植物生長調節劑對玫瑰花之影響

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一、前言

一般植物生長及發育乃是藉由其本身所生產之化學物所控制之觀念，已廣爲人知與確立。而這些物質之產生又受到遺傳所控制，這些物質稱爲荷爾蒙。[2]玫瑰是自發性的花卉作物[32]，而且經年開花不斷，毋需外界引導刺激即可開花。而且有很強的頂芽優勢，其營養生長及生殖生長並沒有互相衝突，而且每一芽基本上都能發育成切花枝[34]，側芽的萌發力則受到與頂芽距離有關[28]，此乃由於下節位的芽受到抑制作用較強之故[38]。

二、內容

本文將所參考之文獻，依植物生長調節劑對(一)扦插繁殖(二)組織培養(三)撚枝栽培(四)更新主枝(五)生產(六)頂芽優勢及盲芽(七)貯運等幾方面之影響予以討論。

(一) 扦插繁殖：

以植物生長素處理插穗可以促進發根，Hortmann et al 1990認爲這是發根輔因子與Auxin生長結合後，經過抗氧化酵素的分解作用，促進RNA的合成，在葡萄糖、含氮化合物及微量元素存在下誘發根的產生[15]。AL-Sigri 1996指出IBA 3500 ppm可比500及1500 ppm較容易促進玫瑰Rosa Centifolia之發根率及根長[7]。Dubois 1988指出組合成不同濃度研究對玫瑰扦插繁殖的根及側芽生長之影響，IBA隨著濃度之提升會抑制側芽萌發。側芽伸長受到濃度BA之提高而被抑制。BA會促進第二個芽的萌發，使用低濃度之IBA有促進發根、根重及新稍之長度。BA濃度提高對發根率及根重反而有減少之趨勢[13]。Sun, W. and Bassuk, N. L.指出‘Poyalty’ 玫瑰單節扦插實驗中，發現乙稀的合成隨著IBA增加而增加。IBA可促進扦插發根，但濃度若高於600 mg/liter則會抑制側芽之萌發。IBA的處理會導致乙稀的合成，而影響側芽之萌發。Ethephon亦會抑制側芽之萌發。使用ethephon噴灑前在前10天防止側芽發生。STS-乙稀抑制劑可促側芽之萌發。初期根的形成會抑制初期芽的萌發，但後期則會促進芽的萌發[29]。朱氏指出Auxin可促進接插苗之癒合發根1988[1]。

(二) 組織培養：

Khosh-Khui 1982指出IBA單獨使用對發根效果並不顯著，而NAA再配合IBA或IAA則有較佳之效果[17]。Davies 1980指出NAA 0.004 mg/l及IBA 2 mg/l可促進增殖速率(‘Parade’品種)[12]。Bressan等1982指出(1)BA在低濃度(0.03~0.3 mg/liter)促進側芽之生長(2)TIBA亦可促進側芽之萌發(3)Cytokinin濃度太高抑制根的形成[8]。

(三) 撚枝栽培：

撚枝栽培法係將玫瑰之枝條，分成二部份進行栽培管理，一部份撚折下來作營養枝，另一部份未撚折係供採花之切花枝[3]。光線可促使果樹及玫瑰之基部潛芽萌發，可能是光線增強了芽體的積蓄能力，造成養分往芽體運移的結果[6,9]。Zieslin和Halevy 1976以玫瑰'Baccara'品種爲材料作試驗，發現側芽上端的莖幹會抑制側芽的生長，除去頂芽可促進下一個緊臨的側芽萌發。除葉也可以促進腋芽萌發，若葉與莖幹同時存在抑制作用具有累加效果[38]。木本植物的頂芽優勢與頂芽產生的Auxin有關[25]。

Zieslin和Halevy 1976認爲芽在枝條上的位置會影響其發芽能力，上面節位的芽較易萌發，下節位的芽則受到抑制，不易萌發[38]。此乃由於抑制物有朝向基部累積的現象[27]，而由玫瑰莖幹榨汁，汁液可抑制側芽萌發與生長，經分析此抑制物質爲ABA[37]。若將玫瑰枝條橫放可降低相對的抑制作用[20]。玫瑰枝條橫放後腋芽位置朝上者易萌發，位置朝下者萌發率低[32]。這種現象是由於重力作用，使抑制物質往下移動所致[26,30,32]。諶氏1969指出撚枝(bending shoots)可抑制枝條再伸長充實組織，使養分轉向基部，讓基部的芽肥大[5]，枝條經撚折後，會因受傷面產生內生乙稀含量會增加[18]使折曲處腋芽受乙稀之影響而提高萌芽率[14]。另外由於Cytokinins是由根部合成，當往上輸送至折曲處而累積於此一位置，加上光線充足利於Cytokinins的活化所以芽體萌發也比較容易[16]，且由基部之芽所萌發之枝條通常會比較長[14]。BA~PBA羊毛脂均可促進芽之萌發。地心引力可幫助Auxin的運移[2]，因此影響玫瑰頂芽優勢的Auxin在撚折後受重力之影響無法抑制基部芽。

植物其他部位合成GA的能力至今尚未完全清楚，因沒有直接實驗證據[4]，同時或依序使用BA及GA_3應用於玫瑰側芽可增加其乾重和碳水化合物的運轉[31]。GA的含量以上位芽多於下位葉[33]。

(四) 更新主枝的生成：

Zieslin 1981指出Renewal shoot更新主枝的生成受到低溫的促進，低光度及NAA卻會抑制更新主枝的生成[35]。Parups 1971指出在強剪或未修剪的玫瑰植株處理BA及adenine可促進更新主枝生成[24]。朱建鏞引用文獻中指出anti-Auxin、Cytokinin、ethephon處理強剪過的植株可促進更新主枝。春季第一季切花採收後，以GA+硝酸銨處理可以得到較多的基部芽，修剪前先處理Ethrel可促進基部芽生成[1]。Zieslin 1972指出Ethephon ((2-choroethyl) phosphonicacid)可促進更新主枝生成。若再加上Scored(切槽法)效果更好[36]。Ohkawa 1979指出BA有促進基部芽的形成，但其效果受到品種不同，植物年齡；芽的狀態、頂稍生長狀態及修剪方法之影響。其實驗結果如下：(1)突出的芽較平寂的芽效果好(2)生長期的枝條處理效果較採收期效果好(3)3、4月處理效果較好(4)Scoring位置在芽的上方效果較好[22]。

(五) 在生產方面：

Carpenter 1975指出PBA，BA 1000至2000 ppm在玫瑰回剪後處理可增加花的枝條數，且用泡沫噴法較傳統噴施法效果較好[9]。Carpenter 1971指出PBA，BA可顯著促進側芽及基部芽之萌發，可促使其萌發成切花枝或盲芽[10]。Nikolova 1985指出PBA可以促進芽的萌發促使其開花，減少盲芽率可以增加產量，尤其在休眠較深的第二芽及第三芽，而得到的花品質較第一位芽的所萌發的花較好[21]。Ohkawa 1984指出切花採收在冬季常有不萌發之現象，在日本設施栽培玫瑰中 'Blue moon' 品種即使以去葉方式亦無法促其側芽萌發，塗抹BA 0.25%羊毛脂後促進萌發，較未處理者增加57~78%之切花率[23]。Cohen指出ABA 100和200 ppm可抑制玫瑰萌發但對莖長伸長沒有抑制[11]。Faber 1977指出：PBA可促進低節位及期部芽之萌發，無論採用強剪法及撚折強剪法。PBA處理後之枝條再加施GA_3可促進新稍之生長，(撚折強剪法才有效)。增加基部芽的生成主要是PBA之影響而非GA_3之影響[14]。

(六) 頂芽優勢及盲芽：

玫瑰是頂芽優勢強的作物，當頂芽萌發時下位側芽則一般很難再萌發[25]。Phillips 1975指出頂芽會萌發NAA可抑制下位側芽之萌發，外加IAA亦可抑制下位側芽的萌發，顯示頂芽優勢受Auxin類荷爾蒙所影響。盲芽是指進行營養生長而不開花的枝條，會影響切花之生產，Zeslin等1976指出比較盲芽及非盲芽枝之葉片分析發現，在盲芽枝中GAs、Auxins、Cytokinins等荷爾蒙均較低，但有較高之ABA濃度[33]。

(七) 貯運：

朱建鏞引用文獻中指出Cytokinin可防止落葉。ABA可抑制裸根苗在貯運期間萌芽生長。IBA可以促進裸根苗新根生長[1]。Cohen指出ABA 200和400 ppm對冷藏之玫瑰可抑制發芽，而且400 ppm比200 ppm效果好[11]。

三、結語

植物生長調節劑影響並控制作物之生長發育，因此了解植物生長調節劑對玫瑰花之影響，將有助於玫瑰之管理經營理念之建立。

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表 6. 根修剪和 Auxin 處理對根再生之影響[8]

Table 6. Influence of root pruning and auxin trearment on root regeneration, expressed as number of new roots, of "Motrea"/Inermis" plants 4 weeks after treatment.

Treatment	Number of new roots
Control	32.4^{ab}
Root pruning	17.2^{a}
Root pruning and water	13.5^{a}
Root pruning and IBA 50 ppm	59.1^{bc}
Root pruning and IBA 500 ppm	177.7^{e}
Root pruning and IAA 50 ppm	20.7^{a}
Root pruning and IAA 500 ppm	21.5^{a}
Root pruning and NAA 50 ppm	44.8^{abc}
Root pruning and NAA 500ppm	68.0^{c}
Root pruning and IBA 0.4% (talc-powder)	108.8^{d}

Mean separation by Duncan's multiple range test, 5% level.

表 5. 噴佈 PBA 對船運玫瑰植株落花、落葉及黃葉的影響[12]

Table 5. Effect of spraying with various concentration of PBA on flower bud and leaflet abscission and on foliage yellowing of "Pink Margo Koster" plants "shipped" for 5 days at 22℃

Treatment	No. buds dropped	No. leaflets dropped	Foliage yellowing (%)
Control (no spray)	19^{a}	267^{a}	24^{a}
PBA (25 ppm)	2^{b}	103^{b}	5^{b}
PBA (50 ppm)	1^{bc}	64^{c}	0^{c}
PBA (100 ppm)	0^{c}	26^{d}	0^{c}

Mean seperation within columns by Duncan's multiple range test, 5% level.

Table 2. *Cytokinin content in extracts of leaves from flawering and non-flowering shoots of Baccara roses*. Flower bud diameter at time of sampling was 4mm. Comparison of three biological tests: growth of soybean callus, carrot callus and radish cotyledons. Extracts from 10g fresh weight of leaves. Values are means of 15 replications.

Source of leaves	Soybean callus mg/test tube	Carrot callus mg/test tube	Radish cotyl. mg/cotyledon
Flowering shoot	476	185	9.0
Non-flowering shoot	324	95	4.9
LSD, 5%	112	46	3.8

Table 1. *A comparison of the level of growth substances in leaves of flowering and non-flowering shoots of Baccara roses*. Flower bud diameter at time of sampling was 4mm (developmental stage 10). Values are means of six replications for wheat and barley bioassays and 15 replications for soybean callus bioassay.

Type of shoot	IAA-equivalent (mg/100g d. wt.)-wheat coleoptile bioassay	GA_3-equivalent (μg/100g d. wt.)-barley endosperm bioassay	Kinetin equivalent (mg/100g d. wt.)-soybean callus bioassay
Flowering	1.06	17.5	0.34
Non-flowering	0.04	0.9	0.10

Table 4. Effect of ABA on bud break and length of new shoot growth of Rosa cv. Helen Traubel through 28 days.

Conen-of-ABA (ppm)	Immersion application(s), weeks before rem oval from storage[z] 4	4 & 0	3 & 2	0[y]	Mean
			Days to bud break		
Control	9.0	8.8	10.3	12.4	10.1A[x]
200	14.5	15.3	13.8	13.9	14.3B
400	12.7	15.1	14.1	16.5	14.6B
Mean[x]	12.0a	13.0a	12.5a	14.3b	
			Shoot growth (cm)		
Control	24.5	27.6	25.2	24.1	25.3A
200	19.1	18.4	19.2	16.6	18.3B
400	19.6	19.9	17.7	16.1	18.4B
Mean[x]	21.1a	22.0a	21.0a	19.0a	

[z] Each treatment value is the mean of 16 plants.

[y] Immersed at time of removal from storage.

[x] Mean separation by Duncan's multiple range test at the 1% level in capitals; at the 5% level in lower case letters.

The effect of media cutting type and IBA concentration on rooting of R. centifolia outtings in Oman (n=3). SED denotes the Standard Error of Difference between means.

Cutting type	IBA conc. (ppm)	Vermiculite Rooting (%)	Root number	Root length (mm)	Peatperlite Rooting (%)	Root number	Root length (mm)
Sub-apical	Control	1.1	0.3	0.3	42.3	3.8	21.2
	500	6.0	0.6	3.8	62.9	5.3	31.2
	1500	18.3	1.3	18.0	64.8	7.5	65.5
	3500	44.7	1.6	4.2	88.3	7.6	92.7
Medial	Control	4.4	1.3	9.3	33.0	2.2	9.1
	500	6.2	1.2	21.5	67.7	4.5	31.6
	1500	21.5	5.2	29.2	65.0	5.1	44.0
	3500	35.6	3.6	22.3	65.3	9.5	92.6
Basal	Control	9.9	2.7	68.4	49.7	4.2	20.0
	500	11.4	3.2	17.2	72.0	7.2	38.8
	1500	13.8	2.0	54.6	91.0	7.6	68.8
	3500	24.0	2.4	48.7	84.8	9.4	99.3
SED (media)		3.1**	0.3**	6.3**			
SED (cutting)		3.8*	0.4*	7.8*			
SED (IBA)		4.4**	0.5**	9.0**			
SED (media × cutting)		n.s.	0.6**	n.s.			
SED (media × IBA)		6.2*	0.7***	12.7***			
SED (cutting × IBA)		n.s.	n.s.	n.s.			
SED (media × cutting IBA)		n.s.	n.s.	n.s.			

* Significant at P<0.05; ** significant at P<0.01; *** significant at P<0.001; n.s. not significant.

Table 1. Effect of growth regulations and application method on flowering stems per rose plant, 9 weeks after cutback.

Treatment			Flowering stems per plant			
			Timing treatment to cutback			
Growth regulator	Method of application	Concn (ppm)	3 wks before	At cutback	1 wk after	2 wks after
Ethephon	Spray	1000	4.3a[2]	4.4a	4.1a	4.0ab
		2000	5.1b	5.5b	4.9ab	3.8ab
	Agrifoam	1000	4.7ab	5.8b	4.8a	3.3a
		2000	4.9b	7.1c	6.0b	3.4a
PBA	Spray	100	3.9a	4.2a	4.1a	3.9ab
		500	4.4a	4.5a	4.0a	4.6c
		1000	4.3a	4.5a	4.6ab	4.3bc
		2000	4.5ab	5.6b	4.4a	4.0ab
	Agrifoam	100	3.8a	4.1a	4.0a	3.5ab
		500	4.3a	5.3ab	4.5a	3.3a
		1000	4.4a	9.1d	7.6c	2.9a
		2000	5.5b	8.8d	6.5b	3.1a
BA	Spray	100	4.1a	4.3a	4.0a	4.1b
		500	4.0a	4.7ab	4.4a	3.7ab
		1000	4.4a	5.7b	4.3a	3.9ab
		2000	4.5ab	5.9b	4.8ab	4.3b
	Agrifoam	100	4.3a	4.1a	4.4a	3.0a
		500	4.0a	5.1ab	4.3a	3.6ab
		1000	4.5ab	7.3c	5.7b	3.2a
		2000	5.2b	8.0cd	6.4b	2.8a
Control	Spray	0	4.1a	4.3a	4.3a	4.0b
	Agrifoam	0	4.0a	4.1a	4.3a	3.3a

[z] Mean separation in columns by Duncan's multiple range test, 5% level.

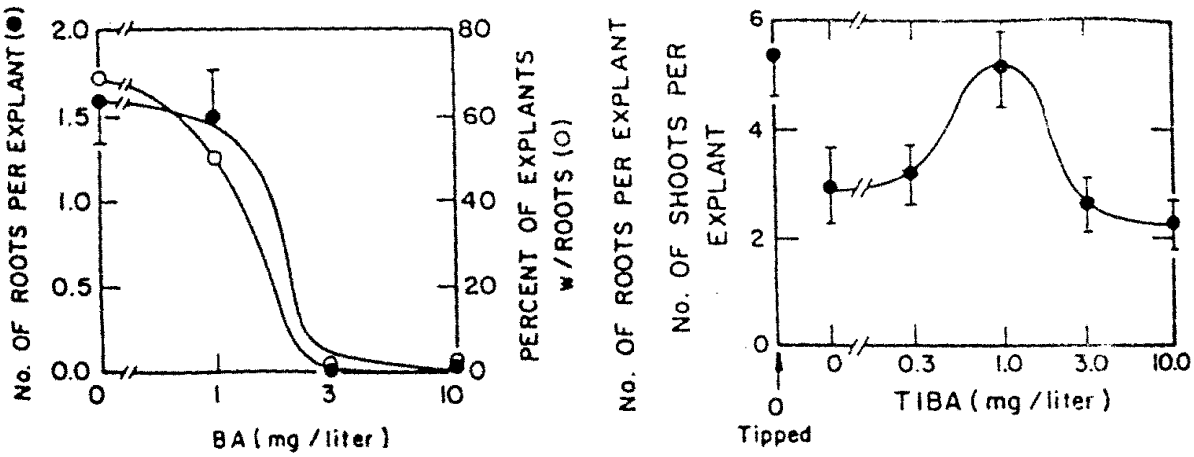


Fig. 11. The effect of TIBA on shoot multiplication from 'Improved Blaze' rose shoots. Two drops of the TIBA solutions (at the concentrations indicated) were applied to the apex of the shoot. Distilled water was applied to the apex of shoots treated with 0 TIBA. A comparison was made with shoots where the shoot apex had been excised (tipped). The explants were cultured in Petri plates with either 4 or 5 explants per plate. The bars represent SE of 32 explants for the tipped shoots, and 24 explants at 0. 13 explants at 0.3, 22 explants at 1.0, 23 explants at 3.0 and 18 explants at 10.0 mg/liter TIBA.

Table 1. Effect of abscisic acid (ABA) on bud break and length of new shoot growth of Rosa cv. Helen Traubel through 28 days.

	Spray applications, days after removal from storage[z]			
Concn of ABA (ppm)	6th & 7th[y]	10th & 11th[x]	6th & 7th[w] 10th & 11th	Mean[v]
		Days to bud break		
Control	17.2	15.0	15.3	15.9a
100	20.3	17.3	17.6	18.6b
200	16.5	20.2	23.4	20.0b
Mean	18.0a	17.5a	18.8a	
		Shoot growth cm		
Control	15.1	16.1	15.9	15.7a
100	10.1	16.6	14.5	13.7a
200	14.9	11.6	13.2	13.2a
Mean	13.4a	14.7a	14.5a	

[z] Each treatment value is the mean of 12 plants.
[y] Application of ABA during dormant stage.
[x] Application of ABA at time of bud-swell stage.
[w] Application of ABA at dormant and bud-swell stage.
[v] Mean separation by Duncan's multiple range test at the 5% level.

Table 2. The effect of BAP on the time and frequency of sprouting, on the rooting percentage and the root fresh weight of 'Amanda' rose single-node softwood cuttings.

	BAP concentration (mg l^{-1})							
	0	62.5	125	250	500	1000	2000	mean
Days to bud-break	3.1a	4.3a	3.8a	4.0a	5.0a	6.9a	5.7a	5.5
Sprouting frequency (Z)	100a	100a	100a	100a	100a	100a	100a	100
Z Cuttings rooted	100a	100a	98a	97ab	94b	61c	57d	87
Root weight (cg)	33.4b	41.6a	26.7c	26.7c	29.9bc	24.0d	13.8e	28.4

Means in the same row indicated by the same letter do not differ significantly for p = 0.05.

Table 1. Effect of PBA in lanolin paste on bud-break of 6-yr old 'Red American Beauty' rose plants with 2 pruning methods.

	Layback pruning				Cutback pruning			
PBA (ppm)	No. stem-treated areas[z]	Bud-break (%)	No. bud unions treated[y]	Bud-break (%)	No. stem-treated areas[z]	Bud-break (%)	No. bud unions treated[y]	Bud-break (%)
0	58	6.9a[x]	16	0.0a	78	2.6a	16	0.0a
500	60	20.6a	16	6.3b	64	22.8b	16	10.4b
1000	67	28.5b	16	6.3b	60	17.8c	16	12.5b

[z] See text for methods. Averaged over 3 groups of 16 plants each for treatments including 500 and 1000 ppm PBA; no. per 16 plants for control.

[y] See text for method. Averaged as in "z" above.

[x] Mean separation in columns by Duncan's modified (Bayesian) least significant difference test, K = 100.

Table 3. Effect of PBA + GA_3 treatment on reproductive shoot formation 4 weeks after GA_3 application with 2 pruning methods of 'Red American Beauty' rose plants.

Treatment		Layback pruning			Cutback pruning		
PBA (ppm)	GA_3 (ppm)	No. shoots	Mean diam (mm)	Mean length (cm)	No. shoots	Mean diam (mm)	Mean length (cm)
0	0	2a[z]	4.0b	31.5a	0a	0.0a	0.0a
500	0	7abc	4.4b	52.7a	1b	4.0b	43.0b
500	50	6ac	4.8ab	47.3a	4b	4.8b	40.0b
500	100	5ac	6.6a	62.6a	2b	4.5b	47.5b
1000	0	14bd	5.6ab	60.9a	3b	4.3b	58.3b
1000	50	16d	5.3ab	48.8a	3b	4.7b	44.7b
1000	100	10bc	5.8ab	51.4a	3b	3.8b	28.2b

[z] Mean separation in columns by Duncan's modified (Bayesian) least significant difference test, K = 100.

Table 3. Renewal cane production after growth regulator treatments on layback-pruned plants of 'Red American Beauty' roses.

PBA (ppm)	GA_3 (ppm)	No. renewal canes formed	Mean diam (mm)	No. renewal canes/plant[z]
0	0	1	6.0	0.05
500	0	1	6.0	0.06
500	50	2	6.5	0.13
500	100	1	8.0	0.06
1000	0	6	6.2	0.38
1000	50	5	6.0	0.31
1000	100	2	6.5	0.13

[z] Based on a total of 16 plants per treatment.

Table 1. The effect of PBA on bud breaking and flower formation of roses cv. Gabriela.
The cytokinin was applied as a lanolin paste
B–sprouts in %; F–flowers in %; A–aborted shoots in %

(PBA) conoentration	1st bud			2nd bud			3rd bud			Total per cane relative to control (100%)	
(%)	B	F	A	B	F	A	B	F	A	breaking	flowering
0	100	85.7	14.3	36.7	11.1	89.9	0.5	0	100	100	100
0.25	100	78.5	21.5	57.1	9.4	80.6	0.3	0	100	116	89
0.75	100	91.3	8.7	91.3	71.4	28.6	34.8	12.5	87.5	163	177

Table 2. Effect of ethephon spray on no. of renewal canes formed in 'Baccara' rose plants, Shahar, Lachish County 1969.

Treatment		No. of renewal shoots per plant[z]
Ethephon (ppm)	No. of applications	
–	–	.08c
5,000	1	.51b
5,000	2	.94a
5,000	3	.80a

[z] Means followed by different letters are significantly different at the 1% level.

Table 3. Effect of ethophon (2500 ppm) spray on renewal canes formation in 3 rose cultivars.

Cultivar	Treament	No. of renewal shoot per plant
Baccara	Control	0
	Ethephon	.52
Golden Wave	Control	0
	Ethephon	.29
Tropicana	Control	0
	Ethephon	.08

Table 4. Effect of scoring and ethephon on renewal shoots formation in ‘Baccara’ roses.

Ethephon conce (ppm)	No. buds scored	% of buds forming renewal shoots
0	0[z]	5
0	82	29.2
5,000	68	75.0
10,000	89	88.8

[z] Check treatment of unscored buds.

Table 5. Effect of scoring and 7,500 ppm ethephon on renewal shoot formations in ‘Red Garnette’ roses.

Treatment	No. of renewal shoots per plant[z]
Control	.29c
Ethephon 7,500 ppm	.27c
Scoring	.94b
Scoring & ethephon	1.60a

Table 1. Effect of ethephon spray on the no. of renewal canes formed in ‘Baccara’ roses, Rehovot 1968.

Treatment		No. of renewal shoots per plant[z]
Ethephon (ppm)	No. of applications	
–	–	1.1b
100	1	1.3b
100	6	1.3b
1,000	1	1.8a
1,000	6	1.0b

[z] Means followed by different letters are significantly different at the 5% level.

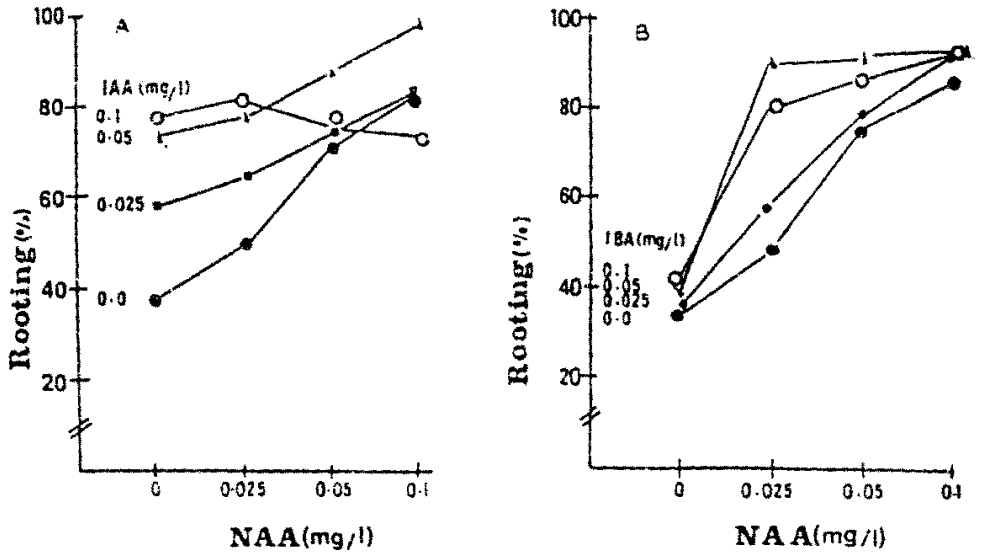


Fig 1. Percent rooting of in vitro propagated shoot tips of ‘Bridal Pink’ on half-strength MS medium containing combinations of NAA and IAA (1A) or IBA (1B) at concentrations of 0.0, 0.0.25, 0.05 and 0.1 mg/1.

Table 3. The effect of IBA on the time and frequency or sprouting, on the rooting percentage and the root fresh weight of 'Amands' rose signle-node softwood cuttings.

	IBA concentration (mg l^{-1})						
	0	312.5	625	1250	2500	5000	Mean
Days to bud-break	4.5a	5.2b	5.8b	6.8c	8.0d	8.3d	6.4
Sprouting frequency (Z)	100a	97.5a	89.2b	89.2b	76.7c	67.5d	86.7
Z Cuttings rooted	100a	100a	100a	100a	87a	100a	98
Root weight (cg)	24.1a	30.4a	29.3a	31.4a	29.9a	29.9a	29.2a

Means in the same row indicated by the same letter do not differ significantly for p = 0.05.

TABLE I

The effect of NAA/IAA or NAA/IBA combinations on root quality of 'Bridal Pink' roses. (1 = poor rooting; 4 = excellent rooting)

NAA (mg/1)	Concentration of IAA or IBA (mg/1)							
	0		0.025		0.05		0.1	
	IAA	IBA	IAA	IBA	IAA	IBA	IAA	IBA
0	1.2	1.5	1.6	1.4	1.7	1.2	1.9	1.0
0.025	1.8	1.9	2.1	2.5	2.4	2.8	2.4	2.6
0.05	2.1	2.0	2.4	2.8	3.0	3.3	2.4	2.8
0.1	2.8	2.8	3.4	3.6	3.6	3.9	3.0	3.8

Rates or propaganon or shoots or a rose cuttivars at ourerent normone leves. values quoted are the mean numbers of shoots produced per unit inoculated, after 4 weeks in culture at 20℃, 16-h day, 400 lux light intensity from Grolux lamps. Standard M&S medium, 4% sucrose, 0.1 mp l^{-1} GA_3.

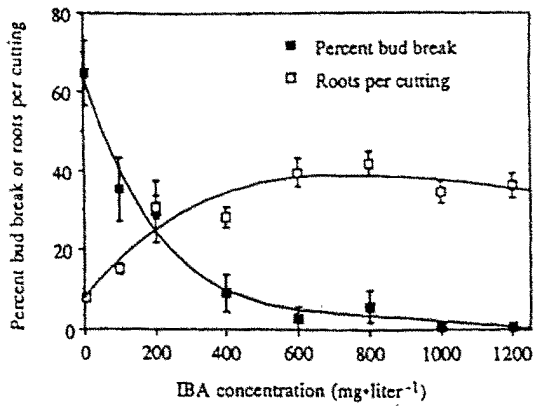
NAA (mg l^{-1})	Cultivar	BAP conc. (mg l^{-1})		
		2	4	8
0.004	Parade	3.9	1.8	1.6
	Plentiful	4.0	4.2	2.3
	King's Ransom	3.6	2.8	2.5
0.002	King's Ransom	1.8	2.0	1.9

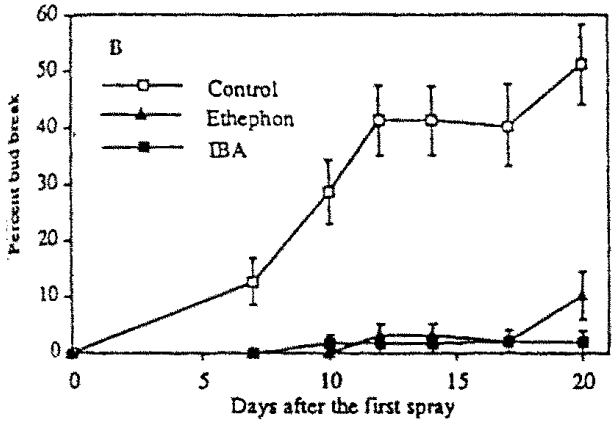
The growth and flowering of 'Blue Moon' rose as affected by different BA concentradons.

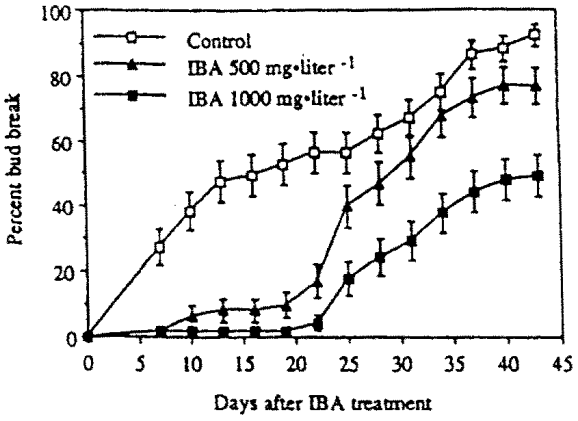
BA concentration in lanoline paste (%)	Number of shoots			Days to first flower	Stem length (cm)	Stem weight (g)
	Dormant	Bllnd	Flowering			
Control	10	0	0	–	–	–
0.125	0	0	10	56.1 ± 2.2	82.2 ± 8.3	32.8 ± 10.3
0.250	0	0	10	53.0 ± 2.3	84.9 ± 7.9	44.4 ± 11.8
0.500	0	2	8	52.1 ± 2.0	82.1 ± 8.5	40.7 ± 7.8

The growth and flowering of 'Blue Moon' rose as affected by the position of BA application.

Position of BA treatment	Number of shoots			Days to first flower	Stem length (cm)	Stem weight (g)
	Dormant	Bllnd	Flowering			
Control	10	0	0	–	–	–
Upperm ost bud	0	0	10	57.4 ± 4.0	81.4 ± 8.8	35.4 ± 8.6
Cut surface 0.5 cm above the bud	0	0	10	53.4 ± 2.3	84.4 ± 7.9	44.4 ± 11.9
Cut surface 1.0 cm above the bud	2	0	8	56.0 ± 2.2	78.5 ± 7.5	30.0 ± 1.7
Cut surface 1.5 cm above the bud	5	0	5	59.3 ± 2.1	76.0 ± 7.9	30.7 ± 5.1
Cut surface 2.0 cm above the bud	10	0	0	–	–	–
Petiole bend	8	0	2	55.0 ± 1.4	77.0 ± 2.8	55.0 ± 1.4







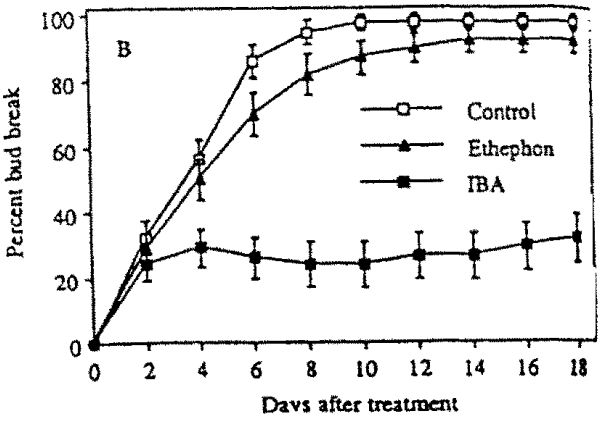


Table 2. Effect of bud condition and BA concentration on reaewal cane development in rose cultivars.

Cultivar	Concn (%)	Bud condition[z]	No. buds developed	Renewal cane length (cm)
Nordia	0	A	0d[y]	–
		B	0d	–
	0.125	A	3d	25.0d
		B	0d	–
	0.250	A	24a	60.5b
		B	16b	65.3ab
	0.500	A	23a	68.1ab
		B	14b	52.3c
	1.000	A	23a	55.6bc
		B	14b	52.3c
Golden Rapture	0	A	0d	–
		B	0d	–
	0.125	A	0d	–
		B	0d	–
	0.250	A	5d	68.4ab
		B	6d	58.0bc
	0.500	A	19ab	79.3a
		B	9c	72.6a
	1.000	A	11c	52.4c
		B	8c	48.1c

[z] A = round buds jutted out from the stem; B = quiescent flattened buds from the stem.
[y] Mean separation in columns by Duncan's multiple range test, 5% level.

Table 3. Effect of top growth stage on the BA effect on developing renewal canes in 'Carina' roses.

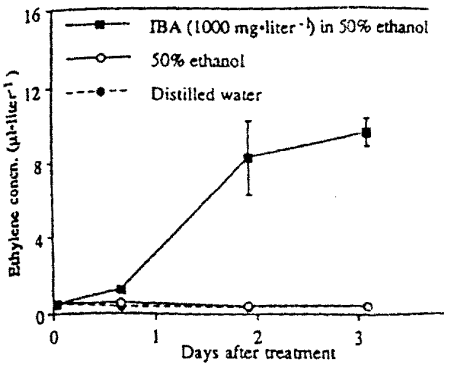
Top growth stage	Concn (%)	No. buds developed	Renewal cane length (cm)
Developing shoot	0	0b[z]	–
	0.125	3b	71.0a
	0.500	21a	81.9a
Harvest stage	0	0b	–
	0.125	0b	–
	0.500	5d	58.2b

[z] Mean separation in columns by Duncan's multiple range test, 5% level.

Table 1. Effect of BA in lanolin paste on the development of renewal canes in 3 rose cultivars.

Cultivar	Concn (%)	No. buds developed	Renewal cane length (cm)
Golden Rapture	0	0c[z]	–
	0.5	32b	73.9a
	1.0	35b	72.8a
Happiness	0	0e	–
	0.5	16d	63.2a
	1.0	24c	64.6a
Mary DeVor	0	0e	–
	0.5	39a	85.2a
	1.0	41a	86.9a

[z] Mean separation in columns by Duncan's multiple range test, 5% level.



Effect of de-shooting and evaporative colling on renewal shoot formation of 'Baccara' rose plants.

Treatments		Renewal during the first 6 weeks of the experiment, 15 February-4 April			Renewal after transfer to colling for, 4 weeks 4 April-1 May		
		Number of plants	Number of plants renewed	Total number of renewal shoots	Number of plants	Number of plants renewed	Total number of renewal shoots
No de-shooting	No cooling	25	2	2			
	Cooling	25	6	8			
De-shooting	No cooling	100	6	6	25[1]	7	9
	Cooling	50	37	86	75[2]	43	70

[1] Plants remained in the uncolled greenhouse.
[2] Plants were transferred from an uncooled to a cooled greenhouse on April 4.

Table 5. Effect of scoring on the development of renewal canes in 'Golden Rapture' roses.

Scoring	No. buds developed	Renewal cane length (cm)
Above & below	14b[z]	45.5b
Above	14b	60.1a
Below	18a	48.8b
None	4c	50.3b

[z] Mean separation in columns by Duncan's multiple range test, 5% level.

Table 4. Effect of treating time with BA in lanolin paste on the development of renewal canes in 'Nordia' roses.

Treatment date	No. buds developed	Renewal cane length (cm)
1–8	17c[z]	40.0d
2–5	24b	45.7c
3–5	35a	58.1d
4–2	37a	60.0a
5–1	22b	58.4a
6–12	18c	51.5b
7–10	23b	49.1b
8–7	9d	40.5b
9–4	4c	36.5d
10–2	10d	48.6b
11–13	16c	40.1d
12–11	15c	37.3d

[z] Mean separation in columns by Duncan's multiple range test, 5% level.

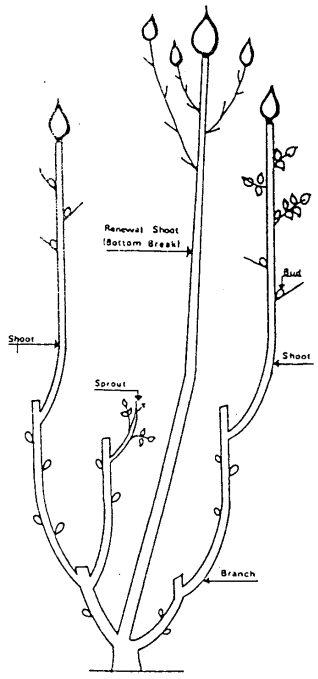


Fig. 1. Schematic drawing of a rose bush showing the terms we used for plant parts.

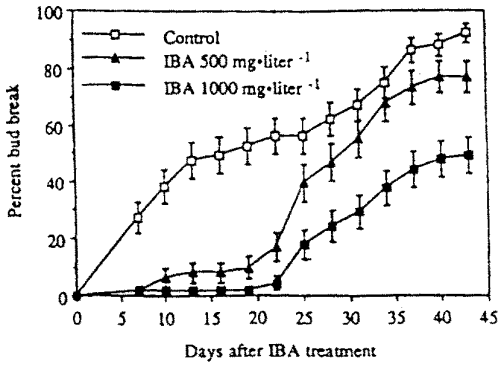
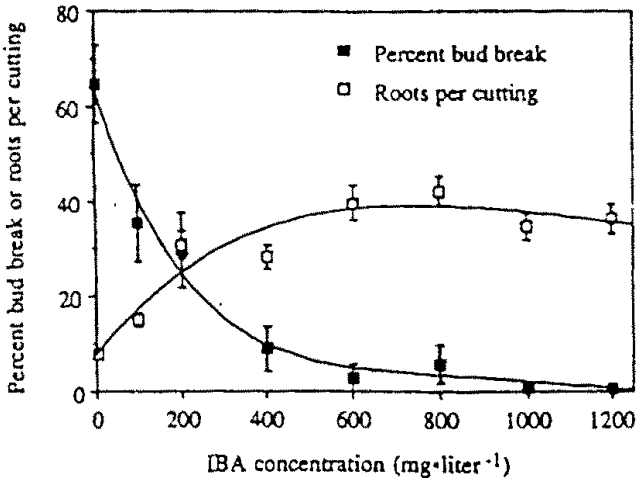


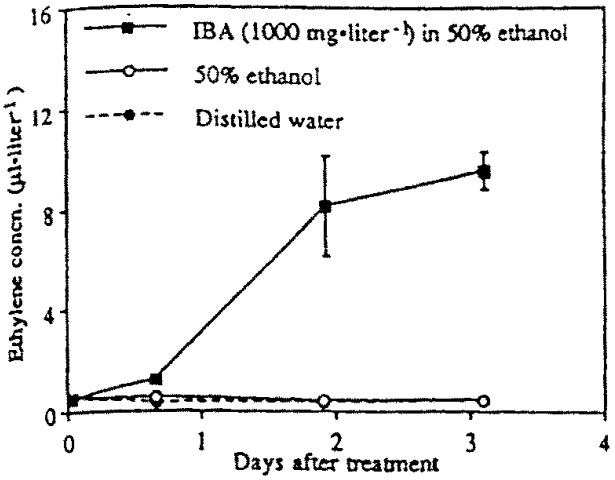
Table 2. Growth regulation chemicals effect on axillary and basal shoot development when applied in tloral foam cubes to cut rose canes.

	Basal shoots	Axillary shoots	
		No. flowering branches/plant	No. blind branches/plant
Response to chemicals			
Untreated	2.16	5.47	3.22
TIBA	2.00	6.69	3.31
Ethephon	1.78	5.44	5.58
PBA	2.10	9.50	7.16
N6BA	2.48	7.33	4.97
242	1.92	6.39	4.28
HSD 5%	NS	1.48	1.43
Cultivar response			
Red American Beaury	1.13	4.41	3.89
Forever Yours	1.40	5.17	4.74
Mary DeVor	2.63	8.89	5.53
Jack Frost	2.87	9.33	4.18
HSD 5%	0.64	1.21	1.17

Table 1. Effect of growth regulating chemicals on axillary and basal shoot development when applied as sprays or in paste to greenhouse roses.

Chemical	Basal shoots/plant	Axillary shoots/plant
Spraying cv. Red American Beauty		
Untreated	0.71	1.68
TIBA	0.61	1.87
Ethephon	0.48	1.50
PBA	0.91	2.32
N6BA	0.84	2.53
HSD 5%	NS	0.56
Paste applied to cv. Forever Yours		
Untreated	0.97	1.47
TIBA	1.14	2.50
Ethephon	0.90	0.93
PBA	1.26	3.12
N6BA	1.21	2.85
HSD 5%	NS	0.85


Percent bud break
Roots per cutting
Percent bud break or roots per cutting
IBA concentration (mg•liter⁻¹)
0
20
40
60
80
0
200
400
600
800
1000
1200


IBA (1000 mg•liter⁻¹) in 50% ethanol
50% ethanol
Distilled water
Ethylene concn. (µl•liter⁻¹)
Days after treatment
0
4
8
12
16
0
1
2
3
4