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PROPAGATION OF *Plumbago capensis* BY CUTTINGS FROM *IN VITRO* AND *IN VIVO* PROPAGATED STOCK PLANTS

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ABSTRACT

Cuttings of *Plumbago capensis* from *in vitro* propagated stock plants (IV) had higher rooting percentage, roots number, roots length and leaves number than cuttings from conventionally propagated stock plants (CP). Sub-terminal cuttings from IV were better than terminal ones in rooting percentage. The best results were obtained from the sub-terminal cuttings rather than the terminal ones when using the IV cuttings. Terminal cuttings from CP were perferable than subterminal cutting.

Terminal cuttings from two years old plants gave higher results than from one year old plants. Sub-terminal cuttings from one year old plants had more rooting percentage and leaves number than cuttings from two years old plants.

For rooting percentage, it is better to use indole acetic acid (IAA) than indole butyric acid (IBA) with all cuttings except terminal cuttings from one year old plants. Higher roots number was found with IBA than IAA treatments for all cuttings.

Both sub-terminal cuttings (IV) from one or two years old plants gave the best percentage of rooting (100%) when treated by 3000 and 4000 p.p.m IAA respectively.

The greatest root number (80 roots/cutting) was formed on terminal cuttings (IV) from two years old plants with 3000 p.p.m IBA.

INTRODUCTION

Plumbago capensis, L. (Leadwort plant) belong to family Plumbaginaceae. They are attractive ornamental shrubs, sometimes climbing. The plants have alternate leaves with eared or stem-clasping bases; flowers in terminal, spikelite racemes, the flowers are blue, red or white Plumbago plant blooms when quite small, and it can be used as a flowering pot plant. (Bailey, 1978).

Conventionally propagation by stem cuttings was used on *Plumbago rosea* L. by (Menon and Nybe, 1996). Increasing number of plumbago plants by tissue culture method, was studied by some investigators, i.e. El–Sadat (1996) on *Plumbago capensis*, Susmita–Sahoo *et al.* (1998) and Rout *et al.* (1999) on *Plumbago zeylanica*.

The rooting of cuttings obtained from micropropagation stock plants and from traditionally propagated stock plants were investigated on *Pyrus Communis* (Jones and Webster, 1989), on *Rhododendron* (Marks, 1991 a,b); on *Ficus benjamina* (Kristiansen, 1991) and in *Coffee canephora* (Vos and Snijder, 1996).

Comparison between plant tissue culture and conventionally cuttings were demonstrated by Dubois *et al* (1988) on dwarf rose cultivars, Muras

(1992) on *Rhododendrons*, Yang-Jenqchuan *et al.* (1995) and Wilson (1996) on *Eucalyptus* and Hammatt (1999) on *Prunus aricum* L.

Effect of indole butyric acid on induction of rooting of stem cuttings (from in field stock plants) of *Plumbago rosea* L was tested by Menon and Nybe, (1996) and of *Clerodendron* by Ghate and Sathe, (1998). Auxin application (IBA dips) consistently improved rooting in leaf ctttings of *Rhododendron* from *in vitro* and *in vivo* stock plants (Marks, 1991b).

Age of mother stock plants and position of cuttings were effective on rooting percentage; these factors were studied by Ripphausen (1989) on *Daphne odora*, Marks (1991b) on *Rhododendron.*, Schmidt *et al.* (1995) on ornamental Sorbus hybrids and Ghate and Sathe (1998) on *Clerodendron.*

The aim of this study was to compare two sources of cuttings (micropropagation and conventional mother stock plants) on rooting of different types of *Plumbago capensis* L. cuttings as affected by some auxin treatments.

MATERIALS AND METHODS

This work has been carried out in Tissue Culture Laboratory and Greenhouse, Agricultural Development Systems (ADS) Project (Giza, Egypt), during the period 1995 to 1998. Stock Cuttings (10 cm long) of *Plumbago capensis* plants were used in this experiment. Two sources of cuttings were used: the first, cuttings taken from *in vitro* propagated (IV) as stock plants; the second, cuttings taken from mother stock plants conventionally produced (CP).

Cuttings (IV): Micropropagation involved initiating cultures *in vitro* from shoot tips explants. Shoot tips of *Plumbage capensis* were cultured on MS medium containing 0.5 IBA mg/L for 6 weeks and recultured for 4 times each subculture remained for 6 weeks. After 30 weeks *in vitro* of regeneration, individual shoots were rooted on MS medium containing (MS salts without hormones). Cultures were incubated in a growth room at a constant temperature of 25 ± 1^{o}C under 2000 lux white fluorescent light for 16 h daily photoperiod. After rooting formation on shoots, the plantlets were transferred to a greenhouse in pots (6cm diameter) containing peatmoss + sand (3: 1). After one month the plantlets were transplanted in pots (20cm diameter) and fertilized (1 gm NPK; 1:1:1/pot) every week. After one year in the greenhouse, these plants were used as stock plants (IV_1) and after 2 years, the plants were used as stock plants (IV_2).

Conventionally plants (CP): plants (one year old) produced by traditionally methods (cuttings) and growing in the field were used as stock mother plants (CP_1). After 2 years, these plants were used as stock mother plants (CP_2).

Terminal and sub-terminal cuttings were taken from IV_1, CP_1, IV_2 and CP_2 for rooting and leaves formation. All cuttings were treated by two auxins, IBA and IAA at (0, 1000, 2000, 3000 or 4000 p.p.m). After 6 weeks the following measurements were recorded : rooting percentage, roots number/ cutting, root length (cm) and number of leaves/ cutting.

The obtained cuttings were planted in the medium which contained peat: sand (3:1v/v) under mist in greenhouse (5 second on and 10 minutes off).

All experiments were repeated twice under the same conditions, and conducted by using a completely randomized design in factorial, arrangement with 10 replicates. All data were averaged and statistically analyzed by using one and two ways analysis of variance. In case of percentages, the original data were firstly arcsine – transformed prior to statistical analysis. The least significant difference (L.S. D at 5% and 1%) was used to compare the means (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The results in Table (1) showed that, it was preferable to take the terminal cuttins from IV_1. They had the highest rooting percentage (41.11%), the largest roots number (16.89 roots / cutting), the longest roots (3.27 cm/root) and the biggest leaves number (8.19 leaves/ cutting) compared to the cuttings taken from CP_1. This increase was significant at all levels.

It was found that IBA concentration at 2000 p.p.m led to the highest rooting percentage (56.67%). There was a significant difference between this treatment and the others. Marks (1991a) observed that in all leafy cuttings of Rhododendron, whether from conventional or micropropagated sources, dipping in IBA improved rooting. Also, hardwood cuttings of *Clerodendron phlomidis* showed 60% rooting following a quick dip in IBA at 4000 p.p.m (Ghate and Sathe, 1998).

The interaction between auxin treatment and cutting sources showed that, the highest rooting percentage (83.33%) was recorded on cuttings IV_1, with 1000 p.p.m indole butyric acid (IBA) treatment.

Auxin treatments, indicated that treating the cuttings with auxin at 4000 p.p.m caused the formation of the largest number of roots (28.09 root/cutting). there were significant increases compared to all treatments. The best results (41.67 roots/cutting) was obtained when treating the cuttings IV_1 by IBA at 4000 p.p.m with significant difference compared with the other treatments.

Auxin treatment, (IBA) at 3000 p.p.m led to the longest roots (3.73 cm/root). There were non significant differences between this treatment and the other concentrations of IBA but there was significant difference with IAA concentrations. The longest roots were obtained by treating IV_l cuttings with 3000 p.p.m IBA (7.11 cm/cutting)

Concerning the effect of auxins treatments on leaves number, it was found that, the largest leaves number was formed with 4000 p.p.m IBA (12.59 leaves/cutting). There was non significant difference between this treatment and the other IBA concentrations. There was significant increase at 1 and 5% with IAA treatments and only at 5% compared with control treatment. IBA at 1000 p.p.m was the best concentration to form a large number of leaves on cuttings IV_1 (14.77 leaves/cutting).

The data in Table (2) indicated that, a significant increase in all measures was recorded on the sub-terminal cuttings IV_1 more than CP_1. kristiansen (1991) found that, *Ficus benjamina* cuttings from micropropagated stock plants rooted faster and had a higher rooting percentage (98-99%) than cuttings from traditionally propagated stock plants (91%). On coffee, initial results appear to indicate that cuttings derived from rejuvenated plants exhibit superior rooting to conventional cuttings (Vos and Snijder, 1996). As shown in Table (2) auxin treatments the largest roots number (25.84 roots/cutting) was with 4000 p.p.m IBA, but the longest roots (2.97 cm/root) and the largest leaves number (11.59 leaves/cutting) were formed when the cuttings were treated with the 1000 p.p.m IBA.

The interaction between cutting sources and auxin treatments pointed out that, the best results for rooting percentage (100%) was obtained when treating the sub-terminal cuttings $IV_1$by 3000 p.p.m IAA.

The largest roots number (51.67 roots/cutting) and the longest roots (5.88 cm root/cutting) were formed on the cuttings IV_1 when treated by 4000 p.p.m. IBA with the significant difference at 1and 5% when compared to the other treatments.

The maximum leaves number (14.33 leaves/cutting) was obtained when treating the sub-terminal cutting IV1 by 3000 p.p.m IBA with significant differences at 1and 5%. Data in Table (1and 2) revealed that higher rooting percentage, roots and leaves number were obtained on sub-terminal cutting IV_1 than terminal cuttings IV_1, opposite to the results by using CP_1 cuttings. On *Daphne ordora* cv. Leucanthe (Ripphausen, 1989), mentioned that, after 6 weeks, roots were visible on sub-terminal cuttings, and after 10 weeks, the terminal cuttings had produced adventitious roots, but these were fewer/ cutting and shorter than with the sub-terminal cuttings.

Data in Table (3) showed that, the rooting percentage was significantly higher with IV_2 cutting (47.22%) than the CP_2 cuttings (30.00%).

Marks (1991a) mentioned that, percentage rooting and root scores were greater in cuttings from *Rhododendron* 2 years after micropropagation, than in cuttings from conventionally raised stock plants.

The rooting percentage (70%) was higher when treating the terminal cuttings by 4000 p.p.m IAA and there was a significant difference between IBA and control treatments. The interaction between auxin treatments and cutting sources cleared that, the highest rooting percentage (90%) in cuttings IV_2 when treated with 2000 p.p.m IAA and a significant increase was found with other treatments at all levels.

Number of roots on cutting IV_2 (33.41 roots cutting) was significantly higher more than root number on cutting CP_2 (20.35 roots/ cutting). Concerning the effect of auxin treatments on roots number it was remarked that, treating the cuttings with 1000 p.p.m gave the best results (51. 71 roots/ cutting), and there was significant difference with all treatments. The maximum roots number (80 roots/ cutting) was formed on cuttings IV_2 treated by IBA 3000 p.p.m and was significantly higher than other treatments.

The cuttings IV_2 formed the longest roots (5.49 cm/ root) and trere was a significant difference between them and those formed on CP_2 cutting (3.55 cm/root).The best auxin treatment for root length was 4000 p.p.m IAA. The longest roots (7.86 cm/ cutting), was obtained when IV_2 cuttings were treated by 4000 p.p.m IAA.

Non significant difference was found in leaves number between IV_2 and CP_2 cuttings. 3000 p.p.m IAA treatments gave the highest leaves number (14.25 leaves / cutting) with non significant difference with control. Cuttings CP_2 was produced the largest leaves number (17.50 leaves/ cutting) when treated with IAA at 3000 p.p m.

The results in Table (4) indicated that, there was a significant increase in rooting percentage, roots number, root length (cm) and leaves number/ cutting between IV_2 and CP_2 sub-terminal cuttings.

Rooting percentage as a result of auxin treatments was 50 % when cuttings were treated by 4000 p.p.m IAA with significant difference compared to all treatment. Rooting in sub- terminal cuttings IV_2 was (100%) when treated with 4000 p.p.m IAA. Meanwhile, the control treatment gave only 50%. The CP_2 cuttings did not succeed in rooting, except with 1000& 3000 p.p.m IAA treatment.

Roots number, as affected by auxin treatments, showed that, cutting treating by 3000 p.p.m IBA gave the highest roots number (18.40 roots/ cutting). The interaction effect between auxins and cutting sources revealed that, the largest roots number (36.8 roots/cutting) was found when cuttings IV_2 were treated by 3000 p.p.m IBA.

Roots length, as influenced by auxin treatments cleared that, the best concentration for producing the longest roots (5.36 cm/root) was 3000 p.p.m IAA. The interaction effect between auxin and cutting sources showed that, the longest roots (5.71 cm/root) were formed by treating the IV_2 cutting with 3000 p.p.m IAA.

Auxin concentrations indicated that, 3000 p.p.m IAA was the best for producing the highest leaves number (13.82 leaves/ cutting).The maximum leaves number (18 leaves/cutting) was formed on IV_2 cutting with 3000 IBA.

Data in Tables (1, 3 and 2, 4) revealed that, terminal cuttings from two years old plants had good rooting percentage than terminal cuttings from one year old plants, the opposite was with sub-terminal cuttings. Howard *et al* (1989) reported, increasing rooting of plum cutting from micropropagated plants even as long as 9 years after transplantion. Also, Kristiansen (1991) on *Ficus benjamina,* observed the increasing root formation and growth after micropropagation was reduced with time.

CONCLUSIONS

In general, the difference between the cuttings from *in vitro* (IV) and *in vivo* (CP*)* propagated plants are in favour of the cuttings from *in vitro* stock plants. Fig.(1)

- Sub-terminal cuttings (IV_1) had more rooting percentage roots number and leaves number than terminal cuttings IV_1, sub-

terminal cuttings (IV_2) gave higher rooting percentage and leaves number than terminal cuttings (IV_2).

- Terminal cuttings CP were better than sub-terminal cuttings CP.
- 100% rooting was obtained when treating the sub-terminal cuttings IV_1 by 3000 p.p.m IAA and sub-terminal cutting IV_2 by 4000 p.p.m IAA.
- The biggest roots number (80 roots/cutting) was formed on terminal cuttings IV_2 with 3000 p.p.m IBA (Fig 2).
- The longest roots (7.86 cm/root) were formed on terminal cuttings IV_2 with 4000 p.p.m IAA.
- The maximum leaves number was obtained on sub-terminal cuttings IV_2 treated by IBA 3000 p.p.m .

Fig. (1): The difference between roots formation on cuttings IV (A) and on cuttings CP (B).

Fig.(2): Higher roots number (80 roots/cutting) formed on terminal cutting IV_2 with 3000 p.p.m IBA

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إكثار البلمباجو بواسطة عقل مأخوذة من نباتات منتجة معملياً وحقلياً

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عقل البلمباجو المأخوذة من نباتات منتجة معمليا تعطي أعلى نسبة مئوية للتجذير- عدد الجذور – طول الجذور – عدد الأوراق، عن العقل المأخوذة من أمهات منتجة بالطريقة التقليدية. العقل التحت طرفية كانت أفضل من العقل الطرفية المأخوذة من أمهات منتجة معمليا فى النسبة المئوية للتجذير. كانت أحسن النتائج مع العقل التحت طرفية عن العقل الطرفية عندما استعملت العقل المأخوذة من أمهات منتجة معمليا وكانت العقل الطرفية متميزة عن العقل التحت طرفية المأخوذة من نباتات منتجة حقليا.

العقل الطرفية المأخوذة من نباتات عمر سنتين أعطت أعلى النتائج عن العقل المأخوذة من نباتات عمر سنة. العقل التحت طرفية من نباتات عمر سنة تعطى أكبر نسبة مئوية وعدد أوراق عن العقل المأخوذة من نباتات عمر سنتين سواء العقل المأخوذة من أمهات منتجة معمليا وحقليا.

بالنسبة للنسبة المئوية للتجذير، يفضل استعمال إندول حامض الخليك عن إندول حامض البيوتريك مع كل العقل ما عدا العقل الطرفية من نباتات عمر سنة. أعلى أعداد للجذور تكونت مع معاملات إندول حامض البيوتريك عن إندول حامض الخليك مع كل العقل.

أعطت العقل التحت طرفية من أمهات منتجة معمليا عمر سنة أحسن النتائج للنسبة المئوية للتجذير (١٠٠%) عندما عوملت بـ ٣٠٠٠ جزء فى المليون فى حين عمر سنتين عندما عوملت بـ٤٠٠ جزء فى المليون إندول حامض الخليك تكون أكبر عدد للجذور (٨٠ جذر/عقلة) على العقل الطرفية المأخوذة من النباتات المنتجة معمليا وعمرها سنتين باستخدام ٣٠٠٠ جزء فى المليون إندول حامض البيوتريك.

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Table (1): Effect of cutting source and auxins treatments on rooting and leaves number of *Plumbago capensis* L. (terminal cuttings from one year old plants).

Treatment (p.p.m)	Rooting (%)		Mean	Roots number/ cutting		Mean	Root Length (cm)/ cutting		Mean	Leaves number/ cutting		Mean
	IV_1	CP_1		IV_1	CP_1		IV_I	CP_1		IV_I	CP_1	
Control	30.00 (33.21)	20.00(26.56)	25.00(30.00)	4.70	3.00	3.85	1.02	1.29	1.16	5.70	9.00	7.35
IBA 1000	83.33 (68.94)	10.00(18.44)	46.67(47.40)	30.08	2.00	16.04	4.55	1.95	3.25	14.77	6.00	10.39
2000	73.33 (61.98)	40.00(39.23)	56.67(53.14)	26.30	2.50	14.40	4.74	0.49	2.62	8.40	8.50	8.45
3000	60.00(50.77)	10.00(18.44)	35.00(36.27)	36.89	2.00	19.45	7.11	0.35	3.73	13.50	5.00	9.25
4000	73.33(61.98)	20.00(26.56)	46.67(47.40)	41.67	14.50	28.09	5.46	1.11	3.29	13.67	11.50	12.59
IAA 1000	30.00(33.21)	0.00(0.00)	15.00(22.79)	4.33	0.00	2.17	1.70	0.00	0.85	7.67	0.00	3.84
2000	10.00(18.44)	0.00(0.00)	5.00(12.92)	5.00	0.00	2.50	1.24	0.00	0.62	2.00	0.00	1.00
3000	10.00(18.44)	0.00(0.00)	5.00(12.92)	3.00	0.00	1.50	3.57	0.00	1.79	8.00	0.00	4.00
4000	0.00(0.00)	20.00(26.56)	10.00(18.44)	0.00	1.50	0.75	0.00	1.10	0.55	0.00	4.00	2.00
Mean	**41.11(41.72)**	**13.33(24.42)**	**-**	**16.89**	**2.83**	**-**	**3.27**	**0.70**	**-**	**8.19**	**4.89**	**-**

Factor	L.S.D				
Cutting source	5%	1.45	1.03	0.24	0.44
	1%	1.95	1.36	0.32	0.58
Auxin treatments	5%	3.48	1.84	0.80	4.87
	1%	4.68	2.43	1.07	6.48
Interaction.	5%	4.91	2.60	1.12	6.89
	1%	6.60	3.43	1.49	9.16

Table (2): Effect of cutting source and auxins treatments on rooting and leaves number of *Plumbago capensis* L. sub- terminal cuttings from one year old plants).

Treatment (p.p.m)	Rooting (%)		Mean	Roots number/ cutting		Mean	Root Length (cm)/ cutting		Mean	Leaves number/ cutting		Mean
	IV_I	CP_1		IV_I	CP_1		IV_I	CP_1		IV_I	CP_1	
Control	80.00(63.44)	20.00(26.56)	50.00(45.00)	5.63	5.00	5.32	0.79	1.98	1.39	11.75	11.00	11.38
IBA 1000	60.00(50.77)	10.00(18.44)	35.00(36.27)	33.67	4.00	18.84	4.93	1.00	2.97	8.17	15.00	11.59
2000	60.00(50.77)	0.00(0.00)	30.00(33.21)	25.89	0.00	12.95	3.32	0.00	1.66	8.56	0.00	4.28
3000	60.00(50.77)	0.00(0.00)	30.00(33.21)	37.17	0.00	18.59	4.03	0.00	2.02	14.33	0.00	7.17
4000	60.00(50.77)	0.00(0.00)	30.00(33.21)	51.67	0.00	25.84	5.88	0.00	2.94	12.17	0.00	6.09
IAA 1000	80.00(63.44)	0.00(0.00)	40.00(39.23)	7.00	0.00	3.50	0.65	0.00	0.33	13.50	0.00	6.75
2000	90.00(71.56)	0.00(0.00)	45.00(42.13)	6.00	0.00	3.00	0.92	0.00	0.46	9.11	0.00	4.56
3000	100.00(90.00)	0.00(0.00)	50.00(45.00)	6.10	0.00	3.05	0.81	0.00	0.41	6.60	0.00	3.30
4000	90.00(71.56)	10.00(18.44)	50.00(45.00)	13.56	2.00	7.78	1.35	0.20	0.78	8.33	6.00	7.17
Mean	**75.56(64.29)**	**4.44(15.34)**	**-**	**20.74**	**1.22**	**-**	**2.52**	**0.35**	**-**	**10.28**	**3.56**	**-**

Factor	L.S.D				
Cutting source	5%	1.12	3.12	0.10	0.43
	1%	1.51	4.14	0.13	0.58
Auxin treatments	5%	2.85	5.81	0.31	1.33
	1%	3.84	7.73	0.42	1.79
Interaction.	5%	4.05	8.21	0.45	1.88
	1%	5.45	10.91	0.61	2.53

Table (3): Effect of cutting source and auxins treatments on rooting and leaves number *of Plumbago capensis* L. (terminal cuttings from two years old plants).

Treatment (p.p.m)	Rooting (%)		Mean	Roots number/ cutting		Mean	Root Length (cm)/ cutting		Mean	Leaves number/ cutting		Mean
	IV_2	CP_2		IV_2	CP_2		IV_2	CP_2		IV_2	CP_2	
Control	25.00(30.00)	20.00(26.56)	22.50(32.02)	11.63	14.00	12.82	4.81	4.75	4.78	5.63	15.50	10.57
IBA 1000	30.00(33.21)	40.00(39.23)	35.00(36.27)	24.67	78.75	51.71	3.83	4.25	4.04	2.33	5.25	3.79
2000	50.00(45.00)	0.00(0.00)	25.00(30.00)	66.40	0.00	33.20	6.60	0.00	3.30	5.00	0.00	2.50
3000	10.00(18.44)	0.00(0.00)	5.00(12.92)	80.00	0.00	40.00	2.50	0.00	1.25	8.00	0.00	4.00
4000	40.00(39.23)	10.00(18.44)	25.00(30.00)	55.00	30.00	42.50	5.50	2.00	3.75	9.25	4.00	6.63
IAA 1000	80.00(63.44)	50.00(45.00)	65.00(53.73)	16.00	12.40	14.20	5.38	4.70	5.04	6.25	10.60	8.43
2000	90.00(71.56)	40.00(39. 23)	65.00(53.73)	17.56	17.25	17.41	7.44	5.45	6.45	5.78	3.25	4.52
3000	30.00(33.21)	40.00(39.23)	35.00(36.27)	14.33	16.00	15.17	5.50	3.13	4.32	11.00	17.50	14.25
4000	70.00(56.79)	70.00(56.79)	70.00(56.79)	15.14	14.71	14.93	7.86	7.66	7.76	4.71	4.50	4.61
Mean	**47.22(45.97)**	**30.00(33.21)**	**-**	**33.41**	**20.35**	**-**	**5.49**	**3.55**	**-**	**6.44**	**6.73**	**-**

Factor	L.S.D				
Cutting source	5%	2.38	1.17	0.22	0.60
	1%	3.21	1.54	0.30	0.80
Auxin treatments	5%	6.03	2.49	3.33	6.87
	1%	8.11	3.30	4.43	9.13
Interaction.	5%	8.54	3.54	4.67	9.73
	1%	11.48	4.69	6.21	12.93

Table (4): Effect of cutting source and auxins treatments on rooting and leaves number of *Plumbago capensis* L. (sub-terminal cuttings from two years old plants).

Treatment (p.p.m)	Rooting (%)		Mean	Rootss number/ cutting		Mean	Root Length (cm)/ cutting		Mean	Leaves number/ cutting		Mean
	IV_2	CP_2		IV_2	CP_2		IV_2	CP_2		IV_2	CP_2	
Control	50.00(45.00)	0.00(0.00)	25.00(30.00)	16.20	0.00	8.10	4.30	0.00	2.15	9.20	0.00	4.60
IBA 1000	60.00(50.77)	0.00(0.00)	30.00(33.21)	29.67	0.00	14.84	4.42	0.00	2.21	6.50	0.00	3.25
2000	60.00(50.77)	00.0(0.00)	30.00(33.21)	27.50	0.00	13.75	4.00	0.00	2.00	7.67	0.00	3.84
3000	50.00(45.00)	0.00(0.00)	25.00(30.00)	36.80	0.00	18.40	3.50	0.00	1.75	18.00	0.00	9.00
4000	20.00(26.56)	0.00(0.00)	10.00(18.44)	32.50	0.00	16.25	2.25	0.00	1.13	7.00	0.00	3.50
IAA 1000	70.00(56.79)	10.00(18.44)	40.00(39.23)	15.57	7.00	11.29	4.43	4.00	4.22	8.14	8.00	8.07
2000	70.00(56.79)	0.00(0.00)	35.00(36.27)	19.86	0.00	9.93	4.21	0.00	2.11	4.00	0.00	2.00
3000	70.00(56.79)	20.00(26.56)	45.00(42.13)	19.43	12.00	15.72	5.71	5.00	5.36	16.14	11.50	13.82
4000	100.00(90.00)	0.00(0.00)	50.00(45.00)	11.90	0.00	5.95	3.50	0.00	1.75	4.60	0.00	2.30
Mean	**61.11(53.25)**	**3.33(13.27)**	**-**	**23.27**	**2.11**	**-**	**4.04**	**1.00**	**-**	**9.03**	**2.17**	**-**

Factor	L.S.D				
Cutting source	5%	1.83	1.02	0.12	0.20
	1%	2.47	1.35	0.16	0.26
Auxin treatments	5%	2.10	4.07	0.37	0.82
	1%	2.82	5.42	0.50	1.11
Interaction.	5%	2.97	5.77	0.53	1.18
	1%	4.00	7.67	0.71	1.58