0.1%) to increase the wetting power of the plants and enhance the spreading of cycocel over the plant surface. Each plant was sprayed individually so that all foliage was moistened till the point of run-off and spraying volume was 20 ml per plant. Considering the soil drench, no watering was applied for two days before the drenching and the drench volume was 90 ml per pot. Two days after cycocel applications, the treated plants did not receive irrigation. The experiments were carried out in the form of Factorial in Completely Randomized Block Design with three replications (Steel and Torrie, 1980). Factors used were: Cycoceel concentrations (six levels), application methods (two levels) and the season (two levels). Ten plants were used as experimental unit. The experiments were terminated on May 4, 2002 and May 7, 2003 in the first and second seasons respectively. The following parameters were recorded at the end of each experiment using 3 plants from each treatment. Plant height (cm), leaf area (cm2), using the disk methods (Koller, 1972), shoot dry weight (9), leaves chlorophyll content (mg/g fresh weight of leaves) according to Gerig and Tikitte (1968). For postharvest experiments, plants *were* harvested in the morning and transferred to the laboratory within 1 hour of harvest. The experiment was laid out in a completely randomized block design with three replications; three stems were used in each container which contains (750 ml) tap water. Vase life was assessed daily under laboratory conditions 22 ± 2°C, 65 ± 5% relative humidity and 12 h light under cool white fluorescent lamps (600 ± 100 Lux). Vase life was considered terminated when plants lost their turgidity and leaves showed discoloration. The water uptake was estimated by subtracting the amount of water at the end of experiment from the initial volume (750 ml). The postharvest experiments were conducted twice in May of 2002 and 2003. Data were recorded on; vase life (days) and water uptake (ml). The data were analyzed statistically and Least Significant Difference test was applied to compare the differences among the treatment means at 5 % probability level.

RESULTS AND DISCUSSION

Plant height

The results presented in Table 1 and Figure 1 showed that the minimum plant height was recorded at the highest cycocel concentration of the soil drench (4000 ppm) followed by the same concentration of foliar spray in the first and second seasons respectively. Generally, all cycocel treatments were significantly effective in controlling the plant height, compared with the control, but the effect of the soil drench was significantly more than that of the foliar spray in reducing the plant height.

These results may be due to the effect of cycocel on preventing the formation of kaurene a precursor of gibberellins biosynthesis, subsequently inhibiting the division and elongation of stem cells (Wasfy, 1995). Soil application was effective since cycocel is absorbed readily by roots and is xylem- translocated to actively growing tissues (Early and Martin, 1988). in addition, foliar-applied cycocel must travel through the phloem in leaf tissues before reaching xylem tissue in the stem, but it is more readily transported through the xylem than through the phloem (Cramer and Bridgen, 1998).

Table 1. Averages of plant height (cm) and leaf area (cm^2) of *Moluccella laevis* as affected by cycocel concentration and application method during the seasons of 2002 and 2003.

Cycocelconc. ppm	Season	Plant height (cm)			Leaf area (cm^2)		
		Application method		Mean	Application method		Mean
		Drench	Spray		Drench	Spray	
0	2002	44.3	43.9	44.1	60.6	61.1	60.9
	2003	46.1	46.7	46.4	61.8	62.0	61.9
Mean 0		45.5	45.3	45.3	61.2	61.6	61.4
500	2002	43.4	43.0	43.2	58.0	58.2	58.1
	2003	45.6	44.9	45.3	58.4	57.9	58.2
Mean		44.5	44.0	44.3	58.2	58.1	58.2
1000	2002	40.7	41.9	41.3	56.8	57.4	57.1
	2003	41.1	42.5	41.8	55.7	56.8	56.3
Mean		40.9	42.2	41.6	56.3	57.1	56.7
2000	2002	37.7	39.8	38.8	54.2	56.9	55.6
	2003	36.9	40.2	38.6	55.1	55.8	55.5
Mean		37.3	40.0	38.7	54.7	56.4	55.6
3000	2002	34.6	37.2	35.9	50.7	53.7	52.2
	2003	35.7	37.9	36.8	51.5	53.9	52.7
Mean		35.2	37.6	36.4	51.1	53.8	52.5
4000	2002	30.8	35.6	33.2	48.4	50.8	49.6
	2003	31.4	34.8	33.1	49.1	51.6	50.4
Mean		31.1	35.2	33.2	48.8	51.2	50.0
Mean season	2002	38.6	40.2	39.4	54.8	56.4	55.6
	2003	39.5	44.2	40.4	55.3	56.3	55.8
Mean method		39.1	40.7	39.9	55.1	56.4	55.8
A- Cycocel concentrations		2.04			1.65		
B- application method		1.97			0.89		
C- season		N.S.			N.S.		
A x B		2.63			0.61		
A x C		0.93.			N.S.		
B x C		0.84.			N.S.		
A x B x C		1.37			N.S.		

Similar results were reported by Abdel-Maksoud (1992), Yoon and Lang (1998) Das *et al.* (1999), Mostafa (2000), Sharad *et al.* (2000) and Porwal *et al.* (2002)

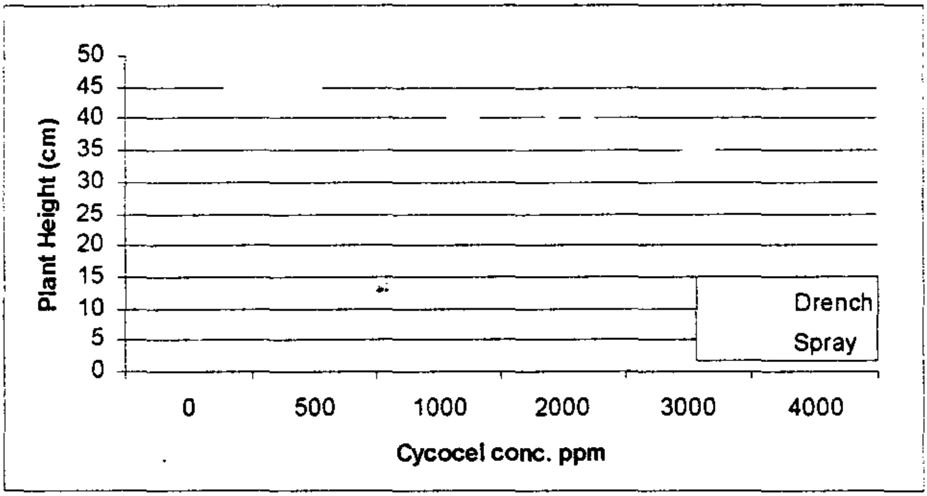

Figure 1: Average plant height (cm) of *Moluccella laevis* as affected by cycocel concentration and application methods as foliar spray and soil drench.

Leaf area

Data in Table 1 indicated that the control plants significantly had the maximum mean of the leaf area, compared with cycocel treated plants in both seasons. The leaf area decreased with increasing concentrations applied as a foliar spray followed by soil drench treatments (Figure 2).

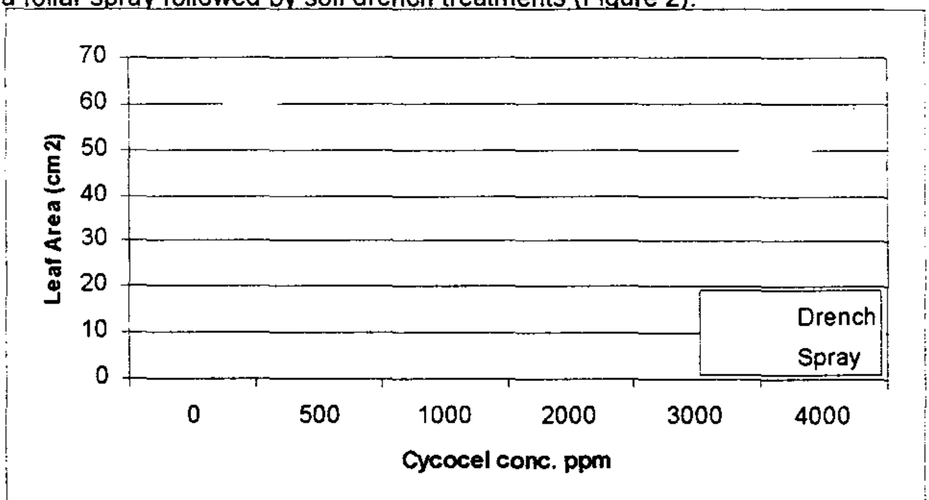

Figure 2: Average leaf area (cm^2) of *Moluccella laevis* as affected by cycocel concentration and application methods as foliar spray and soil drench.

These results may be due to that cycocel retarded cell division rate, possibly cell expansion or both in lamina tissue by inhibiting gibberellin biosynthesis (Tezuka *et al.*, 1989) or it may have induced an inbalance between indogenous auxin and gibberellin levels, resulting in slow leaf growth and expansion (Wang and Gregg ,1994).

These results were in agreement with those stated by Abdel-Maksoud (1992), Hagiladi and Watad (1992), Schuch and Biernaka (1995), Yewale et *al.* (1998) and Auda *et al.* (2002) Wang and Gregg (1994).

Shoot dry weight

Generally, cycocel significantly decreased the shoot dry weight, compared with the control (Table 2). The lowest mean was recorded at the highest cycocel concentration applied as a soil drench. The soil drench was significantly more effective in reducing the shoot dry weight than the foliar spray in both seasons (Figure 3). These results may be due to that the plant height and leaf area were decreased with increasing cycocel concentrations, thereby the reduction in the shoot dry weight was expected regardless of the application methods. Similar trend of results was found by Wang and Gregg (1994), Schuch and Biernaka (1995), Mostafa (2000) and Banon *et al.* (2001).

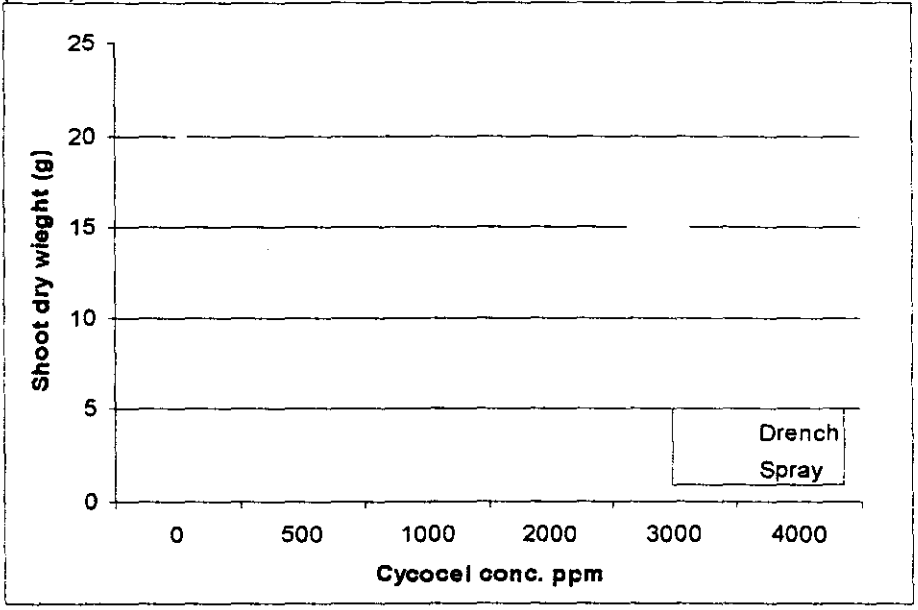

Figure 3: Average shoot dry weight (g) of *Moluccella laevis* as affected by cycocel concentration and application methods as foliar spray and soil drench.

Leaf chlorophyll contents

Data presented in Table 2 showed that the leaf chlorophyll contents were significantly increased in the treated plants, compared with the untreated ones in both application methods. The foliar spray significantly increased the amounts of chlorophyll compared with the soil drench, in the first and second seasons respectively (Figure 4). These results may be due to the influence of the growth retardant on delaying the leaf senescence and hence keeping the green pigments from degradation (Wasfy, 1995).

These results are in agreement with those reported by Hosni (1996), Yoon and Lang (1998) and Mostafa (2000).

Table 2. Averages of shoot dry weight (g) and leaf chlorophyll content of *Moluccella laevis* as affected by cycocel concentration and application method during the seasons of 2002 and 2003.

Cycocelconc. ppm	Season	shoot dry weight (g) Application method Drench	Spray	Mean	leaf chlorophyll content (mg/g fresh weight) Application method Drench	Spray	Mean
0	2002	17.9	19.7	18.8	34.7	32.4	33.6
	2003	18.4	20.3	19.4	35.1	33.7	34.4
Mean 0		18.2	20.0	19.1	34.9	33.1	34.0
500	2002	16.5	17.8	17.2	35.7	37.1	36.4
	2003	17.7	19.1	18.4	34.8	36.8	35.8
mean		17.1	18.5	17.8	35.3	37.0	36.1
1000	2002	15.9	17.0	16.5	36.0	38.2	37.1
	2003	16.2	18.4	17.3	36.4	38.0	37.2
mean		16.1	17.7	16.9	36.2	38.1	37.2
2000	2002	15.4	16.3	15.9	36.8	39.2	38.0
	2003	15.7	17.2	16.5	37.2	40.3	38.8
mean		15.6	16.8	16.2	37.0	40.0	38.4
3000	2002	14.7	15.6	15.2	37.4	40.5	39.0
	2003	15.0	16.8	15.9	39.8	41.9	40.9
mean		14.9	16.2	15.6	38.6	41.2	40.0
4000	2002	14.1	15.1	14.6	42.3	44.9	43.6
	2003	14.8	15.9	15.4	43.6	45.3	44.5
Mean		14.5	15.5	15.0	43.0	45.1	44.1
Mean season	2002	15.8	16.9	16.4	37.2	38.7	38.0
	2003	16.3	18.0	17.2	37.8	39.3	38.6
Mean method		16.1	17.5	16.8	37.5	39.1	38.3
A- Cycocel concentrations		3.86			5.73		
B- application method		2.09			3.41		
C- season		N.S.			N.S.		
A x B		1.84			0.04		
A x C		N.S.			N.S.		
B x C		N.S.			N.S.		
A x B x C		0.07			0.79		

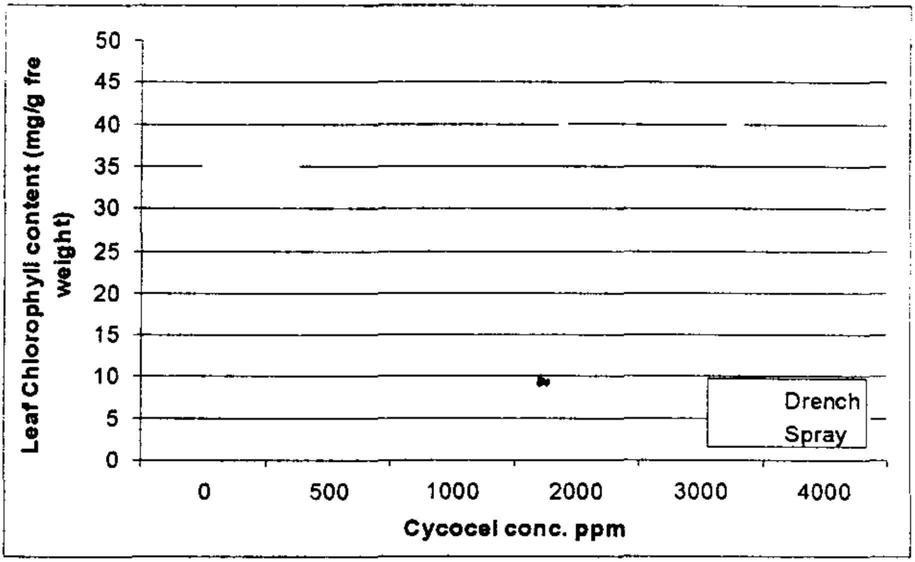

Figure 4: Average leaf chlorophyll content (mg/g F. W.) of *Moluccella laevis* as affected by cycocel concentration and application methods as foliar spray and soil drench

Vase life

Generally, cycocel significantly increased the vase life compared with the control (Table 3). The maximum vase life (12.8, 12.2 days) were recorded in the treatments of (4000 ppm) as foliar spray followed by the treatment of the same concentration as soil drench in the first and second seasons respectively. The control treatments had the shortest vase life (Figure 5). These results may be due to the effect of cycocel treatments in keeping the water potential of the treated cells at high value and reducing the transpiration which is correlated with the reduced leaf area (Mostafa, 2000). With soil drench, the leaf and shoot carbohydrate metabolism may altered, thus carbohydrate became limited, which resulted in less duration of the soil drench than those of foliar spray treated plants, or may be due to the influence of the growth retardant on delaying the leaf senescence and hence keeping the green pigments from degradation (Wasfy, 1995).

These results are in agreement with those reported by Halevy (1976), Pollock (1989) and Forrest (1991).

Table 3. Averages of vase life (day) and water uptake (ml) of *Moluccella laevis* as affected by cycocel concentration and application method during the seasons of 2002 and 2003.

Cycocelconc. ppm	Season	Vase life (day)			Water uptake (ml)		
		Application method		Mean	Application method		Mean
		Drench	Spray		Drench	Spray	
0	2002	6.7	7.9	7.3	33.7	35.9	34.8
	2003	5.9	8.2	7.1	31.6	33.1	32.4
mean 0		6.3	8.1	7.2	32.7	34.5	33.6
500	2002	8.2	8.7	8.5	34.8	36.7	35.8
	2003	8.7	9.2	9.0	31.9	34.8	33.4
mean		8.5	9.0	8.7	33.4	35.8	34.6
1000	2002	8.8	9.4	9.1	32.7	37.1	34.9
	2003	9.2	9.8	9.5	35.8	36.6	36.2
mean		9.0	9.6	9.3	34.3	36.9	35.6
2000	2002	9.4	10.8	10.1	37.2	38.5	37.9
	2003	10.3	11.0	10.7	36.4	37.2	36.8
mean		9.9	10.9	10.4	36.8	37.9	37.4
3000	2002	10.7	11.7	11.2	38.1	37.9	38.0
	2003	11.0	11.2	11.1	36.9	38.8	37.9
mean		10.9	11.5	11.2	37.5	38.4	38.0
4000	2002	11.9	12.8	12.4	35.4	38.4	36.9
	2003	12.1	12.2	12.2	34.8	35.9	35.4
Mean		12.0	12.5	12.3	35.1	37.2	36.1
Mean season	2002	9.3	10.2	9.8	35.3	37.4	36.4
	2003	9.5	10.3	9.9	34.6	36.1	35.4
Mean method		9.4	10.3	9.9	35.0	36.8	35.9
A- Cycocel concentrations		3.1			N.S.		
B- application method		4.7			N.S.		
C- season		N.S.			N.S.		
A x B		1.96			N.S.		
A x C		N.S.			N.S.		
B x C		N.S.			N.S.		
A x B x C		N.S.			N.S.		

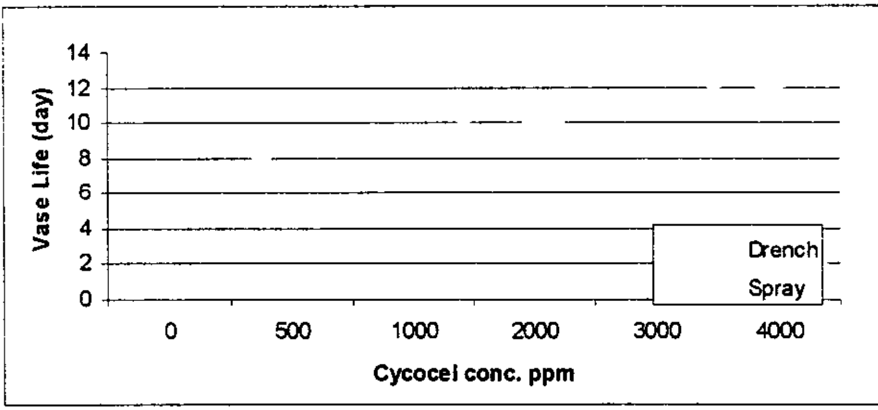

Figure 5: Average vase life (day) of *Moluccella laevis* as affected by cycocel concentration and application methods as foliar spray and soil drench.

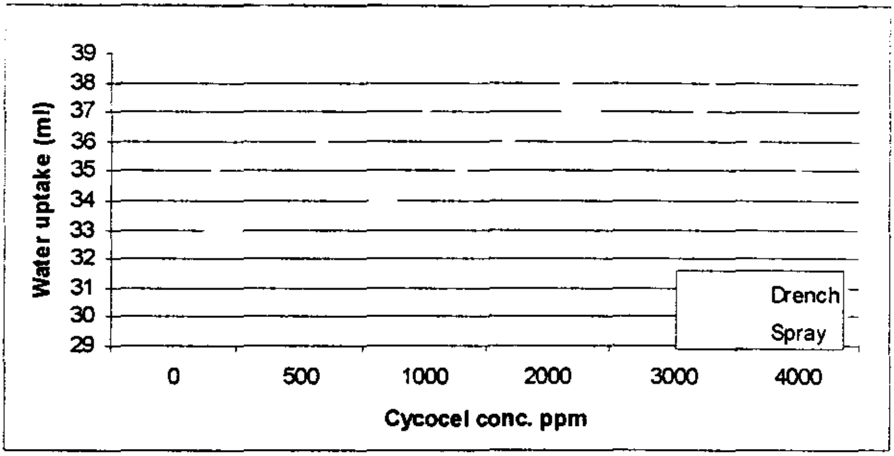

Figure 6: Average water uptake (ml) of *Moluccella laevis* as affected by cycocel concentration and application methods as foliar spray and soil drench.

Water uptake

Water uptake of plants were improved by all cycocel treatments, however, the differences among treatments were not significant (Table 3). The maximum water uptake was obtained by the treatments of 3000 ppm followed by 4000 ppm cycocel as soil drench, in the first and second seasons respectively (Figure 6). Water absorption maintains a better water balance and flower freshness, (Nowak and Rundnicki, 1990) and saves from early wilting resulting in enhanced vase life.

Similar findings have been reported by Salunkhe *et al.* (1990), El-Shennawy *et al.* (1995) and Bhaskar and Rao (1998).

Conclusion

The results demonstrate the importance of cycocel treatments, as soil drench or foliar spray in reducing the height of *Moluccella laevis* plants which looked more compact with sturdy straight stems more attractive in colour and not prone to rapid wilting by the postharvest life.

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تأثيرالسيكوسيل على النمو الخضرى والقدرة الحفظية لنبات الشنشلا (أجراس أيرلندا).

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أجريت تجربتان بمزرعة قسم الزهور ونباتات الزينة بالشاطبى عامى ٢٠٠٢ /٢٠٠١ و٢٠٠٣ /٢٠٠٢ لدراسة تأثير السيكوسيل رشا على النبات أو اضافة للتربة بتركيز ٠، ٥٠٠، ١٠٠٠، ٢٠٠٠، ٣٠٠٠ و٤٠٠٠ جزء فى المليون على النمو الخضرى والقدرة الحفظية لنبات الشنشلا تحت الظروف المعملية

ويمكن تلخيص النتائج فيما يلى:

- أدت كل التركيزات المستعملة من السيكوسيل الى خفض معنوى فى ارتفاع النبات مقارنة بالكنترول وكانت طريقة اضافة السيكوسيل الى التربة أكثر فاعلية من الرش على النبات. سجل أقل ارتفاع للنبات عند المعاملة ٤٠٠٠ جزء فى المليون اضافة للتربة فى كلا الموسمين.
- سجلت أعلى قيمة فى المساحة الورقية عند معاملة الكنترول وانخفضت المساحة الورقية بزيادة تركيز السيكوسيل.
- أدت كل التركيزات المستعملة من السيكوسيل الى خفض معنوى فى الوزن الجاف للمجموع الخضرى و سجل أقل وزن عند المعاملة ٤٠٠٠ جزء فى المليون اضافة للتربة فى كلا الموسمين.
- زاد محتوى الأوراق من الكلوروفيل فى النباتات المعاملة بالسيكوسيل مقارنة بغير المعاملة .
- كانت المعاملة ٤٠٠٠ جزء فى المليون رشا على النبات هى افضل المعاملات فى اطالة عمر النباتات المقطوفة حيث بقيت النباتات فى حالةجيدة لمدة 12.8 و١٢,٢ يوما فى الموسم الأول و الثانى على الترتيب .
- أدت كل المعاملات الى زيادة فى كمية السائل الممتص وان كانت الفروق بين المعاملات غير معنوية. و سجل أعلى امتصاص عند المعاملة ٣٠٠٠ ثم ٢٠٠٠ جزء فى المليون رشا على النبات فى الموسم الأول و الثانى على الترتيب .