Rooting of Cuttings From Plants Sprayed With Growth Regulating Substances

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Different methods of application of growth regulating substances to promote rooting in cuttings such as soaking the bases in dilute solutions, dipping in highly concentrated solutions, in talc dust mixtures, and in lanolin pastes have been reported by various investigators. All of these methods involve treatment of the cutting after removal from the plant. No information is available regarding the practicability of applying growth substances in dilute sprays to the foliage at various intervals before the cuttings are taken, but Hildreth and Mitchell (3) have applied a spray of this type to cuttings in the propagating bed with success. Although the cost of this method may have seemed too great with the use of the indole and naphthalene compounds, the recently introduced halogenated phenoxy acids (5) are not only inexpensive, but remarkably effective at relatively low concentrations.

Experimental Methods

The tests here reported were conducted with one of the most effective of these compounds, 2,4,5-trichlorophenoxyacetic acid and its sodium salt. In a few of the preliminary experiments, the free acid was dissolved in a small quantity of sulfonated castor oil and then brought to the desired concentration by diluting with water. Since this solvent alone appeared to promote rooting, all later experiments were conducted with the chemical dissolved in a small amount of ethyl alcohol (never more than one per cent of the final solution) and then diluted with water. The sodium salt of this compound is slowly soluble in water alone which was used in this case. One gram of sodium lauryl sulfate, a wetting agent, was added to each liter of solution.

In order to minimize variations due to temperature, all foliage spraying was done when the air temperature was above 70 degrees F, usually around noon or in the afternoon. Morning spraying was avoided on account of dew. The spray was applied with portable hand sprayers containing from one and one-half to four gallons of solution, and the foliage was sprayed thoroughly to a point where dripping was imminent in order to keep as much solution as possible on the leaves.

The cuttings used in these experiments were placed in a shaded greenhouse on open benches of washed river sand. Bottom heat was not provided until July 25 when the thermostatically-controlled electric soil heating cables beneath the sand in the benches were set at 70 degrees F for the remainder of the season. Humidification was maintained by means of centrifugal atomizers, as previously described by the writers (1, 2). The humidifiers were operated during the entire day in the early part of the summer, but cuttings made after July 25 were placed in a lean-to greenhouse with northern exposure only and the humidifier in this section was operated only for several hours during the middle of the day.

Lots of twenty cuttings each were placed in randomized blocks on the greenhouse benches. Five replications were used for each treatment, a total of 100 cuttings, with the sole exceptions of *Ilex vomitoria*, with which 60 cuttings were used, and *Ilex opaca*, with which 260 cuttings were used for each treatment. After the cuttings had rooted sufficiently for observation, they were lifted carefully from the sand and washed gently in water. The degree of rooting was classed in three grades according to arbitrarily selected standards, described as heavy, medium, and light. Experience has proved that if the differences cannot be determined from this grading, statistical studies on root weight, number, or length will usually fail to reveal significant differences due to treatments. However, the roots of many lots of cuttings were excised and weighed after drying.

Effect of Sprays on Rooting of Cuttings

These trials were only preliminary in nature and in some instances so few concentrations were used that the data are useful only as a guide to further experimentation. Since no information was available regarding the optimal dosage, some failures were to be expected from this source as too low concentration excites little response while too high tends to injure. The free acid was used only on *Buxus, Rhododendron,* and *Weigela,* and sodium trichlorophenoxyacetate was used in all other experiments. The plants, arranged alphabetically in Table I, show considerable variation in rooting response. With some species, showing little or no stimulation at a low concentration, highly significant responses were obtained at a higher concentration.

Little attempt has been made to correlate the concentration of the spray solution with dosages used in the standard methods of application. One trial was made with cuttings from unsprayed plants of *Buxus sempervirens Handsworthii* on August 8 treated by dipping the bases in a mixture of one part of indole butyric acid per 1000 parts of talc. These were compared with cuttings from plants sprayed with trichlorophenoxyacetic acid at a rate of 25 milligrams per liter of water. Oven-dry weights of the roots showed that the cuttings from sprayed plants produced 938 mg of dry matter and those dipped in the talc mixture produced 469 mg, but unsprayed and untreated cuttings produced only 215 mg. Spraying the foliage of *Pachysandra terminalis* with 25 mg/l of trichlorophenoxyacetic acid failed to increase the per cent of rooting, but the application of a talc dust containing one part of indolebutyric acid per 1000 parts of talc to cuttings from unsprayed plants greatly increased both the per cent of rooted cuttings and the heaviness of rooting.

Individual branches on thirteen different clones of American holly (*Ilex opaca*) were sprayed on July 22 at concentrations ranging from 100 to 500 mg/l. Some injuries were observed later on the foliage of certain trees sprayed with concentrations above 200 mg/l, but other trees did not show these symptoms. Twenty cuttings were made of the best material from the sprayed portion of each tree and an equal number from the unsprayed part on several dates between August 8 and 30. When the cuttings were examined on Nov. 16, in ten of the

TABLE I—ROOTING OF CUTTINGS TAKEN FROM PLANTS SPRAYED WITH 2,4,5-TRICHLOROPHENOXYACETIC ACID OR ITS SODIUM SALT

Plants Sprayed		Cuttings		Per Cent Cuttings Rooted				Dry Wt Roots (Mgs)
Concentration Mg/l	Date	Taken	Examined	Total	Heavy	Medium	Light	
Buxus sempervirens Handsworthii (K. Koch) Dallimore								
None	———	Aug 14	Oct 11	40	4	5	31	215
25	Aug 5	Aug 14	Oct 11	63	13	26	24	938**
Buxus sempervirens var *suffruticosa* L.								
None	———	Aug 14	Oct 11	80	17	31	32	—
25	Aug 5	Aug 14	Oct 11	64	2	11	51	—
Cornus florida L.								
None	———	Aug 7	Sep 21	22	3	3	16	—
10	Jul 18	Aug 7	Sep 21	12	0	2	10	—
Ilex crenata var *convexa* Mak.								
None	———	Sep 26	Nov 8	40	1	6	33	108
50	Aug 19	Sep 26	Nov 8	56	4	15	37	193
100	Aug 19	Sep 26	Nov 8	77**	10	25	43	352**
Ilex Fargesii Franch.								
None	———	Aug 8	Nov 8	81	12	24	39	—
100	Jul 18	Aug 8	Nov 8	79	16	20	38	—
Ilex opaca Ait.								
None	———	Aug 15	Nov 16	51	18	16	17	—
100–500	Jul 22	Aug 15	Nov 16	35	10	8	17	—
Ilex vomitoria Ait.								
None	———	Aug 19	Jan 15	27	0	5	22	69
50	Jul 25	Aug 19	Jan 15	48	1	7	40	95**
100	Jul 25	Aug 19	Jan 15	48	15	16	17	230**
Ligustrum amurense Carr.								
None	———	Aug 14	Sep 16	84	45	24	15	1322
10	Jul 18	Aug 14	Sep 16	98	70	21	7	2846**
20	Jul 18	Aug 14	Sep 16	82	45	23	14	1756*
None	———	Sep 23	Oct 26	52	19	14	19	1041
10	Jul 18	Sep 23	Oct 26	50	15	15	20	1011
20	Jul 18	Sep 23	Oct 26	55	25	12	18	1307**
Ligustrum ibolium Coe								
None	———	Sep 27	Oct 13	100	29	56	15	922
50	Jul 25	Sep 27	Oct 13	95	8	50	37	749
None	———	Nov 9	Dec 14	87	15	25	47	653
100	Sep 25	Nov 9	Dec 14	91	38	25	28	1585**
Pachysandra terminalis Sieb. and Zucc.								
None	———	Aug 23	Oct 11	100	39	34	27	—
25	Aug 5	Aug 23	Oct 11	89	20	26	43	—
Rhododendron yedoense var. *poukhanense* (Levl.) Nakai								
None	———	Aug 11	Oct 11	46	12	12	22	—
25	Aug 5	Aug 11	Oct 11	68*	8	21	39	—
Symplocos paniculata (Thunb.) Miq.								
None	———	Jun 26	Sep 21	21	3	2	16	—
20	May 29	Jun 26	Sep 21	18	0	5	13	—
Weigela floribunda (Sieb. and Zucc.) C. A. Mey								
None	———	Jun 5	Jun 24	67	0	12	55	—
50	May 22	Jun 5	Jun 24	39	11	20	8	—

*Indicates effect of treatment significantly different from no treatment at the 5 per cent level of probability.

**Indicates effect of treatment significantly different from no treatment at the 1 per cent level of probability.

thirteen clones more cuttings from the unsprayed branches had rooted than from the sprayed and likewise the rooting was heavier. The advantage of the spraying was very slight with the three remaining clones. The total per cent rooted for each class is shown in Table I.

The behavior of softwood cuttings of sprayed highbush blueberries varied remarkably with the concentration. In some instances, even when no external effects whatever were visible on the stock plants, cuttings died immediately after they were placed in the rooting medium. All cuttings from plants sprayed with a concentration of sodium trichlorophenoxyacetate at 125 milligrams or more per liter behaved in this manner, but those from plants receiving a spray containing 62.5 mg per liter rooted excellently.

Possibly rooting may be promoted in hardwood cuttings by spraying the foliage in the summer preceding the dormant season in which the cuttings are made. A preliminary experiment in the summer of 1943 which consisted in spraying the foliage of black locust (*Robinia pseudo-acacia* L.) resulted in a definite improvement in both the per cent and the heaviness of rooting of hardwood cuttings taken from sprayed branches in the early spring of 1944. Hitchcock and Zimmerman (4) have shown that the influence of a summer spray of growth substance on the foliage may be carried over and produce a characteristic effect in delaying opening of flower buds in the following season.

Effects of Sprays on the Stock Plants

Noticeable effects were observed on the foliage of the sprayed plants in many instances. Epinasty of the leaves and terminal portions of growing shoots was common. Some plants showed discoloration of the foliage, suggesting disintegration of the chlorophyll, particularly with the higher concentrations of the spray solution. Sprays of indole and naphthalene compounds applied to highbush blueberry plants in May and sprays of sodium trichlorophenoxyacetate in June caused shoot elongation to cease for the entire season. The injury caused by Japanese beetles to the foliage of sprayed blueberries was much more severe than to the foliage of unsprayed plants or parts of plants purposely left unsprayed for control purposes. Apparently, changes in the leaves caused by the spraying rendered the foliage more attractive to the beetles.

Another notable effect was observed on bushes of *Ligustrum compactum* Hook. f. & Thoms. sprayed on May 22 with sodium trichlorophenoxyacetate at 50 mg/l. Although the concentration of the spray solution may have been above the optimum, cuttings from sprayed plants rooted heavily and quickly, but those from unsprayed plants rooted only sparsely when held all summer in the propagating bench. All bud growth on the sprayed plants was completely inhibited until the latter part of the summer when the terminal shoots made a vigorous growth, although the laterals remained suppressed as before. The leaves on the vigorous terminal growths were much larger than normal and had an unusually deep green color. This foliage persisted longer in the fall than that of the unsprayed plants.

Discussion

These experiments must be considered as preliminary in nature, but they indicate that if plants are sprayed with 2,4,5-trichlorophenoxyacetic acid or its sodium salt in a suitable concentration, the cuttings taken from such plants after a certain interval show essentially the same rooting responses as do cuttings treated with growth substances according to one of the generally accepted methods. These experiments are not sufficiently extensive to indicate the most desirable time interval between the application of the spray and the making of the cuttings. A suggestion that the effect gradually diminishes with time is seen in the two experiments with *Ligustrum amurense*. The plants were sprayed on July 18 and with cuttings taken on August 14. The best rooting was obtained with a spray of 10 mg/l and the concentration of 20 mg/l was definitely too strong. However, with cuttings taken from the same plants on September 23, the higher concentration gave the better response and no improvement in rooting occurred with the lower.

These experiments indicate the necessity of adjusting the concentration of the spray to the different species of plants in order to obtain the best results, a problem which is present irrespective of the manner of applying growth regulating substances. Whether or not the external effects sometimes observed on sprayed stock plants may persist and cause abnormalities in the following season is undetermined. Further investigations are needed on the concentrations, most suitable stages of growth for application, and the time interval between spraying and taking cuttings.

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