EFFECT OF CERTAIN AMINO ACIDS AND GROWTH REGULATING SUBSTANCES ON THE SURVIVAL AND ROOTING BEHAVIOUR OF *DURANTA PLUMIERI* CUTTINGS

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INTRODUCTORY

Duranta plumieri is a common hedge plant and is popularly planted around most ornamental gardens and on road sides. If properly and frequently trimmed, it forms a unique hedge for gardens and in view of possessing a fairly prickly character, it also serves as ample protection from cattle and trespassers. It can nicely be cut into beautiful and picturesque designs and almost supersedes every other hedge in this respect.

Duranta though fairly hardy, has a high water requirement at least in the early stages of growth. For this reason, its plantation by cuttings has only been possible during rains. Experience has shown that this plant can better survive as a hedge, if previous to permanent planting, its cuttings are allowed to root in a nursery bed where facilities for watering could be adequate. Because of the extreme popularity of *Duranta* as a hedge plant, it was considered desirable to study the effect of certain amino acids and growth regulating substances on the rooting behaviour of its cuttings.

MATERIAL AND METHOD

Duranta cuttings about 25 cm. in length and 2·50 mm. in girth bearing on an average 30 leaves were obtained from the hedge of the college garden. Special care was taken to have these cuttings of almost the same age. This step was considered essential with a view to nullifying the age factor on the rooting of cuttings which might otherwise markedly affect their capacity to root. Zimmerman and Hitchcock (1946) working on *Syringa vulgaris* L., *Pyrus malus*, *Kalanchæ daigremontiana*, *Spiræa bumalda* and *S. vanhouttei* cuttings found that the change in structure of protoplasm of plants with age is a major controlling factor on the mechanism in plants through which chemicals act and roots are formed. The basal ends of these cuttings were given uniformly oblique cuts so as to expose a larger stelar surface for treatments. The following compounds in concentrations ranging between 10 and 1,000 p.p.m. were used for the treatment of cuttings:

Glutamic acid,
Amino-succinic acid,
Indoleacetic acid,
Indolepropionic acid,
Phenoxyacetic acid, and
2, 4-dichlorophenoxyacetic acid.

Solutions of all compounds were made in distilled water, but a little alcohol was used in certain cases where the compounds did not fully dissolve in water.

The experiments were started on September 18, 1951 and the basal ends (about 5 cm.) of cuttings were immersed in the respective solutions, kept in 250 ml. beakers for 15 hours from 5–30 P.M. to 8–30 A.M. The planting of all experimental cuttings was done in special nursery beds, immediately after the soaking period was over. Every treatment was replicated 4 times to make any fortuitous observations unlikely; each replication consisted of a dozen cuttings.

A set of untreated cuttings was planted side by side for the purpose of comparison. A second control was also maintained by presoaking the cuttings in tap water, in the same manner and for the same period as used for other treatments. This was done primarily to have its comparison with the unsoaked control and secondly to precisely identify the after-effects, following other treatments where also water was used as a solvent and a carrier.

With a view to studying the practical possibility of this scheme, these experiments were preferentially conducted off-season in September and the following months, when the rains in this part of the country had completely stopped. No special manures or fertilizers were added to the nursery bed, but weeding and hoeing were carried out at successive intervals.

Following plantation a light watering was given to the bed and this was repeated every alternate day for the first two weeks. Watering for the next 3 weeks was carried on at weekly intervals and during the month of November only fortnightly. All plantlets were later on left practically uncared for to be subjected to the forces of weathering, the effect of which was studied on survival percentage and rooting behaviour of these cuttings.

OBSERVATIONS

The plantation of *Duranta* cuttings of all the experimental series was done on 19th September 1951, and the experiments continued until November 11, 1951. The weather conditions prevailing in this region during the period of experimentation of nearly 8 weeks have been presented in Table I.

TABLE I

*Certain meteorological observations recorded at the Banaras Hindu University**

Month	Max. Temp. °F.	Min. Temp. °F.	Humidity %	Rainfall (inch.)
	(Average 1938–50)			
July ..	92·7	79·3	86·0	11·87
August ..	90·7	78·1	84·4	14·67
September ..	91·9	77·5	84·7	9·90
	1951			
September (17th to 30th) ..	95·9	76·8	81·0	0·32
October ..	95·6	74·4	81·3	0·02
November ..	92·1	60·7	66·6	0·00

* Banaras is situated in latitutde 25° 19′ and longitude 83′ 03′ at a height of 267 feet above mean sea level.

In order to have a more sound correlation of the above with the findings of this investigation, averages of the past 13 years of meteorological observations (*cf.* Maitra, 1950) have also been tabulated along side.

An analysis of the data presented above would reveal several points of interest, such as the maximum temperature during the months of July and August averaged 91° F., the minimum being 78·5° F. Contrariwise, during the months of Setpember, October and November, the maximum and minimum temperatures were 95° and 91° F. respectively. This indicates that the average maximum temperature is usually high and average minimum temperature low during the months following rains. Similarly, there is quite a marked difference in the percentage humidity, 85 being during the months of July and August and only 77 during the next 3 months that follow. The average rainfall is over 13″ during the months of July and August as against almost nil in the subsequent months of September to November. These factors of environment are likely to affect the initiation of roots in *Duranta* cuttings as also the growth and development of plantlets.

It may be noted that despite regular irrigation, all the untreated cuttings, which were not soaked even in water prior to planting, died within 10 days. A second plantation was, therefore, taken recourse to on 29th September 1951. Even in this case, the survival percentage was too low, being only 4·5. Roots formed on such cuttings were smaller in size and fewer in number. No new leaves were

formed on these cuttings even after a lapse of 2 months. The high mortality of these untreated controls was obviously due to the inclemency of weather, perhaps, high temperature and low humidity.

TABLE II

After-effects pertaining to survival percentage and rooting in cuttings of Duranta plumieri *following treatment with certain amino acids and growth regulating substances*

Treatment	Concentration (p.p.m.)	Average survival (%)	Average roots (No.)	Average root length (cm.)
1. Unsoaked (Control) ..	..	4·5	9·0	10·0
2. Water soaked (Control) ..	..	53·8	16·6	10·7
3. Glutamic acid ..	10	75·0	20·2	12·3
	100	58·3	13·4	11·0
	1000	33·3	10·3	9·2
4. Amino-succinic acid ..	10	58·3	15·8	9·4
	100	50·0	15·2	7·9
	1000	25·0	14·5	12·7
5. Indoleacetic acid ..	10	66·7	44·0	8·8
	100	66·7	23·2	8·8
	1000	50·0	18·8	9·8
6. Indolepropionic acid ..	10	83·3	11·6	19·6
	100	75·0	15·0	12·0
	1000	0·0	0·0	0·0
7. Phenoxyacetic acid ..	10	53·8	13·6	10·3
	100	41·7	15·4	8·8
	1000	16·7	5·0	3·2
8. 2, 4-Dichlorophenoxy-acetic acid ..	10	8·3	13·0	3·7
	100	0·0	0·0	0·0
	1000	0·0	0·0	0·0

Cuttings soaked overnight in water before plantation, on the contrary, exhibited a fairly good stand and quick rooting with the result that the percentage of survival in this case averaged 54 (Table II). Roots formed on these cuttings were more in number. The older leaves dried away with age without any yellowing. Distal ends of leaves began withering first. Fresh leaves formed remained green throughout. A fair resistance of plants to stand the adverse weather conditions may here be accounted to early initiation of roots in the cuttings which continued to maintain a good stand with subsequent watering facilities.

Amongst the amino acids tried in this work, glutamic acid fared better than amino-succinic acid (Table II). It was interesting to note that the survival percentage as well as the root growth of cuttings were inversely proportional to the concentrations employed in this treatment. The compound was highly effective in a concentration of 10 p.p.m. It was characterized with 75 per cent. survival. Cuttings following this treatment rooted profusely. The foliage developed

was best in this case and the leaves formed were largest of all the experimental sets. Some of the plantlets belonging to this series even began to bear flowers within 6 weeks of plantation.

Cuttings treated with relatively low concentrations of amino-succinic acid responded like the water-soaked series. Withering of older leaves here, however, started earlier, from base to top, obviously due to the direct action of the acid on the place of application and in its vicinity. No yellowing of leaves occurred in this case.

Analysing the effects of growth-regulating substances, it was noted that indoleacetic acid initiated a fairly good stand in plants. The survival percentage following this treatment approximated 67 and cuttings excelled in their capacity to root (Table II). At a concentration of 10 p.p.m. the roots formed on cuttings were over $2\frac{1}{2}$ times more than those formed in the water-soaked-controls. Increase in root length was, however, not proportionate. Foliage growth was vigorous. Treatments with indolepropionic acid were also highly effective. Survival percentage following this treatment in 10 p.p.m. concentration was highest (83·3 per cent.) and roots formed were longest of all the series (about 20 cm.). Even at a concentration of 100 p.p.m. the survival percentage was 75. No sprouting was, however, possible at a still higher concentration of 1,000 p.p.m.

Substituted phenoxy compounds did not cause any stimulating effect, either on the survival percentage, or on the rooting response of *Duranta* cuttings. The effects of phenoxyacetic acid in a low concentration of 10 p.p.m. were very much the same as resulting from the water-soaked series. The survival percentage, however, decreased as the concentration of the solution increased. The treatment of cuttings with 2, 4-dichlorophenoxyacetic acid, even in a low concentration of 10 p.p.m., was not found to be useful. Survival percentage was very low and root initiation greatly inhibited. Like the untreated controls, here also, majority of plants died, withering effect evincing earlier or later depending upon the concentration of the compound. A few plants, which survived the treatment of 2, 4-D had an erect posture for a week, but leaf chlorosis developed earlier. Leaf drop, however, started 12 days after planting.

A general survey of the observations made will bring to light the fact that in lower concentrations of 10 p.p.m. some of the compounds, used here, stimulated rooting and enhanced the survival percentage. A few compounds, however, did not prove effective and still others proved injurious. The fact, however, remains that injurious effects followed the treatment of cuttings with increase in concentration of one or the other of these compounds.

If root formation and survival percentage both are taken into consideration and particularly the latter, because it forms the major concern in plant propagation, glutamic acid and indolepropionic acid may be considered as highly effective in initiating beneficial responses in *Duranta* cuttings. It might be mentioned that a pre-treatment with

one or the other of these compounds was so effective that even when plants were left uncared for and even unwatered for several weeks at a stretch, they stood firm and healthy. A pre-treatment of cuttings with solutions of one of these compounds may, therefore, be undertaken with advantage. As the experiments were carried on, after the rains had ceased and the weather was adverse to usual plantations of *Duranta* by cuttings, such pre-treatments should prove highly useful in off-season projects of this nature. This makes possible the practical application of these treatments.

Discussion

The precise manner of the action of the amino acids and the growth-regulating substances in the tissue responses is not clear. The available experimental data seem most satisfactorily interpreted by assuming that the basic rôle of the applied substances used in this work is to bring about a mobilization of materials towards the site of the treatment. While discussing the growth-promoting action of molasses, Classen (1942) postulated that the effect was due to certain amino acids functioning as essential nutrients in the formation of new cells. Considering the mechanism of action of growth-regulating substances, Went (1934) has shown that it is possible to separate two phases in the action of indoleacetic acid towards the formation of roots on cuttings. The first phase is tentatively identified with a redistribution of the hormone rhizocaline within the stem. This phase can be induced by a number of substances not active in root formation proper. The second phase can be induced by indoleacetic acid and similar phytohormones; this phase may be an activation of the accumulated rhizocaline. There is also ample evidence that the rate of starch hydrolysis is increased in treated regions (*cf.* Stuart and Marth, 1937; Stuart, 1938; Mitchell and Whitehead, 1940 and Choudhri, 1948). This would make carbohydrates more readily available for growth processes.

The toxic action of growth substances has been attributed by Macht and Grumbein (1937) to the use of concentrated solutions on the one hand and the longer period to which the plants had been exposed on the other. Similarly Grace (1937) made an attempt to solve the paradox of growth inhibition by synthetic growth substances. He also attributed the phenomenon to over-dosage. As a consequence, perhaps, the mobilization of rhizocaline is inhibited and which in turn affects the growth response of cuttings. Adverse effects in the treated series in the present work may be explained accordingly.

The coefficient of correlation between the survival percentage and the number of roots after computation has been found to be 0·67 and in between the survival percentage and the length of roots 0·69. The insignificant deviation of the value of '*r*' in the two cases well indicates that both the elongation in roots and their number are essential contributors to the well being of the plant and both of them play so important a part towards the growth and upkeep of the plant that none of the two could be ignored.

SUMMARY

The present investigation was undertaken with a view to determining the effect of certain amino acids and growth-regulating substances on the survival and rooting in cuttings of *Duranta plumieri*. Glutamic, amino-succinic, indoleacetic, indolepropionic, phenoxyacetic, 2, 4-dichlorophenoxyacetic acids were used in concentrations ranging between 10 and 1,000 p.p.m. and administered as pre-planting treatments to the cuttings. Both unsoaked and water-soaked controls were maintained for purposes of comparison. The cuttings used were approximately of the same age, of the same dimensions and each set consisting of a dozen cuttings was replicated 4 times.

In order to throw light on the practical bearing of this scheme of treatment, the plantation was done in the third week of September 1951 (off-season) when the rains had stopped and the weather prevailing precluded the possibility of growth and establishment of such cuttings. Weather records were, therefore, maintained to correlate the after-effects of the treatments. Watering and hoeing were carried on uniformly in all the sets, in the beginning at more frequent intervals but later on only occasionally. The following conclusions have been the outcome of the above enquiry:

Unsoaked controls could not stand adverse weather conditions and most cuttings dried and died in a short period of time. Soaking in water, previous to planting, initiated quicker rooting and brought about a higher survival percentage.

When employed in lower concentrations, indolepropionic acid initiated the formation of longest roots and highest survival percentage.

Indoleacetic acid, though it induced the formation of largest number of roots, was relatively less efficacious towards the survival of plantlets. Treatment with glutamic acid was characterized with the formation of prolific foliage and initiated high survival percentage.

Amino-succinic and phenoxyacetic acids did not prove to be very effective, while 2, 4-D treatments were generally deleterious.

As survival percentage is the major concern in raising plants from cuttings, pre-treatment with dilute solutions of either indolepropionic or glutamic acid will be highly useful.

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