LITERATURE CITED

1. Good, G. L., and H. B. Tukey, Jr. 1966. Leaching of metabolites from cuttings propagated under intermittent mist. *Proc Amer. Soc Hort. Sci.* 89:727-33.
2. McGuire, John J., and V. J. Bunce. 1970. Use of slow-release fertilisers in a propagating medium *The Plant Propagator.* 16 (2):10-14.
3. Wott, J. W., and H. B. Tukey, Jr. 1967. Influence of nutrient mist on propagation of cuttings. *Proc. Amer. Soc. Hort Sci.* 90:454-61.

DISCUSSION

In reply to questions, Jim Deen indicated that he had not used fritted trace elements and the analysis of the Osmocote additives were 18:6.12 and 14:14.14, both used at 4 oz./bushel.

THE ABSORPTION OF NUTRIENT MIST INTO CUTTINGS

JOHN A. WOTT[1] and H. B. TUKEY, JR.[2]

Abstract. Cuttings, especially softwood and herbaceous, grew tremendously in new roots, shoots, and leaves during propagation Those propagated under nutrient mist had a higher N, P, and K content than those propagated under water mist Cuttings of *Chrysanthemum morifolium*, Ram rooted in special containers showed that almost all of the P absorbed by the cuttings during propagation was absorbed by the stems and foliage from the nutrient mist and either utilized in new growth or translocated into the developing roots.

INTRODUCTION

Symptoms characteristic of nutrient deficiencies have been reported in cuttings propagated under mist (1, 3). These symptoms may be due to leaching of nutrients or the growth of the

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cuttings causing a dilution of the nutrients within the cuttings. Nutrients applied to cuttings through the rooting medium have shown erratic results (2,7).

MATERIALS AND METHODS

Softwood, hardwood and herbaceous cuttings of more than forty cultivars and varieties of plants were propagated under two mist systems (4). One set of cuttings was propagated under ordinary tap water and the other supplied with a nutrient mist of (Ra-Pid-Gro, analysis 23-9-17) at the rate of 4 oz./100 gal. of water (5).

The nutrients were premixed and injected directly into the mist line by a Goulds Balanced Flow Shallow Well Pump. When a high percentage of each species had rooted, they were harvested and root evaluations conducted. After drying in a forced air oven, the cuttings were analyzed for N by the modified Kjeldahl Method, P by colormetric methods and K by a flame spectrophotometer (5). Growth records were also kept on representatives which were potted and grown for further observation.

RESULTS AND DISCUSSION

Softwood cuttings of many woody species increased tremendously in dry weight and nutrient content during the propagation period.

For example, softwood cuttings of *Philadelphus coronarius* (Table 1) originally had a dry weight of 515 mg/cutting when placed in the propagation benches. After six weeks, those propagated under the water mist system had increased to 845 mg/cutting, an increase of over 50%. Those propagated under nutrient mist increased even more in dry weight, (75%). This indicated growth of the cuttings.

Table 1 Influence of nutrient mist on the total dry weight, nutrient content, and root development of softwood cuttings of *Philadelphus coronarius*

	Before rooting	After rooting	
		Water	Nutrient
	(mg/cutting)		
Dry Wt	515	847	928
N	17 94	12 26	53 92
P	2 17	2 14	7 68
K	14 98	9 86	22 23
% Rooting		54 2	86 2
Root Quality Index		1 67	2 80

The N content of the water mist cuttings decreased during propagation from 17.94 mg/cutting to 12.26 mg/cutting, indicating leaching. However, those under nutrient mist showed a 3-fold increase. The P content showed a similar change whereas K, the most leachable nutrient, also showed an increase.

The rooting percentage and root quality also was better in those cuttings propagated under nutrient mist.

Nutrient mist affected the lateral bud growth of some species of cuttings after propagation. For example, softwood cuttings of *Pachysandra terminalis* propagated under nutrient mist averaged 3.2 more breaks per plant than the water mist propagated plants when counted 3 months after removal from the propagation benches.

Nutrient mist also affected the linear growth of many softwood cuttings after propagation. The results of 4 representative species are given in Table 2. For example, the water mist propagated plants of *Euonymus fortunei* averaged 47 cm in height whereas those grown under nutrient mist averaged 68 cm per cutting.

Table 2. Influence of nutrient mist during rooting on linear shoot growth of selected softwood cuttings after propagation

Species	Days	Increase in Stem Length	
		Water mist	Nutrient mist
	(cm cutting)		
Eyonymus fortunei	114	47	68
Forsythia suspensa	101	73	126
Philadelphus coronarius	106	65	91
Lonicera morrowii	111	66	77

Thus cuttings, especially softwoods, increased tremendously in dry weight and had large amounts of nutrient uptake during the propagation period. Also these cuttings made large increases in linear growth and in lateral bud growth after propagation.

In order to study the effect of nutrient mist on rooting, two cultivars of *Chrysanthemum morifolium* were propagated so that nutrient mist was applied during different times of the propagation period. Results showed that fast rooting cultivars (those which rooted in 7-10 days) were beneficially affected by applications of nutrient mist. For example, cuttings of *C m* .'Giant Betsy Ross' had a higher number of roots when nutrient mist was applied, but the time of nutrient application, whether early or late in the propagation period, had no effect In contrast, a slower rooting cultivar, *C m* 'Yellow Columbia' showed a definite increase of root number when the period of nutrient application was also increased.

Nutrient mist also affected root quality. For example, *C m.* 'Yellow Sceptor' cuttings propagated under nutrient mist, had a thicker type of root system which also had more lateral roots. Those propagated under water mist had thinner, and sometimes longer roots. Similar findings were found in softwood cuttings of *Forsythia intermedia*, *Pachysandra terminalis* and *Salix purpurea*.

It was also of interest to determine whether the large increase in nutrient content was due to absorption by the foliar stems and leaves or through the cut stem bases. Thus an experiment involving the use of radioactive phosphorus was conducted.

Four hundred *Chrysanthemum morifolium* 'Giant #4 Indianapolis White' cuttings were inserted through the lids of Freezete polyethylene containers (20 cuttings/container) 4 cm into a rooting medium of quartz sand (6). The aerial portions were misted with nutrient mist. The rooting portion was supplied with an identical nutrient solution only labeled with radioactive P to a specific activity.

The radioactive solution was contained in large 5-gallon plastic carboys suspended above the cuttings. Then by a series of spigots, the labeled solution was allowed to drain, by gravity, through polyethylene tubing to the inside of the rooting containers where by means of a sprinkling system, the medium was thoroughly watered. The solution drained out of the containers and was collected for disposal.

Thus by using ^{32}P, it was possible to propagate plants with a different environment to the aerial (above ground) and basal (below ground) portions of the plant.

Starting on the second day after insertion into the propagation containers and every second day thereafter, 40 cuttings were harvested, divided into aerial and basal portions and assayed for total P content by colorimetric methods. The total amount of P contained in the cuttings at the beginning of the experiment, also determined colorimetrically on control plants, was subtracted to give the total increase of the P content of the cuttings (Table 3).

Table 3. Method for Phosphorus Determination.

	Total P content at harvest time (colorimetric)
—	Total P at experiment beginning (colorimetric)
	Increase in P content
—	Basal Uptake (radioactive)
	Foliar Uptake

The cuttings were also assayed for total radioactivity in the aerial and basal portions, as counted on a Nuclear-Chicago Gas Flow Detector. This was a direct measure to the amount of P absorbed by the cuttings from the labeled solution being applied to the rooting medium. Then the amount absorbed from the basal portion was subtracted from the total increase in P content, to give the total amount absorbed from the unlabeled nutrient solution applied through the mist.

The results showed that the P content of the entire cutting changed from 772 micrograms/cutting to 3196 micrograms/cutting during the 20-day propagation period (Table 4).

Table 4. Absorption of phosphorus by cuttings of *Chrysanthemum morifolium* 'Giant #4 Indianapolis White' propagated under nutrient mist.

Days of propagation	Total P content	P uptake during propagation				
		Total	Basal	Foliar	Foliar	Rooting
		(micrograms per cutting)			(%)	(%)
0	772					
2	823	51	0	51	100	0
4	1071	299	2	297	99	0
6	1174	402	4	398	99	0
8	1379	607	11	596	98	0
10	1487	715	32	683	95	5
12	1547	775	49	726	94	15
14	1636	864	38	826	95	55
16	1887	1115	43	1072	96	68
18	2495	1723	93	1630	95	83
20	3196	2424	371	2053	82	100

During the first 2 days of the propagation period, the cuttings absorbed 51 micrograms/cutting, all of which was absorbed by the aerial portion from the nutrient mist. This trend continued throughout the propagation period. However, there was a larger increase noted on the twentieth day when root growth was quite extensive.

Also the pattern of translocation of the P, once-absorbed, should be noted. Of the 2053 micrograms of P which were foliarly absorbed by the cuttings, 1674 micrograms were retained in the foliar portion and only 379 were translocated into the basal portions and new roots. During the first 8 days of propagation, foliar absorption, accumulation in the foliage, and basal translocation were considerable After root initiation this diminished, but again increased markedly from the 14th to 20th day when roots were elongating.

The percent of the P absorbed by the cut stem bases and foliage was very small. For example, during the entire propagation period, the percent of the P absorbed from the radioactive nutrient solution rose from 0 to 18.1% of the new P absorbed (Table 5). Analyses of the separate foliar portions showed an increase up to 14.6%, whereas the basal portions increased to 18.3%. This meant that 80% of the total new P absorbed by the cuttings during the propagation period was absorbed through the foliar stems and leaves. Even on day 18 when most of the cuttings had rooted, 95% of the P absorbed by the cuttings had been foliarly absorbed from the mist.

Thus, throughout the propagation period, almost all of the P absorbed by the cuttings was absorbed through the stems and foliage. This indicates that nutrients are more efficiently absorbed by chrysanthemum cuttings from nutrient mist than from the rooting medium. Thus nutrient mist would appear to be more effective in applying nutrients to cuttings during propagation than by adding nutrients only to the rooting medium.

Table 5. Percent of total phosphorus absorbed through basal portions of *Chrysanthemum morifolium* 'Giant #4 Indianapolis White' cuttings.

Days	Total Cutting	Aerial Portion	Basal Portion
2	0.0	0.0	0.0
4	0.7	0.5	1.0
8	1.8	0.8	6.1
10	4.5	2.4	15.3
14	4.4	2.2	24.4
18	5.4	3.6	13.6
20	18.1	14.6	18.3

LITERATURE CITED

1. Good, G. L. and H. B. Tukey, Jr. 1966. Leaching of metabolites from cuttings under intermittent mist. *Proc Amer. Soc. Hort Sci* 89:727-733.

2. Kamp, J. R., and C. R. Bluhm. 1950. Effect of nutrients on the rooting responses of softwood cuttings. *Proc Amer. Soc. Hort. Sci* 56:482-484.

3. Tukey, H. B., Jr., J. A. Wott, and G. L. Good. 1965-66. Leaching of metabolites from plants and its implications in plant propagation. *The Cornell Plantations* 21:53-55.

4. Wott, J. A., and H. B. Tukey, Jr. 1965. Propagation of cuttings under nutrient mist. *Proc Inter. Plant Prop Soc.* 15:86-94.

5. ________________, and ________________. 1967. Influence of nutrient mist in the propagation of cuttings. *Proc. Amer Soc Hort Sci.* 90:454-461.

6. ______________, and ______________. 1969. Absorption of phospohorus by *Chrysanthemum morifolium* cuttings propagated under nutrient mist. *J. Amer. Soc. Hort Sci* 94:382-384.

7. Zimmerman, R. H. 1958. Effects of liquid fertilizer on rooting of cuttings. *Proc. Inter. Plant Prop. Soc* 8:162-164.

DISCUSSION

In reply to questions, John Wott gave the following information: The nutrient misting compound had an analysis of 23:19:17 and was used at a rate of 4 oz./100 gallons of misting water. It was used continuously in a timed misting regime of 12 sec. burst every 2½ minutes. Because of the likelihood of run-off, they had assessed the effect of nutrients to the medium but had found foliar application to be superior.

SIMPLIFIED METHOD FOR THE PROPAGATION OF PLUM HARDWOOD CUTTINGS IN SYRIA[1]

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Treatments known to influence the rooting of plum rootstock hardwood cuttings when propagated in heated cutting bins in England have been shown to influence the rooting of two local plum cultivars, Ajami Janirek, and Tephahi janirek (*P cerasifera*), when planted directly into the soil in Syria.

For the greatest level of success, 60 cm long cuttings should be prepared from the proximal portion of the shoot, treated with indolyl butyric acid at 5000 ppm in 50% alcohol to the basal cut surface avoiding, where possible, contact with the epidermis and planted during the months of November, December and January. For a summary of results see Tables 1, 2, 3 and 4.

[1] **Editor's Note** As Nazir Nahlawi was not able to be present because of his recent appointment to a position with F A O , Brian Howard summarised the paper It was not possible to reprint this paper as it was not properly finalised for submission as a scientific contribution and, because of the recent problems in the Middle East, he was unable to obtain data from Damascus to complete the paper Hence the paper is presented as summarised