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Effect of Different Auxins on the Establishment of Damask Rose Cuttings in Different Media

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Abstract. Effect of indole-3-acetic acid and naphthalene acetic acid treatments on the establishment of damask rose (*Rosa damascena* Mill.) cuttings in different growth media was evaluated and it was revealed that the average number of roots and rooting percentage gradually increased with increase in hormone concentration. The maximum number of roots (15.72), rooting percentage (94.17 %), plant height (134.2 cm), plant spread (46.3 cm), primary shoots (6.3), secondary shoots (25) and survival percentage (94.72%) was recorded for 50 mg/l naphthalene acetic acid application; the results were superior to indole-3-acetic acid, the optimum level being in the range of 50 and 75 mg/l. No such conclusion could be drawn for indole-3-acetic acid. The leaf mold was the best growth medium giving the maximum number of roots per cutting (10.78), rooting percentage (87.68%), plant height (125.1 cm), plant spread (37 cm), primary shoots (5.2), secondary shoots (19.48) and survival percentage (85.67%), followed by soil + leaf mold, while soil medium was the least effective.

Keywords: Damask rose, *Rosa damascena* Mill., auxins; indole-3-acetic acid; naphthalene acetic acid; hormones

Introduction

Rose is one of the most important ornamental plants of the family Rosaceae. Damask rose is widely grown for its multiple uses such as for making rose oil (*attar*), rose water (*ark-e-gulab*), extraction of perfumes and vitamin C, as cut flowers besides for its medicinal uses.

Plants propagate through sexual as well as vegetative means. Sexual method of propagation, though plays important role in the development of new species but scores of plant species show complexities and produce off springs with undesirable characters. Vegetative propagation, lead to the plant species with desirable characters true to the type from somatic cells through cutting, budding, grafting, layering etc. Among these, the use of stem cuttings is the most easy and common method applied for growing roses (Anderson and Woods, 1999).

Establishment and growth rate of the cuttings depend upon many factors like the season of cutting, age and portion of the branch, growth media, moisture level, nutrient status and temperature etc. (Kristiansen *et al.*, 2005). Provision of optimal growth conditions, proper timings and plant growth regulators play vital role in establishment of cuttings influencing the important phases of plant growth and development.

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Auxins, also known as phytohormones or plant hormones, play an essential role in coordination of many growth and behavioral processes in the plant life cycle e.g. rooting of cuttings, flowering, aging, root growth, prevention or promotion of stem elongation, colour enhancement of fruit etc.

Among the auxins, both indole-3-acetic acid (IAA) and naphthalene acetic acid (NAA) are the principal auxins used for rooting of cuttings and majority of plant species are responsive to them (Ercisli and Guleryuz, 1999). These chemicals are available in commercial preparations, dispersed in talc or in concentrated liquid formulations.

IAA is a naturally occurring compound having a carboxyl group attached to another carbon-containing group (usually CH_2) that in turn is connected to an aromatic ring. These compounds cause enlargement of plant cells, cell division, lateral branching of shoots and roots, vascular differentiation and early embryonic development (Hobbie *et al.*, 2000). Chaudhry and Khan (2000) reported that IAA promoted expansion of roots. Yang and Davies (1999) suggested that endogenous IAA may play an important role in controlling stem elongation. Sun *et al.* (1998) found that auxins affected the apical dominance of axillary buds. Fatima and Chaudhry (2004) reported that the number of compound leaves increased with IAA application. Chaudhry and Khan (2000) reported that IAA promoted the initiation of cambium and maturity of

meta-xylem elements. NAA is a synthetic auxin. It is known to affect and stimulate rooting more than IAA (Arteca, 1996). Akhtar *et al.* (2002) successfully propagated two rose species i.e. *Rosa centifolia* and *Rosa damascena* using NAA. There have been numerous reports that NAA is involved in the initiation of adventitious roots and that division of root initials depends upon exogenous or endogenous auxin (Haynes *et al.*, 2003).

Keeping in view the role of plant hormones and growth media, in the present study, IAA and NAA were evaluated for their effect on the establishment of rose cuttings in three growth media i.e. soil, leaf mold and soil + leaf mold.

Materials and Methods

The experiment was conducted at the research farm of Arid Zone Research Institute, D.I.Khan during 2004. In the present study, two plant hormones i.e. indol-3-acetic acid (IAA) and naphthalene acetic acid (NAA) and three growth media i.e. soil alone; leaf mold (a compost consisting chiefly of decayed plant matter) and soil + leaf mold mixture (1:1) were used. Different hormone solutions were prepared according to the formula given by Hartmann *et al.* (1997). 25, 50, 75, and 100 mg/l of IAA and NAA were dissolved separately in distilled water along with control having distilled water only. Ethyl alcohol was added at the rate of 10% of the added hormone to facilitate the dissolution process of the solution.

Polythene bags (5 x 15 cm^2), were filled up with 650 g of each of the three growth media. Before initiating the experiment soil, leaf mold and soil + leaf mold were analyzed for their physico-chemical characteristics (Table 1). The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangements and three replications. The bags were lined up randomly in three different blocks in such a manner that each block contained three rows filled up of the same growth media i.e. soil (M1), leaf mold (M2) and soil + leaf mold (M3), which were treated as main plots. Each main plot containing (single row of bags filled up of the same media) 45 bags was then divided into nine sub plots and assigned randomly to different plant growth hormone treatments (mg/l) viz. control (T1), 25 IAA (T2), 50 IAA (T3), 75 IAA (T4), 100 IAA (T5), 25 NAA (T6), 50 NAA (T7), 75 NAA (T8) and 100 NAA mg/l (T9). In this way, each treatment unit contained 5 adjacent bags per plant in the same row.

Disease-free, equally matured 15 cm long semi-hardwood rose cuttings were prepared. Growth hormones were applied to the cuttings, through the dilute solution dip method (Malik, 1999). The cuttings were dipped in hormone solutions for 24 h. at room temperature, which were then sticked in the pre-assigned growth media. The bags were placed in the open air. Irrigation water was applied for 24 h. by overhead sprinklers during the rooting period. Monthly mean temperature and precipitation was recorded during the studies (Table 2). At the end of spring season, the cuttings were dug out and transferred to the field containing their respective media. Prior to transfer in field, the soil on the roots was washed away with water and data was recorded on number of roots and rooting percentage per rose cuttings. After one year of field transplantation, data was recorded on plant height (cm), plant spread (cm), no of primary and secondary shoots and survival

Table 1. Physicochemical analysis of different growth media

Property	Soil	Leaf mold	Soil + Leaf mold
pH	8.53	8.13	8.38
Electrical conductivity (d/Sm)	0.12	0.22	0.15
Organic matter (%)	1.58	21.66	11.52
Total nitrogen (%)	0.078	0.796	0.306
Amm. Acetate extractable K (mg/kg)	143.0	185.4	154.6
AB-DTPA extractable P (mg/kg)	7.68	11.16	9.10
NH_4-N (mg/kg)	7.87	10.50	9.62
NO_3-N (mg/kg)	7.25	64.7	27.12

Table 2. Mean monthly temperature and monthly precipitation during 2004

Month	Temperature °C			Precipitation
	Maximum	Minimum	Mean	(mm)
January	19.13	5.35	12.24	47.0
February	23.90	7.48	15.69	12.0
March	32.13	12.81	22.47	15.0
April	37.00	20.60	28.80	20.0
May	40.71	23.06	31.89	—
June	39.20	25.97	32.59	39.5
July	38.68	26.87	32.78	46.0
August	36.13	25.58	30.86	42.5
September	36.23	23.57	29.90	50.0
October	29.97	19.23	24.60	—
November	26.97	10.67	18.82	—
December	22.48	6.71	14.60	—

Source: Arid Zone Research Institute, Dera Ismail Khan

percentage. The data collected on various parameters were analyzed statistically using analysis of variance technique (ANOVA) as described by Steel and Torrie (1980).

Results and Discussion

Analysis of the data recorded on number of roots per rose cutting and rooting percentage indicated significant response to both plant hormone treatments and growth media (Table 3). The average number of roots as well as rooting percentage per rose cutting increased with increase in plant hormone concentration irrespective of its type. Mean number of roots developed per cutting ranged from 6.39 to 15.78. Mean rooting percentage ranged from 65.0 to 84.0 %. The maximum number of roots (15.72) and maximum rooting percentage (94.17 %) were recorded when 50 mg/l of NAA was applied to the rose cuttings followed by the no. of roots 13.11 and rooting %, 93.21, yielded by 75 mg NAA /l treatment. The minimum number of roots (6.39) and rooting percentage (64.99) per cutting were observed in the absence of plant hormone application. Comparative effects of both growth hormones showed greater synergistic effect of NAA on number of roots as compared to IAA probably due to the role of NAA in metabolite translocation and carbohydrate metabolism The present results corroborate with the findings of Choi *et al.* (2000) and Khan *et al.* (2004) who reported that NAA at the concentration of 50 mg/l gave the best results. The possible reason for these results might be due to the enhanced wound healing response (WHR) by NAA, which in turn induced the cell division and meristematic activity, that may have directly or indirectly stimulated the four stages of adventitious root formation of rose cuttings (Davies and Hartmann, 1988). The data further indicated that different growth media also exerted highly significant effect on the rooting and average number of roots per cutting (Table 4). The maximum number of roots (10.78) per cutting and rooting percentage (87.68) were observed in the leaf mold, while the lowest number of roots and rooting percentage (9.55 and 79.47, respectively) were recorded when the rose cuttings were sticked in the growth media containing soil only, but statistically it did not differ between leaf mold and soil + leaf mold. The maximum number of roots in leaf mold suggests that this medium fulfilled better nutritional and aeration requirements of the rapidly growing roots than the other two media. These studies coincide with that of Witt (1997), who found that the root density increases with rising nutrient supply as root branching depends on the nitrogen supply. The interacting effect of different plant hormones and growth media was found to be significant on average number of roots per rose cutting and rooting percentage (Table 5). The highest number of roots (18.50) was recorded in the leaf mold with 50 mg/l NAA (Fig. 1); maximum rooting percentage (98.17%) was also recorded in the leaf mold with 50 mg/l NAA which was followed by statistically close value of (96.33%) in soil + leaf mold at the same concentration of NAA (Fig. 2).

Plant height gradually increased with increase in growth hormone concentration irrespective of the type (Table 3). Moreover, 50 mg/l NAA significantly gave greater plant height (134.2 cm) amongst all the hormone treatments apart from NAA applied at 75 and 100 mg/l and IAA at 100 mg/l. The minimum plant height of (111.6 cm) was recorded in control treatments. The plant height increased up to the final concentration i.e. 100 mg IAA/l. However, in the case of NAA the plant height first increased at 50 mg/l, remained constant at 75 mg/l and then showed a drastic decrease at 100 mg/l. Hence

Table 3. Effect of plant hormones on the establishment of damask rose cuttings

Plant hormone levels (mg/l)	No. of roots/ cutting	Rooting (%)	Plant height (cm)	Plant spread (cm)	No. of primary shoots/ plant	No. of secondary shoots/ plant	Plant survival (%)
T1 = Control	6.39 f	64.99 f	111.6 e	28.1 f	3.8 f	11.2 g	53.94 f
T2 = 25 IAA	7.79 e	80.88 e	113.5 de	29.0 f	4.2 ef	13.3 f	61.17 e
T3 = 50 IAA	8.18 e	82.38 de	117.0 ce	31.1 e	4.3 de	14 .4 ef	67.28 d
T4 = 75 IAA	8.22 e	82.48 cde	119.5 ce	32.8 de	4.3 de	15.7 de	73.61 c
T5 = 100 IAA	10.11 d	89.28 b	126.4 ac	38.2 bc	5.2 bc	21.8 b	85.28 b
T6 = 25 NAA	10.41 d	85.11 c	122.6 bd	32.7 e	4.8 cd	16.3 d	77.06 c
T7 = 50 NAA	15.72 a	94.17 a	134.2 a	46.3 a	6.3 a	25.1 a	94.72 a
T8 = 75 NAA	13.11 b	93.21 a	129.2 ab	40.3 b	5.7 b	24.1 a	90.94 a
T9 = 100 NAA	11.44 c	84.01 cd	125.1 ac	35.5 cd	5.2 bc	19.9 c	82.28 b
LSD at P < 0.05	0.76	2.71	9.60	2.75	0.52	1.61	4.45

Means within a column followed by different letters are significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$)

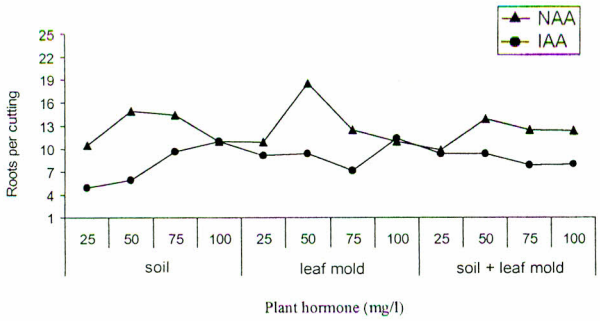

Fig. 1. Number of roots per cutting (plant hormone versus media).

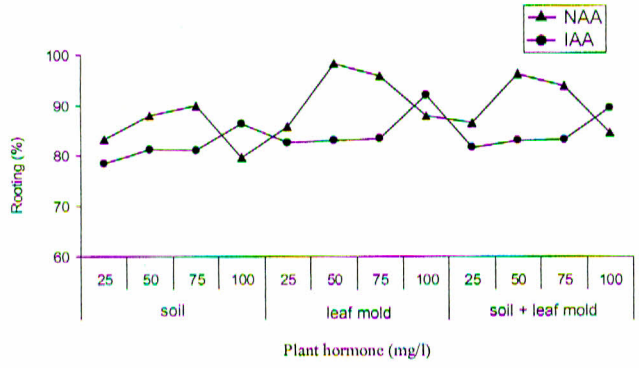

Fig. 2. Rooting percentage (plant hormone versus media).

50 or 75 mg NAA/l was the optimum dose for maximum plant height. Such conclusion could not be drawn for IAA as the plant height increased linearly up to the last concentration i.e. 100 mg/l. Different growth media also had a significant effect ($P \leq 0.05$) on the plant height of rose (Table 4). The maximum plant height (125.1 cm) was observed in leaf mold followed by at par value of (123.2 cm) in soil + leaf mold, while the lowest plant height (118 cm) was recorded in soil only. These results are in line with Zhao *et al.* (2005) who found that decreased photosynthetic activity is mainly associated with reduced nitrogen content in the media resulting in lower biomass production. The interaction between growth

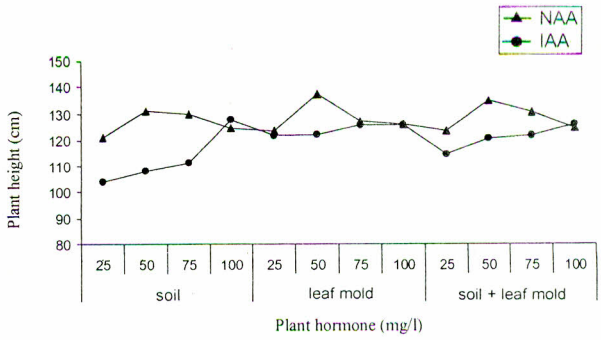

Fig. 3. Plant height (plant hormone versus media).

hormones and three growth media did not differ significantly (Table 5). However, leaf mold at 50 mg/l in both plant hormones appeared to be the best treatment by giving the plant height of (137.3 cm) as depicted in (Fig. 3).

Different plant hormones and growth media had significant effect ($P \leq 0.05$) on the plant spread (Table 3). The maximum plant spread (46.3 cm) was recorded with 50 mg/l of NAA followed by plant spread of 40.3 cm observed at 75 mg NAA/l. The minimum plant spread (28.1 cm) was recorded in the control. This might have been due to the inhibition caused by the downward transport of endogenous plant hormones from the dominant shoots, causing a phenomenon of partial apical dominance, while in case of plant hormone treatments, this inhibitory effect of the endogenous hormones is counteracted by the exogenous applications of hormones especially NAA resulting in the cancellation of apical dominance and more plant spread. The effect of different growth media on plant height appeared significant at ($P \leq 0.05$), which ranged from 31.9 to 37.0 cm (Table 4). The maximum plant spread (37.0 cm) was found in leaf mold followed by soil + leaf mold, while the lowest plant spread (31.9 cm) was recorded in the growth media containing soil only. This effect might be because of well balanced and adequate carbon/nitrogen (C/N) ratio in the leaf mold and soil + leaf mold, ensuring continuous supply of intermediate compounds as source of

Table 4. Effect of different media on the establishment of damask rose cuttings

Media	No. of roots/ cutting	Rooting (%)	Plant height (cm)	Plant spread (cm)	No. of primary shoots/ plant	No. of secondary shoots/ plant	Plant survival (%)
M1 = soil	9.55 b	79.47 c	118.0 b	31.9 b	4.5 b	16.19 b	68.85 c
M2 = leaf mold	10.78 a	87.68 a	125.1 a	37.0 a	5.2 a	19.48 a	85.67 a
M3 = soil + leaf mold	10.13 ab	85.01 b	123.2 a	35.8 a	4.9 ab	18.26 a	74.24 b
LSD at $P < 0.05$	0.69	2.550	1.76	3.37	0.36	1.66	4.04

Means within a column followed by different letters are significantly different according to Duncan's Multiple Range Test ($P < 0.05$)

Table 5. Effect of interaction of plant hormones × growth media on the establishment of damask rose cuttings

Plant hormones x media	No. of roots/ cutting	Rooting (%)	Plant height (cm)	Plant spread (cm)	No. of primary shoots/ plant	No. of secondary shoots/ plant	Plant survival (%)
T1x M1	3.83 o	47.63 m	104.7	26.8 o	3.3	9.6 k	38.00 l
T2 x M1	4.83 no	78.33 k	103.9	27.5 mo	4.0	11.3 jk	55.17 ijk
T3 x M1	5.87 mn	81.17 hijk	108.3	29.3 lo	4.0	12.3 ik	65.17 gh
T4 x M1	9.67 gi	81.00 ijk	111.4	29.8 lo	4.3	12.6 ij	62.50 hi
T5 x M1	11.00 ef	86.33 efg	127.7	36.2 dj	5.0	21.6 ce	74.83 ef
T6 x M1	10.55 eh	83.10 ghij	121.0	30.0 ko	4.7	12.6 ij	71.17 fg
T7 x M1	14.83 b	88.00 def	130.7	37.9 dh	5.3	23.3 bc	94.50 ab
T8 x M1	14.33 b	90.00 cde	129.9	36.7 di	5.0	21.6 ce	82.50 cde
T9 x M1	11.00 ef	79.67 jk	124.7	33.1 il	5.0	20.3 df	74.83 ef
T1 x M 2	7.17 lm	80.67 ijk	117.2	31.7 jn	4.3	11.6 ik	75.00 ef
T2 x M2	9.17 ik	82.67 ghijk	121.7	32.2 im	4.7	14.3 hi	74.33 f
T3 x M2	9.33 hj	82.97 ghijk	122.2	33.8 gl	4.7	16.6 gh	75.00 ef
T4 x M2	7.16 lm	83.33 fghij	125.6	37 fk	4.3	17.6 fg	83.33 cd
T5 x M2	11.33 ce	92.00 bcd	125.7	39.0 cf	5.7	22.0 cd	89.00 bc
T6 x M2	10.83 eg	85.73 efgh	123.3	35.0 ej	5.3	19.0 eg	84.00 cd
T7 x M2	18.50 a	98.17 a	137.3	47.4 b	6.7	26.6 a	97.67 a
T8 x M2	12.50 c	95.77 ab	127.0	40.7 cd	5.7	25.3 ab	98.33 a
T9 x M2	11.00 df	87.83 def	126.1	38.3 dg	5.7	22.0 cd	94.33 ab
T1 x M3	8.17 jl	66.67 l	112.9	25.7 o	3.7	12.3 ik	48.83 k
T2 x M3	9.37 hj	81.63 hijk	114.8	27.3 no	4.0	13.3 ij	54.00 jk
T3 x M3	9.33 hj	83.00 ghijk	120.6	30.0 hl	4.3	14.3 hi	61.67 hij
T4 x M3	7.83 l	83.10 ghij	121.6	30 gl	4.3	17.0 gh	75.00 ef
T5 x M3	8.00 kl	89.50 cde	125.8	39.5 ce	5.0	22.0 cd	92.00 ab
T6 x M3	9.83 fi	86.50 efg	123.4	33.0 il	4.3	17.3 g	75.00 ef
T7 x M3	13.83 b	96.33 ab	134.7	53.6 a	7.0	25.3 ab	82.00 ab
T8 x M3	12.50 c	93.87 abc	130.7	43.7 bc	6.0	25.3 ab	92.00 ab
T9 x M3	12.33 cd	84.53 fghi	124.7	35.2 ej	5.0	17.3 g	77.67 def
LSD at P < 0.05	1.318	4.68	N.S	4.76	N.S	2.78	7.77

Means within a column followed by different letters are significantly different according to Duncan's Multiple Range Test (P< 0.05)

energy and carbon skeletons which are lost during hydrolysis of starch during root development. Regarding the interaction of different plant hormone treatments and growth media, the data demonstrated that the average plant spread was significantly higher at all levels of both growth hormone concentrations over control (Table 5). But 50 mg/l NAA significantly increased the plant spread (53.6 cm) in soil + leaf mold followed by the plant spread of 47.4 cm at the same level in leaf mold (Fig. 4).

Statistical analysis of the data showed highly significant variations among the treatments pertaining to average number of primary and secondary shoots per plant (Table 3). Mean values indicated that the maximum number of primary shoots (6.3) and secondary shoots (25.1) were recorded with 50 mg/l NAA followed by (5.7) primary and (24.1) secondary shoots at 75 mg NAA/l. The minimum number of primary shoots (3.8) and secondary shoots (11.2) were observed in control. It appears that the above stated doses of NAA are mainly concerned with enhanced development of shoot initially and their further development. Comparative effects of both the hormones showed that NAA had stronger synergistic effect on number of primary and secondary shoots as compared to IAA. This may be due to more physiological activity of NAA in the intact rose cuttings. The data on further investigation showed that all the growthe media had significant effect ($P \leq 0.05$) on the number of primary shoots (Table 4) with maximum number of primary shoots (5.2) and secondary shoots (19.48), observed in leaf mold followed by statistically non-significant value of (4.9) primary and (18.26) secondary shoots in the soil + leaf mold, while the minimum

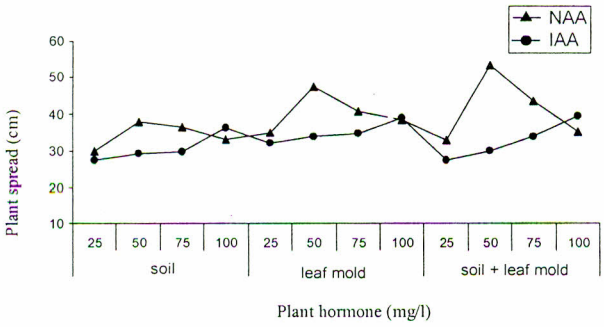

Fig. 4. Plant spread (plant hormone versus media).

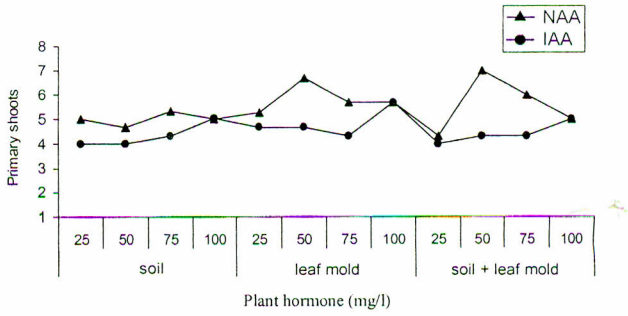

Fig. 5. No. of primary shoots (plant hormone versus media).

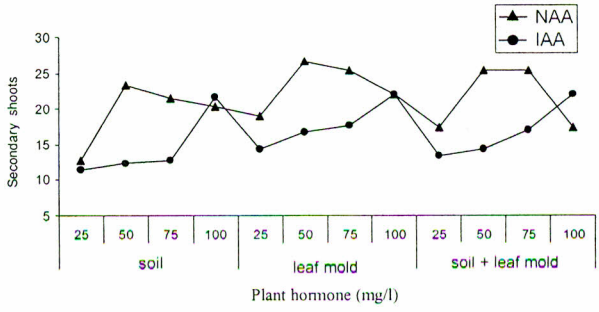

Fig. 6. No. of secondary shoots (plant hormone versus media).

(4.5) number of primary and (16.19) of secondary shoots were recorded in the soil. The above results might be due to the improved media characteristics of leaf mold followed by soil + leaf mold ensuring the proper growth and development as compared to the soil only. The interaction of growth media and plant hormones did not differ significantly (Table 5). However, the treatments receiving 50 mg/l of NAA produced the maximum (7.0) primary shoots in soil + leaf mold media followed by (6.7) shoots in leaf mold at the same level of growth hormone as shown in (Fig. 5).

The average number of secondary shoots were comparatively higher at all levels of both growth hormones over control but the highest number of secondary shoots i.e. 26.6 was recorded in the leaf mold with 50 mg/l NAA which was at par at the same level of NAA in soil + leaf mold (Fig. 6).

Plant survival was significantly ($P \leq 0.05$) influenced by both plant hormones and growth media (Table 3). The survival percentage per rose cutting increased proportionally with increase in plant hormone concentration irrespective of type. Mean survival percentage ranged from 53.94 to 94.72%. Maximum (94.72%) plant survival was recorded in the cuttings treated with 50 mg/l NAA followed by statistically close value of (90.94%) observed at 75 mg IAA/l. Minimum plant survival (53.94 %) was observed in the absence of any hormone i.e. control. These differences might be due to the positive correlation between survival percentage and number of roots. NAA at 50 and 75 mg/l might have induced favourable environment for root and shoot development and the resultant enhanced plant survival as compared to the minimum in the control. The survival percentage increased linearly up to the final concentration of 100 mg/l of IAA, while in case of NAA it increased up to 50 mg/l, remained at par at 75 mg/l and then began to decline at the highest concentration of 100 mg/l. It might be due to the specific biochemical activity of the plant hormones up to the optimum level showing positive effect but above this level they showed the inhibitory effect. As regard different growth media, maximum plant survival (85.67 %) was recorded in leaf mold while minimum survival (68.85 %) was recorded in soil only (Table 4). These results suggest that leaf mold media provided better nutritional and aeration requirements of the rapidly growing roots than the other two media. Similar results were also reported by Bibhaskumar (2003) who stated that a well-drained loose, friable soil permits good root aeration and healthy growth of roots and shoots. Mean interaction data on percent plant survival showed maximum plant survival (98.33%) in the leaf mold with 75mg/l NAA followed by statistically close value of (97.67%) at 50 mg/l in the same growth media and plant hormone (Fig. 7). The minimum plant survival (38.00 %) was observed in the media consisting of only soil in the absence of any hormone i.e. control (Table 5).

The findings of this study reveal that the plant growth hormones and the growth media, both have significant effect on the establishment of damask rose cuttings. Naphthalene acetic acid has a much stronger synergistic effect as compared to indole-3-acetic acid on root initiation and plant development. The optimum level of NAA is observed between 50 and 75 mg/l while no such conclusion could be drawn for IAA as all growth parameters linearly increased up to the highest concentration of IAA i.e. 100 mg/l. Among the growth media, leaf mold is superior in terms of its encouraging effects on the growth and the establishment of rose cutting followed by soil + leaf mold.

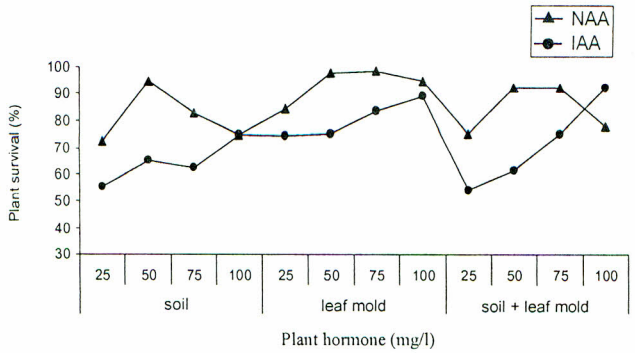

Fig. 7. Plant survival percentage (plant hormone versus media).

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