ROOT REGENERATION OF ROSE PLANTS AS INFLUENCED BY APPLIED AUXINS

H.W.M. Fuchs
Agricultural University
Department of Horticulture
P.O. Box 30
6700 AA Wageningen
The Netherlands
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Abstract

Root regeneration of rose plants was promoted by application of auxin in all experiments. Indolebutyric-acid (IBA) applied to root segments of Rosa multiflora 'Kanagawa' increased number of regenerated roots as well as root length. The best results were obtained with the highest concentrations (1 000 ppm). Addition of sucrose 5% to the solution enhanced the results.

IBA or naphtalene acetic-acid (NAA) applied to roots of dormant 'Motrea' on rootstock R. canina 'Inermis' promoted root regeneration, while indole acetic acid (IAA) showed no promoting effect. Most effective was IBA in a concentration of 500 ppm.

The promoting effect of IBA on root regenerating of dormant 'Sonia' on rootstock R. canina 'Inermis' was observed in a range of temperatures from 5 to 25°C. Optimum concentration depended on temperature: at the lowest temperature the highest IBA concentration was the most effective; at the higher temperature it was the lower concentration.

1. Introduction

A rose crop in the Netherlands often starts with transplanting dormant material. Survival and good growth of these transplants is only possible when during the first weeks after transplanting the temperature can be maintained at about 5°C. This is only possible in a small period in winter. Problems with survival and bush development may be due to bad root regrowth (root regeneration). Any treatment that would decrease the time to new root initiation and increase the number of roots or the elongation rate of the roots should increase the chances of successful establishment and early productivity of rose plants. Regrowth of roots is generally known as root-regenerating potential (RRP) which is defined as the capacity of roots to elongate or initiate and elongate new lateral roots (Stone et al., 1962). In woody ornamentals the RRP varies with the species (Struve et al., 1984b), with scion variety in roses (Lee et al., 1978) and with physiological stages of the shoot system (Stone et al., 1959; Lathrop et al., 1971; Lee et al., 1976). Several researchers showed that stimulation of RRP is possible by auxin treatments (Looney et al., 1968; Lee et al., 1976; Kelly et al., 1983; Struve et al., 1984b). A review of species studied, method of application, types and concentration of auxin was recently made by Struve et al. (1984b). This study was undertaken to determine the effects of types of auxin, auxin concentrations and their interaction with temperature on root regeneration of rose plants.

2. Material and methods

2.1. Auxin effect on root segments

Use of root segments instead of intact plants for determination of RRP has been reported to be a convenient measure of the inherent capacity of roots to initiate lateral roots in Pistacia (Lee et al., 1976) and in rose (Lee et al., 1978). Rosa multiflora 'Kanagawa' 4 years old and grown outside were dug up in February when the plants are completely dormant. Root segments 7.5 cm long and with a diameter of 1-2 mm were collected from 6 plants. Root segments were soaked in 0.5% sodium hypochlorite for 10 minutes and then washed thoroughly with tap water. The segments were divided over the treatments and within these in 3 replications of 5 root segments each. The segments were treated with auxin by soaking them for 5 minutes in a solution of 0, 10, 100 or 1 000 ppm indolebutyric acid-potassium salt (IBA), with or without sucrose 5%. The segments were buried, polar and vertically in plastic coffee containers with moistened perlite, covered with polyethylene bags and placed in a dark growth chamber and a constant temperature of 21°C. Number of new roots (> 1 mm) regenerated per segment and total new root length per segment were recorded after 21 days.

2.2. Auxin effect on young plants under greenhouse conditions

This experiment was carried out from December till January with 'Motrea' plants, about 6 months old, T-budded on rootstock R. canina 'Inermis' grown outside and dormant. Before treatment the plants were stored for 4 weeks in cool conditions (about 2°C). After storage they were randomized in 20 groups of 5 plants each. The 10 treatments (2 groups per treatment) were as follows: 1. control, no treatment; 2. roots pruned to 15 cm in length (root pruning); 3. root pruning and roots soaked for 1 h in tap water; 4. root pruning and soaked for 1 h in a solution containing 50 ppm indolebutyric acid (IBA); 5. root pruning and 500 ppm IBA; 6. root pruning and 50 ppm indole acetic-acid (IAA); 7. root pruning and 500 ppm IAA; 8. root pruning and 50 ppm naphthalene acetic-acid (NAA); 9. root pruning and 500 ppm NAA; 10. root pruning, wetting the roots and covering them with 0.4% IBA talc-powder. Root pruning was carried out to be sure that the plant could take up the solution and could be easily handled. The groups were randomized in 2 blocks and planted for 4 weeks in a normal greenhouse. The temperature in the first 3 weeks was 18°C. After this period the plants were dug up and the number of roots longer than 0.5 cm was counted.

2.3. Auxin effects on young plants under several temperature conditions

This experiment was carried out from January till February. Six months old plants of 'Sonia', T-budded on rootstock R. canina 'Inermis' and grown outside were stored for 6 weeks at about 2°C before the experiment started. Then the plants were selected for uniformity, special attention being paid to the root system, and randomized in 4 groups of 24 plants. After the roots had been pruned to 15 cm, the root and shoot of every plant were weighed separately by the method described by De Stigter (1980). After weighing the plants were treated with auxin by soaking the roots for 1 h with either 0, 100, 250 or 500 ppm IBA. After treatment the plants were weighed again. Two plants of each treatment (the experimental unit) were then planted in plastic trays (50x30x20 cm). The trays were randomized over 5 air conditioned rooms (phytotron) with either 9, 13, 17, 21 or 25°C, with natural light and daylength. While no 5°C room existed in the phytotron this temperature treatment was given in a normal glasshouse. After 6 weeks all plants were dug up and root and shoot of every plant were again weighed separately.

3. Results

3.1. Auxin effect on root segments

IBA applied to root segments of dormant R. multiflora 'Kanagawa' promoted root regeneration, expressed as number of new roots and total new root length per segment, at a concentration of 100 and 1 000 ppm IBA. The best root regeneration was found after application of 1 000 ppm IBA. Application of sucrose 5% enhanced all these effects (Table 1).

3.2. Auxin effect on young plants under greenhouse conditions

IBA applied to roots of dormant plants of 'Motrea' on R. canina 'Inermis' rootstock, promoted the number of new roots when the roots were soaked before planting for 1 h in a solution containing 500 ppm IBA or NAA, or when the roots were covered with 0.4% IBA talc-powder. In the root pruned plants IBA had a promotive effect on root regeneration also in the lowest concentration (50 ppm). IAA proved to be ineffective in both concentrations (Table 2). It was obvious that NAA gave more root primordia than the other auxins, especially in the highest concentration but since only roots longer than 0.5 cm were counted, these were not included.

3.3. Auxin effect on young plants under several temperature conditions

IBA applied to roots of dormant 6 months old 'Sonia' on R. canina 'Inermis' rootstock gave an increase of root weight in the whole range of tested temperatures except at 5°C for the lowest IBA concentration (100 ppm) and at 21 and 25°C for the highest concentration (500 ppm). For 5, 9 and 13°C the most promotive effect is found at the highest concentration and for the higher temperatures, 17, 21 and 25°C the best effect was found at a lower concentration (250 ppm) (Table 3 and Figure 1).

4. Discussion

Auxin enhanced root regeneration in dormant rose roots as was observed in several other woody plants (Looney et al., 1968; Lee et al., 1976; Kelly et al., 1983; Struve et al., 1984b). The best root regeneration in dormant rose plants occurred after application of IBA, rather than IAA or NAA. This was also observed in scarlet oak seedlings (Struve et al., 1984a). IAA seemed to be less effective and NAA only initiated a large number of roots, but these did not elongate in the same way as those caused by IBA. A similar effect was observed in seedlings on other plants (Kelly et al., 1983; Struve et al., 1984a) and also in cuttings with high concentrations of IBA (Hartmann et al., 1975).

The promoting effect of auxins on dormant rose roots was partly due to an increased number of newly initiated roots and partly to elongation of these roots, while in oak seedlings the promoting effect was due primarily to increased number of regenerated roots rather than to elongation (Struve et al., 1984a). In other species it varied with the season, in autumn almost exclusively from elongation of roots, whereas in spring regeneration results from both initiation and elongation (Struve et al., 1984a, b). The promoting effect of sucrose on root regeneration was due partly to an increase of number and elongation of new roots, but it seemed that especially elongation is promoted. The reason for this could be the limitation of available carbohydrates. The need for reserve material for good root growth and regeneration has been reported for several species (Richardson, 1958a and 1958b; Blakeley et al., 1972; Rogers et al., 1968; Lathrop et al., 1971). Another possible mode of action can be the increase of auxin efficiency (Nanda et al., 1968). Auxin affected root regeneration in the whole range of temperatures from 5 to 25°C, but optimum concentration of IBA changed with temperature. The lower the temperature, the higher the concentration of optimum IBA, hence at high temperatures the optimum concentration for good root regeneration is lower. This can be due to the generally known fact that a concentration range of auxin yields an optimum response curve which changes with temperature. Although according to the literature cold storage before treatment should unify both root and shoot growth under forcing conditions (Webb, 1977; Farmer, 1979) in the present experiment only uniform root development was observed. An explanation could be that the selection criterion was the root rather than the shoot system. The application of auxin could have contributed also to this lack of uniformity because auxin prohibits bud release. Perhaps this prohibition is for some reason not the same for each plant, however the treatment without auxin also showed this lack of uniformity. Another possibility is that the chilling required for good uniformity is different for the root and the shoot (Lathrop et al., 1971). It should be kept in mind that shoots and roots in these roses are even genetically different. It can be concluded that stimulation of root regeneration of dormant rose plants is possible but further work has to be done on its after-effects on shoot growth and bush development (cut flower production, renewal canes). Other fields of study are the different methods of application and the effect of auxin application on other rose plants that are not dormant (e.g. regeneration of roots after harvest of the flowers).

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Table 1 - Influence of auxin concentration with or without sucrose 5% on root regeneration, expressed as number of new roots and total new root length (mm) per regenerated segment of R. multiflora 'Kanagawa'.

Treatment	Number of new roots	Total new root length
0 ppm IBA	3.73 a[z]	13.28 a[z]
10 ppm IBA	3.63 a	15.21 ab
100 ppm IBA	7.40 b	41.59 c
1 000 ppm IBA	11.40 c	49.52 d
0 ppm IBA + sucrose 5%	3.84 a	13.83 a
10 ppm IBA + sucrose 5%	2.13 a	20.54 b
100 ppm IBA + sucrose 5%	8.40 b	53.09 e
1 000 ppm IBA + sucrose 5%	14.40 d	78.16 f

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

Table 2 - Influence of root pruning and auxin treatment 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[z]
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 500 ppm	68.0 c
Root pruning and IBA 0.4% (talc-powder)	108.8 d

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

Table 3 - Effect of auxin concentration under several temperature conditions on root regeneration, expressed in increase of root weight (g) of 'Sonia'/'Inermis' plants 6 weeks after treatment.

Concentration	Temperature °C					
IBA ppm	5	9	13	17	21	25
0	0.69 a[z]	0.37 a	1.19 a	1.31 a	1.03 a	0.24 a
100	2.84 ab	3.94 b	5.02 b	5.85 b	9.14 b	4.15 bc
250	3.50 b	4.83 b	9.38 c	9.86 b	10.86 b	5.23 c
500	5.23 b	5.57 b	9.56 c	8.27 b	3.17 a	2.09 ab

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

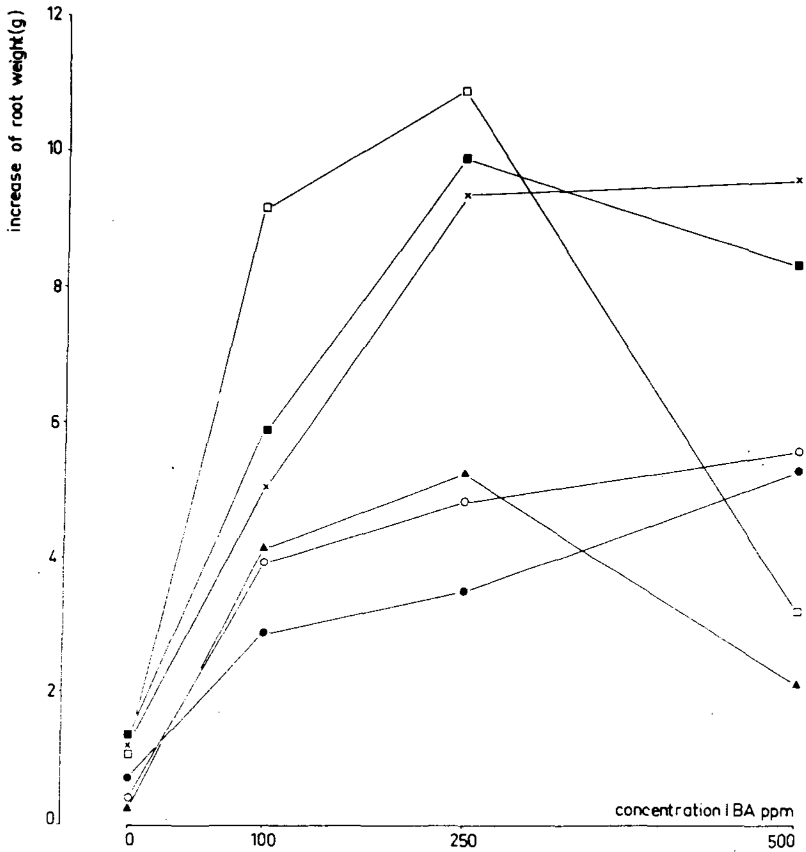

Fig.1: Effect of auxin concentration under several temperature conditions on root regeneration of rose roots.