attachment of the broad-leaved sucker to the parent corm, the availability of food supply to it from that source becomes restricted. This leads to a weak and stunted pseudostem in the early stages and an adaptation to form a broad leaf to build up food materlal.

The initial growth attained by the sword sucker is recognised by all to be superior to the broad-leaved sucker to such an extent that planters throughout the world take care to eliminate broad-leaved suckers at the time of planting. After some time when both the type of suckers are planted without the parent corm, it is possible that the rate of growth of either may vary being subject to environmental factors also and the broad-leaved sucker may approach or even overtake the growth made by the sword sucker. Such a study, with the ultimate performance of each type of sucker as the main objective is well worth investigation and is now under way at the Central Banana Research Station at Aduthurai.

REFERENCES:

COOK, O. F.: 1911. Dimorphic buds in tropical crop plants. Bull. 198—1911 of the Bur. Plant Industry, U. S. Department of Agriculture.

SKUTCH. F. ALEXANDER: 1929. The naturo of sword and water suckers in the banana. Bull. 22—1930 of the Research Dept. of the United Fruit Co., Boston.

https://doi.org/10.29321/MAJ.10.A04504

Rooting of Cuttings — Part II

Rooting media, depth of planting and basal cut

By

V. N. MADHAVA RAO, B. sc. (Ag.), D. I. H.
Horticultural Instructor, Coimbatore

Introduction: Among the various factors influencing the rooting of cuttings, the rooting medium demands, perhaps, the foremost consideration. No less important are depth of planting and the position of basal cut. A precise knowledge on these aspects will be of practical benefit to a nurseryman dealing with large-scale propagation of fruit and ornamental plants.

Numerous instances have been cited by workers on the variable performance of cuttings of the same species in different media. The more common among the media put to test were sand, pumice, peat, peat moss, peat and soil, fiber, saw-dust charcoal etc. Water has also been tried by some. The results of these studies are not only diverse but are also in some cases inapplicable to conditions obtaining here, so that it seems necessary to conduct independent trials with cuttings commonly met with in our regions, before one can safely make a satisfactory

recommendation. The details presented in this paper relate to an observational trial conducted by the author at the College Orchards, Coimbatore, during April–June 1949, to test the efficacy of six different media.

Review of Literature: The salient points of interest in the results in this field of workers may be summarised as follows:

(a) *Rooting media:* 1. The choice of medium for soft wood cuttings generally demands special care, whereas hard wood cuttings are more tolerant.

2. The medium requires good aeration

3. There should be adequate warmth and replenishment of air at the basal end of the cutting.

4. The most successful media for rooting of cuttings are all of open texture.

5. Clean, sharp sand has long been a standard rooting medium for most cuttings because (a) it is easy to obtain and provides good aeration; the chances of getting too wet is reduced, (b) it is devoid of organic matter and of organisms which induce rotting (c) the low moisture content of sand is deemed as one of the reasons for its preference and (d) in experimental work it can most readily be freed from traces of unknown substances that affect root formation.

6. Roots produced in a sandy medium are generally brittle. Admixture of organic substances with sand is helpful in the propagation of cuttings of a number of ornamental plants which ordinarily root only with difficulty.

7. The acidity of the sand is the most important consideration. A pH of 6 or less is preferable.

8. Some varieties of cuttings root best when the reaction of the medium conforms to that in which the parent plants are known to produce maximum growth.

9. The efficiency of a mixture of peat moss and sand appears to be mainly due to its relatively high moisture-retaining capacity and in some cases to its acid reaction.

10. Another type of medium which has given good results with different cuttings, especially of acid-loving plants, is peat moss. Its very high waterholding capacity, however, renders the cuttings liable to rot before they commence to root.

11. Under conditions of high moisture and temperature those containing charcoal were generally best, as in the rooting of avocado and mango cuttings.

12. A clay medium favoured callussing in contradistinction to sand which favoured rooting.

(b) *Depth of planting:* 1. Deep planting prevents desiccation but reduces aeration.

2. Deep planting assures firmness to cuttings which is conducive to rooting, but it should go no deeper than it suffices to maintain it steadily in the soil. A dibble should not be used because of the danger of an air pocket between the base of the cutting and the rooting medium.

3. Though cuttings normally root at the basal end showing strong polarity, they also tend to root more at the surface of the medium due to better aeration.

4. Very deep planting renders the lifting of rooted cuttings difficult, especially in compact soils.

(c) *Position of basal cut;* 1. Although most plants propagated by cuttings will root at the node, a cut at some other portions, above the node or below it will give even better results.

2. Whether or not a cutting will produce roots largely depends on the root initials

3. Roots are of two kinds; wound roots and morphological roots. The former usually appear directly above the callus and are not in any definite relation to the anatomical structure of the plant tissue. The morphological roots on the other hand, have a definite relationship to the anatomical structure of the tissue but may vary with different species of plants. The so-called morophological roots arise in many cases from the root initials located in the meristematic tissue which is present in the internodal region as well as at the node of the cutting. Therefore both the types or roots are important. As the wound roots are produced directly above the callus, it does not matter whether the cut is made at the node or elsewhere.

4. A large percentage of root initials is located in the first half-inch below the node.

5. Out of 86 plants studied, Laurie and Chadwick (1931) five rooted best when cut at the node, 41 when the cut was made a short distance below the node and 23 gave equally good results in at least two of the three regions of cutting.

Material and Methods:

Rooting media: The following six media were tried. (1) *Tank Silt:* Made up of fine particles but not sticky. (2) *Orchard Mixture:* A mixture containing three parts tank silt, three parts river sand, two parts red earth and two parts leaf mould. (3) *Orchard Mixture and sand:* (1 : 1). (4) *Sand:* River sand – fine to coarse. (5) *Red-earth:* Consisting of a large proportion of sand. (6) *Clay:* Slightly sticky clay from tank beds. Raised beds of the above materials 3' × 2' × ¾' were prepared.

Cuttings of *Panax Sp.* were selected for the purpose, due to the uniformity and the availability in required numbers during the period of the trials. About a year-old cuttings, six to seven inches long and roughly of the thickness of a pencil were selected for the purpose. Thirty cutting per treatment were planted in rows of 10 each, in each bed.

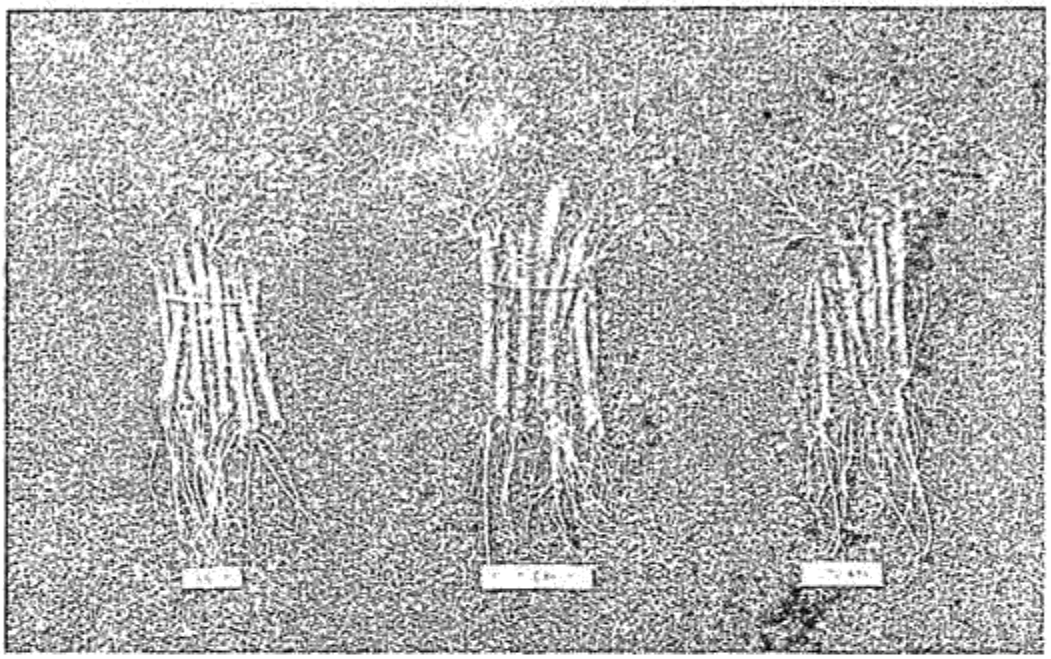

PLATE I — Rooting media : Sand, red earth and clay.

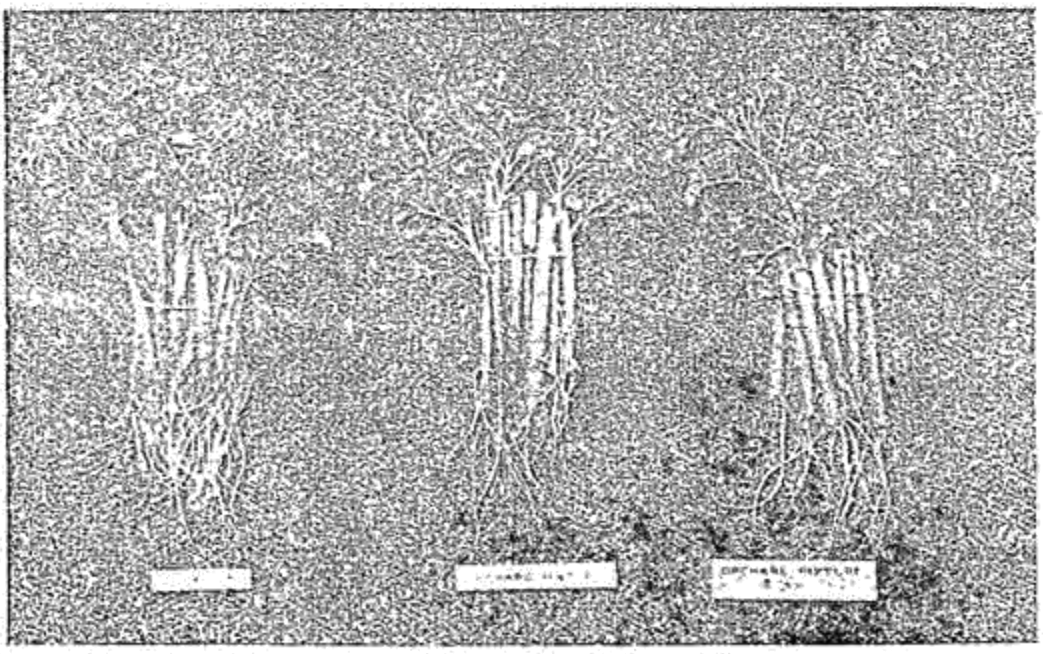

PLATE II — Rooting media : Tank Silt, Orchard Mixture and Orchard Mixture : Sand (1 : 1)

Results : The results are presented in the following table and a general view of the rooting as observed in the several treatments is shown in plates I and II.

It can be seen from the plates that although the difference between the treatments is not very striking the cuttings planted in tank silt and sand, were found to lead others in root production, closely followed by those in red-earth, clay, orchard mixture, sand, in the order presented here. Thirty cuttings were planted in each treatment.

Particulars	Tank silt	Orch. Mix.	Orch. Mix. & sand	Sand	Red earth	Clay
Number rooted	26	18	21	26	20	16
Number of roots	364	135	179	274	228	154
Weight of roots (in gms) ...	145 6	35·8	58·8	119 0	86·5	43·3
Mean No. of roots per cutting ...	12·1	4·5	5 9	9 1	7 6	5 1
Mean Weight of roots (in gms) ...	4·8	1·1	1·1	3 9	2 8	1 4

It may be concluded that : (1) The number of cuttings that rooted is the largest in sand and tank silt media, while orchard mixture and clay did not appear to be very favourable. (2) Correspondingly large number and weight of roots were formed in tank silt and sand media. (3) While tank silt leads sand in the number of roots, the difference when viewed in terms of weight is considerably narrowed down. (4) Among the four treatments, orchard mixture, sand and red earth seem to be better than clay and orchard mixture alone, in respect of the total number of cuttings that rooted in each of these media. (5) Taking the weight of the roots into consideration it is seen that 'tank silt' again leads the other treatments.

It can be said from these data that clay as obtained in this instance is definitely unsuitable as a medium for rooting, although the same amount of definiteness cannot be asserted in the case of orchard mixture.

Depth of Planting : Stem cuttings of grapevine (*Vitis vinifera*), '*Pachadrakshai*' variety, about the thickness of a pencil and with three to five nodes in each were selected. Care was taken to see that the material was as uniform as possible.

Treatments : The following three treatments were tried ; 1. Planting with one node under the soil. 2. Planting with two nodes under the soil. 3. Planting with three nodes under the soil.

Ten cuttings were used for each treatment. The rooting medium was a raised bed (about $3' \times 2' \times \frac{3}{4}'$) of fine to coarse river sand without the addition of any other material.

Results : On the 73rd day after planting, all the cuttings were removed by careful and gradual washing away of the sand without damaging the fibrous roots.

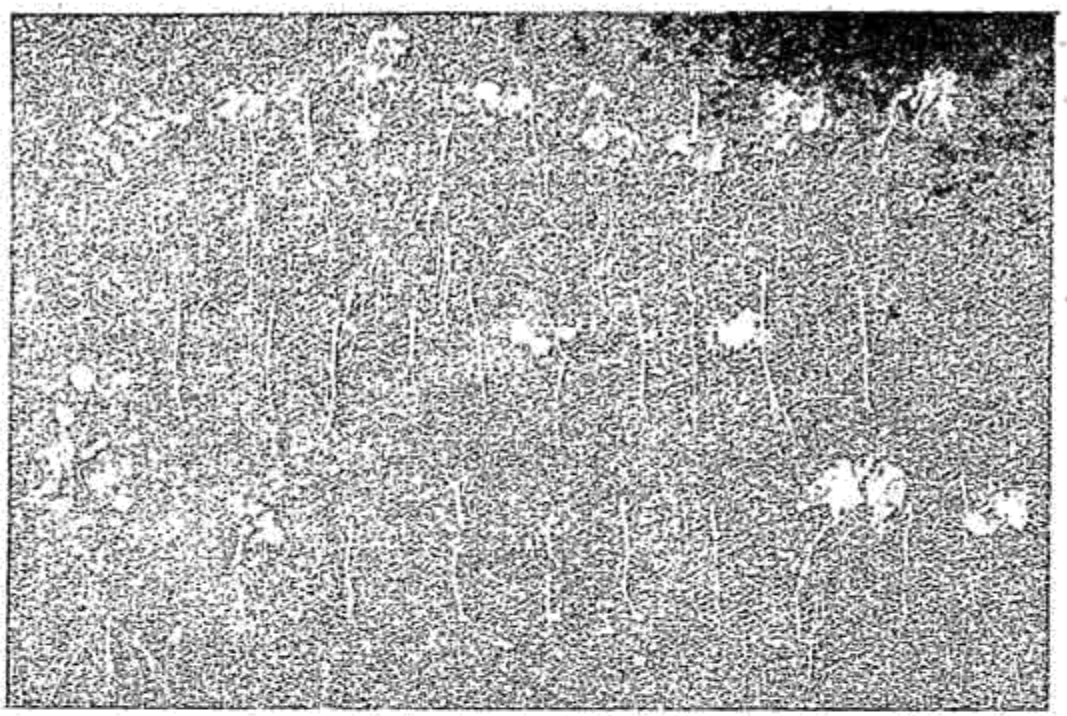

PLATE III — Depth of planting: One node (1st row); two nodes (2nd row) and three nodes.

The rooting response under each treatment is represented in Plate III in the order one node, two nodes and three nodes.

An attempt was also made to record the number of roots obtained from each cutting and their total dry weight. The actual number of roots, irrespective of the size was counted and as the variation in size and length of roots was found to be enormous, the comparison by weight was adopted. The details are furnished in the following table:

Treatments—Depth of Planting.

Cutting No.	One Node	Two Nodes	Three Nodes
	Number of Roots		
1.	4	1	12
2.	21	...	16
3.	13	1	29
4.	8	...	15
5.	14	18	2
6.	6	9	3
7.	14	...	...
8.	2	1	1
9.	5	...	2
10.	8	1	...
Total ...	95	31	80
Mean No. of Roots per Cutting ...	9·5	3·1	8·0
Total Weight (in gms.) ...	3·62	0 32	1 85

As the roots were too brittle and in some of the cuttings too scanty, it was found desirable to take the total weight of the roots of all ten cuttings together.

The cuttings planted with one node under the soil were remarkably uniform with profuse root formation. Of those with two nodes under the soil, only six cuttings showed slight rooting, of which the rooting in four could be deemed as almost negligible. The cuttings with three nodes under the soil, however, occupied an intermediary position, with eight rooted, of which four had produced a fairly large number of roots.

A study of the table reveals that the 'two node' treatment can be ruled out as the least promising. Between the other two treatments, the difference is only 15, the corresponding figures for 'one node' and 'three nodes' being 95 and 80 respectively. Expressed in percentage, the 'one node' treatment has produced 18·8% more roots than the 'three nodes' treatment. It is however, interesting to note that when the weight is considered the position is considerably altered. Although there is no change in the order of superiority of the treatments, the roots obtained from the 'one node' treatment weigh 95·4% more than those of the other. This is due to the varying lengths of roots ranging from mere stubs to those measuring even as much as five to six centimetres and to the varying thickness of the roots.

Observations at the seat of emergence of roots showed that in seven out of ten cuttings planted with one node under the soil, the roots were concentrated about $\frac{1}{2}$ to $\frac{1}{4}$ inch above the terminal end while in the remaining three cuttings some roots were also formed higher up, almost just beneath the soil surface. In the 'three nodes' treatment, although a major portion of the roots was formed at the terminal end, fairly large clusters also emerged from the two nodes higher up.

Basal Cut: Stem cuttings from one-year old wood of the following plants were selected.

1. *Panax Sp.*
2. *Eranthemum Sp.*
3. *Bougainvillea Sp.*
4. Mulberry. (*Morus alba.*)
5. *Moringa pterigosperma.*
6. *Glyricidia maculata.*
7. Acid lime (*Citrus aurantifolia*)
8. Lemon (*Citrus limon.*)
9. Pomegranate (*Punica granatum.*)
10. Jasmine (*Jasminum flexile.*)

Treatments: The following were tried: 1. Cut at the node. 2. Cut $\frac{1}{2}$" above the node. 3. Cut $\frac{1}{2}$" below the node. Ten cuttings were taken for each treatment. In some cases as in *Panax* the internodes are so short that a cut made $\frac{1}{2}$" above a particular node was not different from a cut $\frac{1}{2}$" below the node. In such cases only two treatments

were considered. The cuttings were removed for examination 116 days after planting. Of the ten tried, only four batches survived. These were *Panax*, *Bougainvillea*, *Eranthemum*, and mulberry. Except in the case of *Bougainvillea* it was seen that the cut 'at the node' seems to have favoured better rooting than the other treatments.

In respect of these four materials the cut at the node seems more desirable. It is also noticed that of the other two treatments the cut $\frac{1}{2}$" below the node seems to have been better in three types out of four

Discussion: Most workers have favoured sand as the medium for satisfactory rooting but a mixture of peat and sand has been found to be better than peat and sand alone. This is seen in the present trials where the cuttings in orchard mixture: sand (1 : 1) proved to be better than in orchard mixture alone. The promising performance in tank silt and red earth is analogous to the findings of Woycicki and Terpenski (1937) quoted by Garner (1944) that the moisture of a sandy medium has a marked effect on rooting. Sand with 25% water-holding capacity was unsuitable, while they considered a capacity of 50 to 70% to be the best. The red earth and tank silt used here being more or less sandy in nature have both the required water-retaining capacity and adequate aeration.

Although clay as a medium has not been very encouraging, yet it seems worthwhile noting the observations of Knight (1926) who found that clay favours callussing while sand favours rooting. This special feature of clay seems especially desirable in the case of cuttings which are moderately difficult to root in a normal sandy medium. Planting such cuttings in the clay medium to begin with and transplanting in a sandy medium after the formation of callus is a method which may yield useful results.

Somewhat contrary to the findings reported by workers elsewhere is the poor rooting observed in the cuttings in orchard mixture medium, which was made of leaf mould, sand, farmyard manure and red earth. At least in respect of cuttings of *Panax* the addition of such moisture-retaining ingredients as farm yard manure and leaf mould, seems to be not only superfluous but also unfavourable for satisfactory root formation.

The influence of depth of planting cannot be separately assessed from that of length of cutting, for one bears a proportionate relation to the other. The condition at the base of the cutting is chiefly governed by the depth of planting. The profuse and uniform rooting obtained with the cuttings planted with one node under the soil is a feature which is striking and this is all the more interesting when the almost negligible rooting in the 'two node' treatment is considered. The difference is too

large to be ignored. The only possible reason that can be advanced for this specially noteworthy feature in the 'one node' batch of cuttings is the greater aeration afforded by the shallow planting and concentration of the root-forming substances within one node. In the other two treatments the deeper planting appears to have not only inhibited proper aeration but might have also distributed the root-forming substances over a wider area and in the absence of necessary stimuli such as aeration, moisture etc., the activity of these substances should have been restricted to some extent in a few cuttings and reduced to negligible proportions in some others.

The observations in regard to the position of basal cut are in agreement with those of Laurie and Chadwick (1931) who have stated that the cut should be made through the node for the best rooting, the reason advocated being that greater amounts of nutrients are stored at the node and as a consequence quicker regeneration of the tissues takes place and the adventitions buds are forced out rapidly. While some workers advocate cutting at the node or below it, much is not said in favour of the cut above the node and the present trials also indicate that the cut above the node has not responded well enough to recommend its adoption.

From the point of view of the nurseryman it can be said with some measure of certainty that these findings will not only minimise his losses in the nursery but will also help him multiply his stock by adopting judicious methods of planting. As a rule the nurseryman is not aware of the finer distinctions in terms of optimum depth of planting or position or nature of basal cut, which the cuttings demand for the best success. He consequently assumes the failures he faces as inevitable and consoles himself by attributing them to wrong selection of planting material. If therefore, the implications of the results of a trial of the type described here are appreciated and adopted by him in dealing with his material, it is needless to mention that he will certainly stand to gain by minimising avoidable losses. It cannot also be held that a recommendation suggesting for instance, the planting of grapevine cuttings with only one node embedded in the soil requires any extra effort or attention nor can such an improvement in the existing methods be deemed as uneconomical.

These observations, though limited to only cuttings of certain kinds, nevertheless, are such that may be expected to apply to other types also. On this score, the need for conduct of similar trials, with these plants dealt with by nurseries on a commercial scale, is manifest.

SUMMARY

1. The findings of several workers on the choice of rooting media, depth of planting and the position of basal cut have been reviewed.

2. Among the various media tested by the author, sand and tank silt appear to be very favourable, while clay was unsuitable.

3. Planting cuttings of grapevine with one node under soil proved to be best in the matter of root-production.

4. Planting with two nodes under the soil was definitely unsuitable, while cuttings with three nodes embedded in the soil occupied an intermediary position.

5. A cut at the node favoured better rooting in respect of cuttings of *Panax*, *Eranthemum*, and mulberry.

6. Between the other two treatments viz: cut $\frac{1}{2}''$ above and cut $\frac{1}{2}''$ below the node, the latter was found to be better in three types out of four.

Acknowledgments. The author is grateful to Sri S. N. Chandrasekhara Iyer, M. A., Government Lecturing and Systematic Botanist, Coimbatore, under whose guidance the work was carried out and to Sri U. Narasinga Rao, B. Sc., (Ag.), Fruit Specialist, Madras, for his valuable guidance in the preparation of this paper.

REFERENCES.

Gardner, F. E., (1929) :— The relationship between tree age and rooting of cuttings, Proc. Amer. Hort. Sci. 26: 101—104.

Garner, R. J., (1944) :— Propagation by cuttings and layers, Imp. Bur. Hort. Plant. Tech. Comm. No. 14.

Hitchcock, A. E., and P. W. Zimmerman (1932) :— Relation of rooting response to age of tissue at the base of greenwood cuttings, Contr. Boyce. Thomson. Inst. 4: 85: 98

Laurie, A., and L. C. Chadwick (1931) :— The Modern Nursery, A guide to plant propagation and handling.

Zimmerman, P. W., (1926) :— Vegetative propagation with special reference to cuttings. Proc. Amer. Soc. Hort. Sci. 1925, 223—228.