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THE RELATIONSHIPS BETWEEN MINERAL NUTRIENTS AND ENDOGENOUS ROOTING CO–FACTORS IN CARNATION[1]

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ABSTRACT

Effect of mineral nutrients used prior to propagation was studied on the changes in levels of endogenous rooting co-factors in carnation *(Dianthus caryophyllus* L.). The extracts obtained from leaf and stem of plants were chromatographed for separation of different components and were subsequently bioassayed using the mung bean test to determine the levels of rooting co-factors.

Only Hess's rooting co-factor 4 derived from chloroformic fraction was found in considerable quantity in extracts. High rooting activity was found in extracts of unfertilized plants and those which received lower rates of N and P. The rooting was suppressed when K was included in fertilizer or higher rate of NPK was applied.

INTRODUCTION

Both environmental (2) and internal factors (3, 5, 8, 9) are known to influence the rooting of cuttings. Rooting co-factors have also been the subject of many investigations (1, 4, 8, 10, 12, 13). The presence of 4 rooting co-factors in the tissues of English ivy *(Hedera helix* L.) cuttings was held responsible for their high rooting capacity (4). On the other hand, the inhibitory effects of mineral nutrients on the initiation and development of root primordia have been observed in some plants (7, 11). Nitrogen starvation of stock plants of justicia (*Justicia gendarussa* L.) induced rooting in cuttings (1); rooting co-factor activity was inversely related to nitrogen supply and the activity was highest under

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low nitrogen. Holley and Baker (6) indicated that nitrogen nutrition of carnation mother plants affected the number and size of cuttings produced. However, the effects of other nutrients on the rooting of cuttings have not been studied. The objectives of the present study were to find the rooting co-factors available in the stem and leaf tissues of carnation and to investigate the effects of different levels of N, P and K (supplied to mother plants) on the rooting capacity of carnation.

MATERIALS AND METHODS

Rooted cuttings of carnation (*Dianthus caryophyllus* cv. William Sim) were individually potted in 15-cm clay pots in a medium consisting of one part of horticultural grade sphagnum peat and one part sand (v/v). They were kept for two months in a greenhouse in which the temperature fluctuated within the range of 10 to 15 C. The pots were moved outdoor in early May 1974.

The design of the experiment was randomized blocks with four replications. Three elements (N, P and K) were supplied at three levels of 0 (N_0, P_0 K_0), 1000 (N_1, P_1, K_1) and 2000 (N_2, P_2, K_2) mg/l of N, P_2O_5 and K_2O, respectively, as urea, phosphoric acid and potassium sulphate. Five treatment combinations numbered from 1 to 5, respectively, were applied as follows: $N_0P_0K_0$ $N_1P_0K_0$ $N_1P_1K_0$, $N_1P_1K_1$ and $N_2P_2K_2$. The nutrient solutions were applied every two weeks from May 5 to July 1, 1974.

Samples were taken in early July 1974; 50 g of fresh leaf and stem tissues from each treatment were placed in boiling ethanol at least for 2 min. The ethanol extracts were concentrated to dryness under reduced pressure and the residue was taken up in distilled water for subsequent purification and fractionation of the rooting co-factors based on the methods of Hess (4).

The fraction containing rooting co-factor 4 was concentrated to dryness and was taken up in a known volume of n-hexane for subsequent chromatography and bioassay. The solution was then placed on a silica gel (Mallinckrodt, 100 Mesh) column. The column was eluted with a series of ethyl acetate n-hexane solutions in which the percentage of ethyl acetate was gradually increased from 5% to 100%. After evaporation of the ethyl acetate n-hexane solutions, aliquots of each eluate were bioassayed.

The mung bean bioassay developed by Hess (4) was used to determine the root

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promoting activity of the separated extracts where the amounts of co-factors were indicated by the number of roots on the mung bean cuttings. Confidence intervals were calculated at the 5% level of probability.

RESULTS AND DISCUSSION

Extracts from leaf and stem tissues of carnation plants were found to contain 4 root promoting substances. Only rooting co-factor 4 was found in considerable quantity in extracts. Attempts were made to find out by column chromatography if more than one substance was present in the extract containing this rooting co-factor. The results obtained showed that no separate peak of rooting activity was found in the eluates from silica gel column.

The root promoting activity of co-factor 4 is presented in Fig. 1. The horizontal so-

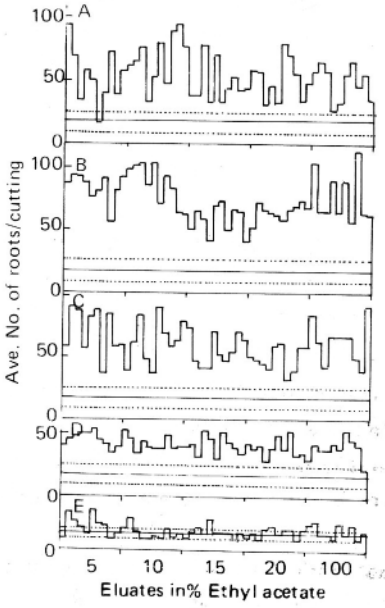

Fig. 1. Number of roots per mung bean cutting treated with rooting co-factor 4 extracted from carnation plants grown under varying nutrient levels: (A) $N_0P_0K_0$, (B) $N_1P_0K_0$, (C) $N_1P_1K_0$, (D) $N_1P_1K_1$, (E) $N_2P_2K_2$. Each histogram represents a bioassay of aliquots eluted from silica gel column with ethyl acetate-n-hexane mixtures. The solid horizontal lines represent the average number of roots per control cutting and dotted lines indicate the confidence interval at 5% level of probability.

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lid lines in these histograms represent the average number of roots per control cutting. Columns above and below the horizontal line respectively represent promotion and inhibition of root initiation as compared with control.

A considerable increase in rooting co-factor 4 level and a decrease in inhibiting activity, as measured by root initiation, was found in extracts from plants grown with $N_0P_0K_0$, $N_1P_0K_0$ and $N_1P_1K_0$ treatments as compared to the extracts from $N_1P_1K_1$ and $N_2P_2K_2$–treated plants (Fig. 1). The decrease of rooting co-factor 4 level and appearance of the inhibitor in the extracts from $N_2P_2K_2$–treated plants is remarkable (Fig. 1,E). The inhibitory effects of nutrients on root formation were most severe when K was included in nutrient solutions. This is in agreement with the results of other investigators (1,7,11) who showed inhibitory effects of mineral nutrients on the initiation of root primordia in plants. Results obtained showed that nutrient levels prior to propagation may have an important effect on the levels of endogenous rooting co-factors in carnation. These results are in accordance with those of Basu and Ghosh (1) for *Justicia gendarussa* L.

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