THE EFFECTS OF NUTRIENT SOLUTION, FOLIAR SPRAY, 3-INDOLEBUTYRIC ACID AND DIMETHYL SULFOXIDE (DMSO) ON ROOTING OF HIBISCUS SYRIACUS

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Growing plants in nutrient solutions or aggregates moistened with nutrient solutions is by no means a recent development. In 1699 Woodward (6,9) grew plants in media such as spring rain, river, and distilled water to which he added garden soil. He observed a positive correlation between growth of plants and the amount of soil in the various media. These crude experiments represented the beginning of attempts by scientists to determine the nutrient requirements of plants. Very little additional study was reported in this field until Sachs, Knop, and Nobbe from 1859 to 1865 developed the general procedure for growing plants in aqueous culture solution. Knop later proposed a solution that has been widely used in the study of plant nutrition. Nutrient solutions have been proposed by Shive, Hoagland and many others (3,6,8). These studies provided experimental verification for the early theories that plants were made up of chemical elements secured from water, soil and air (5).

We have employed solution culture or hydroponics to study the effects of various factors on rooting of *Hibiscus Syriacus*. Bailey (2) described this plant as being nearly or quite glabrous, an erect-growing shrub ten to twenty feet in height, which is hardy in the northern states. The plant is grown for its summer and autumn bell-shaped flowers.

Dimethyl sulfoxide (DMSO) is presently being intensively investigated in both zoology and botany. Great interest has been shown in the possible use of this solvent in medicine and agriculture. DMSO, made from a by-product of the paper manufacturing industry, was synthesized in Germany in 1867 (1); however, no use was found for it until 10 or 15 years ago. Currently it is principally used as a solvent in the production of synthetic fibers. It is a good solvent for many organic chemicals and inorganic salts which it apparently has the capacity to transport in plants and animals. This characteristic seem to suggest that DMSO may act as a vehicle to carry substances "piggy-back" to desired sites in plants (4).

The growth retardants B995 and CCC containing DMSO were administered as a spray by Seiuchetti and Born (7) to

[1]This work was supported in part by a grant from the Society of the Sigma Xi and RESA Research Fund

[2]The authors express their appreciation to Dr Barton R Farthing, Professor and Head, Department of Experimental Statistics, Louisiana State University, for his advice and assistance regarding the experimental design and statistical analysis

[3]The authors express gratitude to Dr Robert J Herschler, Crown Zellerbach Corporation, Camas, Washington for the supply of DMSO and the concentrated foliar spray

[4]Appreciation is expressed to Mr Simuel W Austin, Assistant Professor of Photography, Southern University, for photographic assistance

the aerial parts of *Datura tatula*. Inhibitory effects on height, growth, and alkaloid content were greater in those plants receiving the combined treatment of DMSO and retardant than in those treated with retardant alone. Phytotoxicity was noted in the plants treated with CCC alone, and with CCC combined with DMSO.

MATERIALS AND METHODS

A 2 x 4 factorial experimental design replicated five times with one cutting per one gallon glass jar per treatment for each replication was employed in this study.

Softwood cuttings eight inches in length and ten to twelve mm in diameter at the base were inserted in the solutions to a depth of four inches. Four different treatments were applied prior to placing the plant material in two types of rooting media: continuously aerated distilled water and Hoagland solution, each containing five ml of a saturated captan solution. The treatments were:

01 Control

02 Foliar spray which consisted of:
1.5 parts NAA
50.0 parts DMSO
30.0 parts Acetone
10.0 parts Glycerine
10.0 parts Triton X100
Five ml of this emulsifiable concentrate was diluted in water to 100 ml. The stock plant was sprayed with this solution the afternoon of 20 September and morning of 21 September 1966 and all cuttings were taken 30 September 1966.

03 Fifteen minute soaking in a solution containing 1000 ppm IBA and 0.5% DMSO.

04 Thirty minute soaking in a solution containing 1000 ppm IBA and 0.5% DMSO.

The data were obtained by counting the number of roots formed on each cutting during a 45 day period. An analysis of variance and orthogonal comparisons were used to determine differences among treatments.

RESULTS AND DISCUSSION

There were highly significant differences among the four treatments. No significant difference was found between Hoagland solution and distilled water. However, there was a significant interaction between types of solution and treatments (Table 1). Examination of the orthogonal comparisons and the treatment means (Table 2 & 3) shows that the main difference among treatments was due to the large number of roots resulting from treatment three. The interaction was between types of solutions and treatments two and three. With treatment two, distilled water was the better solution, while

with treatment three Hoagland solution was superior.

The result obtained with treatment four, thirty minutes soaking in 1000 ppm IBA and 0.5% DMSO solution, was no different from that obtained with the control. For this treatment phytotoxicity was noted from the complete defoliation of the cuttings. If DMSO has the capacity to transport substances in plant tissues these substances may reach toxic or inhibitory levels if exposure is for an extended period.

TABLE 1 ANALYSIS OF VARIANCE

Source of Variation	d/f	SS	MS	F
Total	39	18,670		
Replications	4	1,306		
Treatment A (1,2,3,4)	3	8,758	2,919	15.12**
Treatment B (5,6)	1	130	130	1
Treatment A X B	3	3,064	1,021	5.29**
Error	28	5,412	193	

TABLE 2 ORTHOGONAL COMPARISON

Treatments	d/f	M S.	F
1 vs 2, 3, 4	1	1,470.00	7.62**
2 vs 3, 4	1	843.75	4.37*
3 vs 4	1	6,444.05	33.39**
Error	28	193	

TABLE 3 TABLE OF MEANS

Treatment Solution	01	02	03	04	Average
Hoagland	9.0	3.4	57.2	11.2	20.2
Distilled Water	14.0	32.6	37.2	11.4	23.8
Average	11.5	18.0	47.2	11.3	22.0

Treatment three, fifteen minutes soaking in a solution of 1000 ppm IBA and 0.5% DMSO, was significantly better than treament two, foliar spray. The foliar spray was applied ten days prior to taking the cutting and it is conceivable that some of the root-inducing effect was lost during that period. The reason why treatment two is most effective in distilled water and treatment three is most effective in Hoagland solution is not suggested by the data.

SUMMARY

A 2 x 4 factorial experimental design replicated five times with one cutting per one gallon glass jar per treatment per replication in continuously aerated Hoagland solution and distilled water was employed to study the effects of nutrient solution, foliar spray, 3-indolebutyric acid and DMSO on rooting of *Hibiscus syriacus*. Highly significant differences were found among the four treatments. Treatment two, foliar spray; and treatment three, fifteen minutes soaking in 1000 ppm IBA and 0.5% DMSO solution were significantly better than treatment one, the control; and treatment four, thirty minutes soaking in 1000 ppm IBA and 0.5% DMSO solution. Treatment three was significantly better than treatment two. There were no differences found between Hoagland solution and distilled water. A highly significant interaction was found between treatment two and treatment three with type of solution.

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HUGH STEAVENSON: We have several minutes for questions.

JAMES WELLS: I just wanted to comment on an effect of Captan which has not been mentioned. When we first tested this I did so on a batch of cuttings taken after Christmas. The variety was *Rhododendron roseum* and I treated the batch of cuttings with 1% IBA and half of the batch was

treated with 1% IBA plus 5% Captan. There was a marked inhibition of top growth on the cutting in the bench while they were rooting where they had been treated with Captan. This was of real value because this variety naturally makes early growth in the bench and certainly cuttings put in that late are very subject to growth in the bench at that time of the year. After the cuttings were moved on there was no further inhibitory effect on the development of the cuttings.

HUGH STEAVENSON: I would like to ask Dr. Stoltz or Dr. Whatley if there is any possibility that DMSO will be used commercially.

LEN STOLTZ: Based on the work I have done I would say probably not with the materials we have tried so far. Also there is some concern with its danger. So many people who have worked with DMSO have had an impairment of vision, usually when relatively high amounts are absorbed.

BOOKER WHATLEY: There is some indication from the limited number of tests we have conducted that you may be able to use a lower concentration of auxin when supplied in combination with DMSO.

VINCE BAILEY: I would like to ask Mr. McGuire about the terminal application of hormones. Was any of the terminal tissue removed before application?

JOHN MCGUIRE: Nothing was taken off the terminal portion of the cuttings.

RALPH SHUGERT: Has anyone used Captan and an auxin on pfitzer cuttings?

JOERG LEISS: We have made up a powder consisting of IBA, NAA, Captan, and Ferbam and it gave us good results.

The following session, moderated by Mr. Roy Nordine, was the first presentation of plant material worthy of introduction to the trade.

ROY NORDINE: The plant material described this afternoon from arboreta will be available at your request for propagation-seeds, cuttings, or whatever it happens to be. Nurseries, of course, are allowed to sell their plant material.

(Editor's Note: The following plant material was presented.)

CERCIS "OKLAHOMA"

Cercis "Oklahoma" was discovered in Spring 1964 in the "Arbuckle Mountains" of Oklahoma. The flowers are a rich wine red over the entire bloom. The leaves are almost round, heavy textured with a glossy sheen that appear to be waxed. The leaves are closely spaced creating a neat appearance throughout the growing season. The trees start blooming at one year and bloom heavily at an early age. This tree seems to grow more compact and will probably not grow as large as the *Cercis canadensis.*

The "Oklahoma" Redbud is thought to be a natural hybrid between *Cercis reniformis* and *Cercis canadensis* having some characteristics of each. The best method of propagation