HARVESTING, PRUNING AND ROOT REACTIONS OF ROSES

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Abstract

Harvesting flowers caused dying off of roots of 'Motrea' rose plants on 4 root systems: 'Indica Major', 'Veilchenblau', 'Fredica' and 'Motrea'. Sixteen days after harvest the total root mass reached a minimum. From then on it increased quickly and towards the time the next flowers could be harvested the root mass was higher than at the previous harvest. After removing also the active lateral shoots initially no decrease of root mass was found, but the relative growth rate of the roots was lower than in plants, from which flowers had been harvested in the normal way. Harvesting flower stems with simultaneous removal of extra leaves resulted in a dramatic decrease in root mass. Regrowth started later and relative growth rate of the roots was lower compared to the control treatment. There was no difference between the 4 root systems tested with respect to this behaviour.

1. Introduction

It is generally known that root and shoot are interdependent: the shoot needs the water and mineral nutrients absorbed by the root, while the root needs the carbohydrates produced in the shoot. This consideration led to the concept that the ratio of root mass to shoot mass remains constant for a specific plant at a certain stage of its ontogeny and under constant environmental conditions (Turner, 1922; Crist et al., 1929; Brouwer, 1962a, b). Throughton (1977) and others also showed that disturbance of the environmental conditions causes the plant to react with a rapid change of its root/shoot ratio to a new stable ratio, apparently attuned to the new situation. Apart from competition for water and minerals at one hand, and carbohydrates at the other, this relation between shoot and root is probably regulated by biochemical signals but how these are involved is still not clear (De Wit et al., 1983). The role of competition is demonstrated by the results of De Stigter (1969), Van der Post (1968) and others, who found that when reproductive organs are formed the resulting demand for assimilates competes with the supply to the roots and hence decreases root growth.

In a preliminary experiment a decrease in root growth was found in rose plants after cutting the flowers. This could be due to a disturbance of the shoot/root ratio because harvesting roses implies removal of the better part of the leaves (Aikin, 1974; Mor et al., 1979). It also could be due to competition, because removing shoots causes bud break and new shoots which need carbohydrates. Hence there are more sinks for a smaller amount of photosynthates.

The aim of this experiment was to investigate:
1. the time course of root growth after harvest;
2. the reactions of different root systems;

3. the (physiological) background of the relationship between root and shoot after disturbance of the shoot/root ratio.

2. Materials and methods

Plants of 'Motrea' stented (Van de Pol et al., 1982) on 3 different root systems, viz. 'Indica Major', 'Veilchenblau' and 'Fredica' or grown on their own roots (from cuttings) were grown for 3 months in containers. Three months before the start of the experiment they were transferred to a hydroculture system according to Steiner (1965), where they were treated in a normal way. The nutrient solution was made according to Van de Berg (1980). The air temperature in the greenhouse in which the hydroculture system had been set up varied between 22 and 26^{o}C, the temperature of the nutrient solution was about the same. The experiment was carried out from the end of June till the beginning of August 1984. No supplementary artificial light was used. All plants of each scion/rootstock combination were divided into 3 groups, which received different pruning treatments as follows: 1. harvesting flowers in a normal way (stems cut back to the third 5-leaflet) at the beginning of the experiment; 2. harvesting flowers in the same way and subsequently taking away all active lateral shoots, twice a week during the first 3 weeks and once a week during the rest of the observation period; 3. harvesting flowers and subsequently taking off half the number of the remaining leaves and during the observation period half the number of the newly appearing leaves, in the same frequency as mentioned before. All the removed parts were weighed. The observation period went on till the control plants (treatment 1) produced a new harvestable flower (=39 days after treatment).
The experimental layout was a randomized block design: 4 root systems x 3 treatments x 2 plants per plot in 3 blocks of 12 plots, which makes a total of 36 plots. During the observation period root and shoot fresh weights were recorded separately once a week according to the method described by De Stigter (1980). Before weighing the roots were rinsed in tap water.

All observations were analyzed by means cf the univariate analysis of variance (ANOVA) as well as with the multivariate analysis of variance (MANOVA) because the combination of the 3 variables (level m, slope l and curvature q) determines the growth curve (Keuls et al., 1982). The MANOVA takes into account the correlations between m, l and q. As an extension it will appear how far m, l and q contribute individually and/or in combination to differences between growth curves. The natural hierarchy among m, l and q will be taken into account; m having the lowest complexity and highest power, q having the highest complexity and lowest power for discovering differences in growth curve (Keuls et al., 1982).

3. Results

In this paper only the effect of pruning treatment as well as the effect of the root system on root fresh weight will be examined and discussed.

From the ANOVA appeared that the effect of root system on root fresh weight was significant for all three growth components namely the level m ($p<0.001$), the linear l ($p<0.013$) and the quadratic q ($p<0.03$). However from the MANOVA appeared that only the level and linear components were responsible for root fresh weight differences. Further by carrying out the Tukey test for each of the above named components separately appeared that for the mean level we can distinguish two groups of root systems namely the first group of the 'Indica Major' and 'Fredica' with high root fresh weight and the second group of the 'Veilchenblau' and 'Motrea' with lower root fresh weight. However the root growth expressed in g fresh weight per day for 'Indica Major' was smaller than the rest. The effect of pruning treatment on root fresh weight was also significant for all three growth components namely the level m ($p<0.01$), the linear l ($p<0.001$) and the quadratic q ($p<0.001$). From the MANOVA appeared that all three components contribute for root fresh weight differences (Table 1).

One can obtain the critical values of the quadratic functions of each pruning treatment by taking the first derivative equal with zero, namely a minimum of root mass äfter 15.7 days for the plants with normal harvested flowers, a maximum of root mass after 25.8 days for the plants without laterals, and a minimum after 26.1 days for the plants with the extra removed leaves (Figure 2 and 3).

Harvesting flowers and supplementary removal of active laterals, showed the best root growth in the beginning (l) but the lowest at the end of the observation period (q). Harvesting flowers and taking off extra leaves gave low root growth in the beginning (l) but recovered after a while (q). Root growth in the beginning after normal flower harvest was somewhere in between (l) and at the end not significant better than after taking off extra leaves (Table 1 and Figure 1 and 2).

Dying off of roots was observed also with 2 years old rose plants of 'Motrea' in 5 l containers; as more leaves were removed more root decay was observed.

4. Discussion

Harvesting flowers caused root decay in all tested root systems. Sixteen days after harvest total root mass is at a minimum level. After this time root mass increased quickly and towards the time that the next flowers could be harvested root mass was higher than the previous time flowers were removed. Bad root growth after defoliation has been observed before in other crops like apple trees (Head, 1966 and 1967), tea plants (Visser, 1969) and ryegrass (Ennik, 1966; Kleinendorst et al., 1969). These authors did not determine root decay, however, this phenomenon was not seen in regard to harvest. Because after removal of active laterals root decay was not observed the conclusion can be drawn that the demand for assimilates is an important factor in causing bad root growth. That shortage of carbohydrates can cause bad root growth was actually shown by Davidson et al. (1966) in orchard grass. That demand for carbohydrates by developing shoots of a rose plant is high until flower buds appear, was shown by Mor et al. (1979). This demand for assimilates is such that the roots not only decrease in growth but even in mass. This conclusion is supported by the result that removing extra leaves resulted in a dramatic decrease in root mass, that regrowth started later and that relative growth was lower compared to the control treatment.

The delay in root growth later on in the plants without laterals could have been caused by the deficiency of certain factor(s) from the active buds or apices, as was found in root regeneration of other crops (Lee et al., 1976). Auxin could be an important factor (Lee et al.,

1974) and it actually enhanced root regeneration (Struve et al., 1984). The regenerating capacity could be an interesting field of study because dead roots must be replaced by new ones. Although in the present experiment there were no differences in this respect between cultivars, Kleinendorst et al. (1969) found in ryegrass a difference in regrowth between two clones. This could be due to the fact that plants with a larger root mass may have more reserves available for regrowth (Ennik et al., 1983).

The present experiment was done in summer. In winter when light intensity and daylength are reduced, the effect of harvesting will probably cause even more problems regarding root growth. Also the influence of the scion should be investigated as the scion may influence root regeneration (Lee et al., 1978 and 1974). Besides harvesting, pruning is an important factor while cutting further down, on older stems may also result in a severe defoliation (Zieslin et al., 1981), high rate of bud break and a increased level of flower bud atrophy (Zieslin et al., 1976 and 1981).

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Table 1 - Effect of root system and pruning treatment on root fresh weight (g).

Factor	Root fresh weight		
1. Rootsystem	Mean level component m	linear component l	Quadratic component q
Indica Major	13.94 a[z]	-0.196 b	0.0042 NS
Veilchenblau	7.97 b	-0.053 a	0.0015 NS
Motrea	7.21 b	-0.046 a	0.0016 NS
Fredica	11.98 a	-0.044 a	0.0017 NS
2. Pruning treatment			
Normal harvest	11.43 a	-0.17 b	0.0054 a
Removed laterals	8.52 b	0.16 a	-0.0031 b
Removed leaves	10.69 a	-0.23 c	0.0044 a

[z]Mean separation in columns (per factor) by Tukey's test, 5% level.

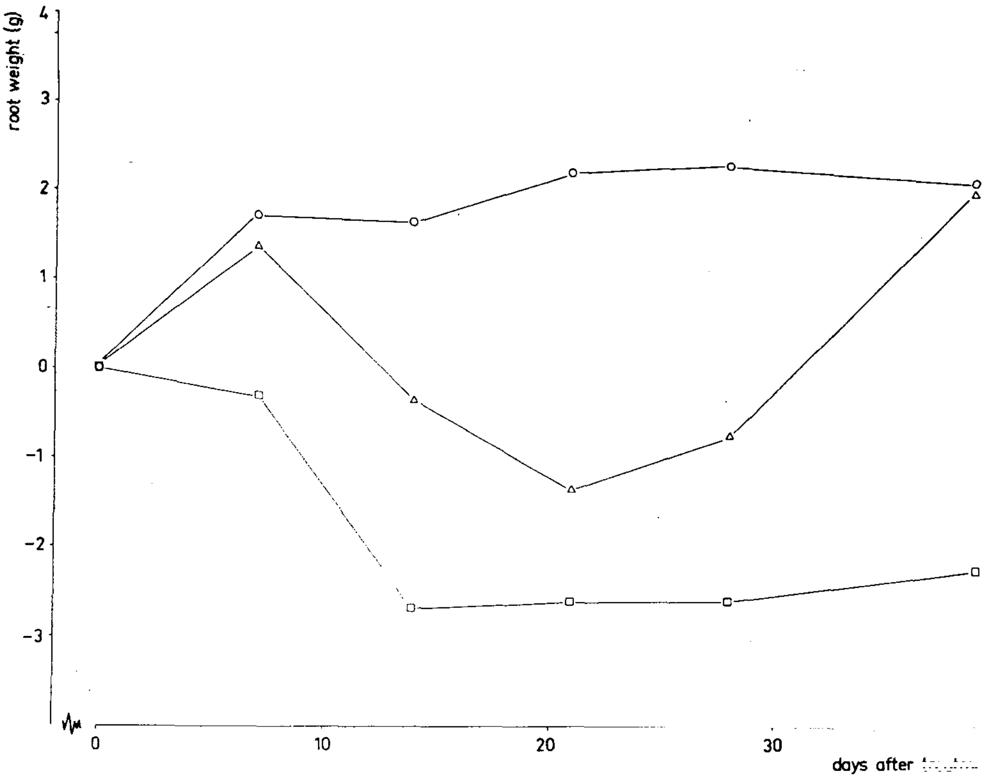

Fig. 1: Influence of three different ways of pruning on root growth course, average of four root systems.

△ normal harvest
○ normal harvest and removed laterals
□ normal harvest and removed extra

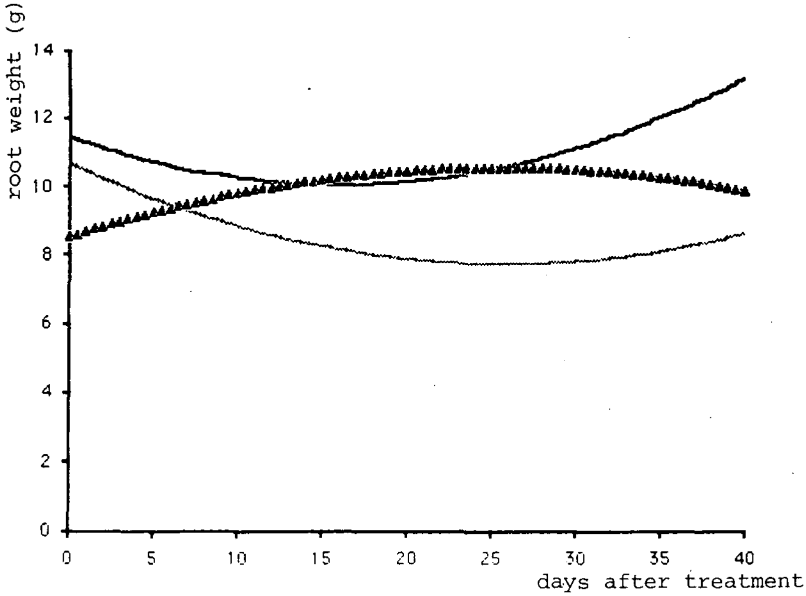

Figure 2 - Influence of three different ways of pruning on root growth course as calculated from the quadratic function of time: $y = m + lx + qx^2$

- normal harvest
- normal harvest and removed laterals
- normal harvest and removed extra leaves

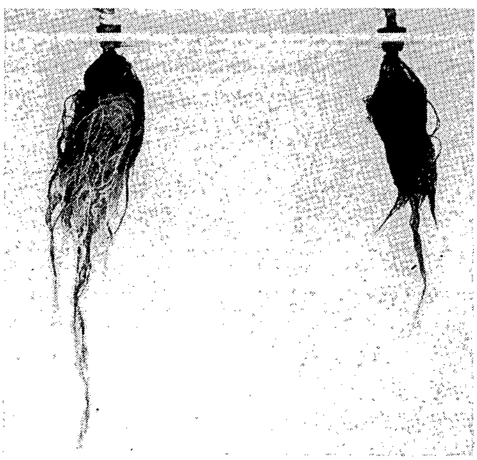

Figure 3 - The root system of Rosa zigri.
left: no pruning, right: 20 days after removal of the flowers