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VEGETATIVE PROPAGATION OF CINCHONA IN SOUTH INDIA.

BY
P. ABRAHAM,
Cardamom Specialist, Madras Agricultural Department, Coimbatore.

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INTRODUCTION

THE problem of increasing the alkaloid content of Cinchona bark for the manufacture of quinine and Cinchona febrifuges is of the greatest importance to India. It is well-known that the seedling progeny of this highly heterozygous tree does not breed true, and the alkaloid content of the population is notoriously variable within a very wide range. The most practical method of solving this problem is the vegetative propagation of selected high yielding Cinchona clones of the Ledgeriana type which are otheswise suitable for cultivation on a field scale; methods of propagating Cinchona vegetatively on a commercial scale under Indian conditions have, therefore, to, be devised and perfected before India can hope to be self-sufficient in the production of quinine.

Methods of vegetative propagation have been successfully employed in several perennial crop trees of commercial importance. In Cinchona, much work on vegetative propagation has been done in countries like Java (1938), Russia (1938), Belgian Congo (1939) and Guatemala (1941); but as far as the writer is aware there is no record of similar work done in India. In India, Cinchona is almost wholly propagated from seed, the technique of which has, however, vastly improved in the important Cinchona plantations of the country. The chief methods of vegetative propagation of perennial crop plants viz., budding, grafting, rooting of stem cuttings and root cutting, lyering, inarching etc., are well-known; but the degrees of success of these methods vary very much and depend on a variety of factors such as the species of plant, climatic conditions, seasonal variations and to some extent on the dexterity of the operators. It is therefore obvious that research is needed on the relative merits of the various plausible methods, bearing in mind the practicability of their application on a plantation scale.

This note briefly describes the preliminary work done by the writer between 1941 and 1945 on the vegetative propagation of Cinchona at a research station of a private Cinchona plantation on virgin land in the Tinnevelly district of the Madras Province, situated at an altitude ranging from 3,500 to 4,500 feet above mean sea level.

MATERIALS AND METHODS

As a preliminary to propagation trials, sample barks of Ledgeriana type of trees of vigorous growth, good tree shape and other desirable features were taken at 3 feet from ground level and analysed for quinine contents. The earlier analysis was done by a firm of well-known analysts in Calcutta, but eventually the research station set up its own analytical department and with the exception of a few samples sent to this firm for check analysis, the material was handled by the chemical section of the research station. All trees which showed less than 8 per cent anhydrous quinine sulphate were rejected, while those showing 8 per cent and above were permanently labelled and utilised as clonal trees. Both budding and side grafting methods were tried. In budding the following methods were tried.

(1) A patch budding which is a slight modification of the method popularly known as the Jaffna method (Paul and Gunaratnam 1937 a., 1937 b.), (Naik 1941).

(2) The Forkert method.

(3) The shield method.

In the matter of grafting, the following methods were tried :

(1) The side graft - Nakamura method (Tanaka 1939).

(2) The bark side graft.

(3) The wedge graft.

(4) The saddle graft.

BUDDING

1. *The patch or modified Jaffna method* :— This method which was arrived at after some preliminary trials may be described as follows. (See figs. 1, 2 & 3). By the use of a knife two parallel cuts AA_1 and BB_1 are made horizontally above and

below the selected bud. Two vertical cuts CC_1 and DD_1 connect the horizontal cuts (Fig. 1). The patch of bark containing the bud is gently lifted and removed (Fig. 2). The stock received two parallel

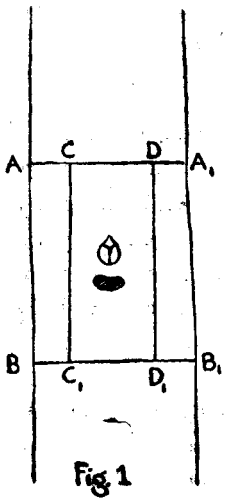

Fig. 1


Fig. 2

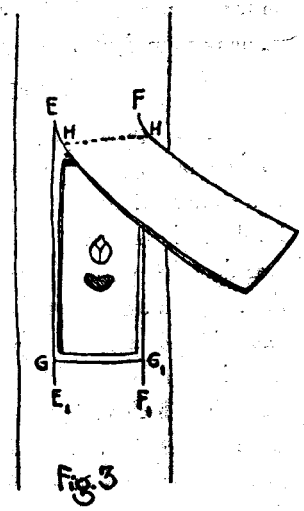

Fig. 3

vertical cuts EE_1 and FF_1. The distance between these cuts was slightly larger than the width of the patch. A single horizontal cut GG_1 was made connecting the lower ends of the vertical cuts. The three cuts thus made enable the bark to be raised and peeled upwards to the required distance so that the selected bud may be placed in position, but leaving a small margin of about 1 mm. between the bud patch and the cut margins of the stock bark surrounding it. The flap of bark peeled from the stock is then placed over the bud patch, pressed slightly, and then bound with a strip of wax-cloth or raffia fibre, when the operation is completed. In the ordinary patch budding and some of its modifications, (Fielden and Garner 1940) the flap of stock bark is cut off immediately after peeling. In the Jaffna method however, the flap is retained, but the cut is made on the top and the peeling made downwards. The peeling of the flap upwards instead of downwards as usual affords protection against the entry of rain water into the wound. In all methods, no special effort is made to leave a narrow gap between the patch and the cut edges of the stock bark. In the writer's experience, this gap which was quickly callused over, appeared distinctly beneficial. Whether this is due to the extra protection which the flap affords to the budded patch

by preventing rain water contacting the cambial layer, it is not possible to assert. After the bud patch is established, which under local conditions was effected in 10 to 15 days, the bandage is removed and the flap of bark cut off by a horizontal cut HH (vide figure 3). The stock is then pollarded by a slanting cut about an inch or two above the bud union. Dormant buds taken from half-ripened woody stems and branches which had just turned brown in colour and were at least of pencil thickness, proved to be the best. Fielden and Garner (loc. cit. p. 57) state that a somewhat similar method called "a variation of modified Forkert" with the flap (which is retained) peeled from below upwards instead of in the reverse directions which is the usual method used for budding rubber in Indo-china. The method in vogue for budding rubber in South India, however, is the plain patch method with out leaving any protective flap.

2. *The Forkert method* :—This method exactly as described by Fielden and Garner, (1940) was tried.

3. *Shield budding* :—This standard method as described in horticultural literature was also employed.

RESULTS OF EXPERIMENTS ON BUDDING

The results of preliminary trials of these three methods carried out in 1941 in bulk fields of transplanted seedling stock of an average girth of 3 inches are given below :—

TABLE I

Results of preliminary trials with three methods of buddings done in 1941.

No.	Method of budding.	No. of plants budded.	Season.	Percentage of success.	Remarks.
1.	Medified Jaffna method.	117	October, 41	75·2	There was a fair amount of rainfall during this period.
2.	Forkert method.	150	Do.	10·0	
3.	Shield method.	70	Do.	5·7	

Based on the above results, further budding trials were conducted between January and April 1942, but these trials were conducted in a nursery where stock seedlings were fairly uniform and had grown to double pencil thickness. The results are given below ;—

TABLE. II

Results of preliminary budding trials conducted in 1942 in a nursery.

No.	Method of budding.	No. of budded plants	Season.	Percentage of success.	Remarks.
1.	Medified Jaffna.	567	January to April, 1942.	88·0	The budding by all methods was done through a prolonged period of 4 months.
2.	Forkert.	50		16·0	
8.	Shield.	80		3·8	

The above results showed that the modified Jaffna method was distinctly more successful than the two other methods in a varying range of seasonal conditions both in the field and in the nursery. Based on these findings, trials were made on a more extensive scale to study the possibilities of budding seedling stocks already planted out in the field. The budding was programmed to spread out over five comparatively dry months, but contrary to expectations a moderate rain fall was received in September and October. The results were as follows :—

TABLE III

Results of modified Jaffna method of budding conducted in the field in 1943.

No.	Method of budding.	No. of plants budded	Season	Percentage of success.	Remarks.
1.	Modified Jaffna method.	120	February.	44·2	Cool but dry weather and in a field exposed to winds.
2.	do	290	March.	24·8	Hot and dry weather. Field exposed to winds.
3.	do	205	April.	22·9	do
4	do	600	September October,	88	Usually rainless period, but rains were received a few days after budding.
5.	do	884	do	52	do

Based on the experience that the unforeseen, though moderate, showers of rain received in September-October were apparently responsible for a significant increase in bud-take, large-scale budding was undertaken in the field in 1944. A total of 6390 plants covering an area of 9¼ acres was budded. The operations were planned to spread out over eight months of the year, the remaining months being too rainy for sustained work in the field. It may be mentioned, however, that during 1944 the rainfall in the tract was more evenly distributed through the year than usual, with the result that normally rainless months bad a moderate rainfall and normally heavy rainfall months had somewhat restricted rainfall. The result was that the period between January and June proved to be eminenty suitable for buding operations and even the normally dry months of August and September also proved satisfactory. Budding was not attempted in the heavy rainfall months of July, October, November and December though the rainfall in October later proved to be below the normal for that month.

TABLE IV

Result of modified Jaffna method of budding done in 1944 in the field of 9¼ acres.

No.	Month.	Rainfall in inches.	Total No. of plants budded.	Percentage of success.
1.	January.	10·80	623	93·6
2.	February.	7·44	699	95·5
3.	March	5·67	839	93·7
4.	April.	2·09	997	90·3
5.	May.	3·28	1085	92·7
6.	June.	13·01	961	89·1
7.	July.	23·37	Nil	—
8.	August.	2·23	817	81·1
9.	September.	5·83	369	84·8
10.	October.	12·63	Nil	—
11.	November.	27·54	Nil	—
12.	December	27·40	Nil	—

Budding of nursery stock:—

Experience has shown that a uniformly high percentage of success is obtained by budding on suitably grown stock growing in a nursery. This is partly attributable to the fact that conditions obtaining in a nursery are to a large extent controllable and partly to the fact budding can be done much more rapidly and efficiently than in the open field. It was found that, given all facilities, 100 to 125 plants

could be budded in the nursery in a working day of seven hours. But the chief snag in the extensive adoption of budding in the nursery as a plantation practice, lies in the fact that even with reasonable care, a fair percentage of loss is sustained in the transplants. If such loss could be reduced to a reasonable level, budding in the nursery should prove a more economical proposition than budding in the field. It is reported that a system of transplanting 'budded stumps' immediately after the stock is cut back, but before the bud has started growing, has been successfully evolved in the case of tung oil plants. But the feasibility of adopting this system for Cinchona has been worked out and its investigation is under way.

GRAFTING

It has been mentioned that clonal meterial for budding operations were taken exclusively from half-ripened woody stems and branches which had turned brown and were of at least pencil thickness. The stems with green bark and the growing tips have to be rejected as unfit for providing buds. It is obvious that if these rejects could be successfully utilized for grafting, the rate of multiplication of a desirable scion tree could be increased several fold. With this object in view, a series of preliminary trials were conducted on the following methods of grafting.

(1) The side graft (Nakamura method).
(2) The bark side graft.
(3) The wedge graft.
(4) The saddle graft.

Of the above methods, the side graft is reported to be the method in vogue for Cinchona in Java. Belgian Congo (Fielden and Garner 1940), (Stoffels 1939) and Guatemala (Popenoe 1941). The description of the various methods as given by Fielden and Garner were closely followed, but the extent of success was poor as shown below :

TABLE V.

Resuls of trials on grafting Cinchona in the field—1942

No.	Method,	No. of plants grafted,	Season,	Percentage of success,	Remarks.
1.	Side graft.	200	January	11·0	Grafting done in
2.	Bark side graft,	200	and	5·0	the open field on
3.	Wedge graft.	50	February	10·0	stock plants of
4.	Saddle graft	50	1942	8·0	pencil thickness and over,

Since the extent of success obtained in grafting was not satisfactory, it was felt desirable to obtain the services an expert in the profession. Through the courtesy of Mr. K. C. Naik, Fruit Specialist, Kodur, Mr. David was deputed for this work. Subsequent trials made after his practical demonstrations of the above methods were more successful as the following results show :

TABLE VI

Results of grafting in the nursery and the field in 1943 and 1944

No.	Method of grafting.	Season,	Location of stock plants.	No. of plants grafted.	Percentage of success.	Remarks.
1.	Side graft.	August to October, 1943.	Nursery.	210	74·3	Seedlings 1½ years old of fairly uniform size (pencil thickness)
2.	Wedge graft.	do	do	112	40·2	do
3.	Saddle graft.	do	do	135	31·8	do
4.	Side graft.	March, 1944	Field.	79	46·8	Seedlings of varying size (pencil thickness and over).

The improvement in the success of side grafting obtained in 1943 and 1944 (the latter in more or less dry months and done in the open field) was encouraging. The wedge and saddle grafts were also fairly successful; but two factors militated against their extensive adoption. Firstly, it took considerably more time to operate these methods than side grafting. Secondly the need for a more or less uniform thickness of the stock and scion for the adoption of these methods limited the scope of the choice of the clonal material. In these circumstances, the side graft was the obvious choice for a commercial plantation.

Further trials on side grafting :— Large scale trials on the side graft method were conducted in some nurseries between February and and April 1945. However, the materials available in the nurseries were not of the best, being confined largely to the rejects left in the nurseries after the most vigorous plants were removed for planting out in the field. The season also proved to be exceptionally rainless and dry. The trials were not laid out as regular experiments, much less to study the response to such treatments as shading and watering of

grafted plants. The scion materials were also not uniform, but certain observational studies were made as a result of resorting to these methods in the exigencies of the situation caused by the abnormal weather conditions prevailing during the season.

TABLE VII

Result of observational studies on side grafting done in the nursery, (February to April 1945).

No.	Nature of stock material.	Special treatments done to minimise the effects of the weather.	Nature of graftwood used.	No. of plants grafted.	Percentage of success.
1.	Second rate nursery stock exposed to hot and dry weather.	nil.	Both supple and half ripend graft wood.	1182	9·9
2.	Healthy and vigorous nursery stock but exposed to hot dry weather.	nil.	do	243	30
3.	Second rate nursery stock.	Artificial shading given for a week after grafting. Plants lightly watered.	Young woody materials of the same season's growth used. Very tender material rejected.	253	15·9
4.	do	Grafts shaded for a month and lightly watered.	do	185	41·9
5.	Healthy and vigorous nursery stock.	No shade provided but grafts liberally watered.	do	19	63·1
6.	do	Grafts shaded for a month and copiously watered.	do	35	74·3

These observational studies roughly indicated the need for moisture in the soil and fairly humid atmospheric conditions for successful grafting. They also indicated that the nature of the scion wood has much to do with grafting success. The current season's growth of wood with short internodes appeared to give more success than supple green shoots with longer internodes. Short lengths of scion wood of not more than two inches length appeared to give better results than longer

shoots. Previous observations made in 1943 also showed that precured scions in which the leaf blades were partially clipped off about 10 to 14 days before they are cut out from the scion tree, proved better than freshly cut scion wood.

GENERAL OBSERVATION ON WEATHER CONDITIONS FOR BUDDING AND GRAFTING

In the tract where this work was done and which is fairly representative of south Indian hills where Cinchona cultivations is undertaken by Government and private agencies, the actively growing seasons, as evinced by external symptoms of growth and the ease with which the bark is peeled from the wood, fall between January to May and August to September. During other months when the weather is too dry or too wet, the percentage of success is considerably reduced. It was, however, observed that even during comparatively dry spells in a normally rainy season, good results could be obtained. But heavy rains closely following the budding and grafting operation, definitely reduced the percentage of success much in the same manner as hot dry spells following the operations. Intermittent light showers and cloudy weather reducing the intensity of sun shine were of distinct advantage in warm weather. Generally speaking, the amount of rainfall and its distribution in the tract, were favourable for these operations over two distinct periods occupying about seven months of the year. During dry rainless months, when weather conditions were far from ideal for the operations in the open field, the adverse effects of the weather could be considerably alleviated in the restricted area of nursery beds by resorting to provision of artificial shade, adjustment of soil moisture and humidity by watering the nursery stock. With this knowledge the next obvious step is to evovlve a satisfactory method of transplanting 'budded stumps' in field without serious loss.

SUMMARY AND CONCLUSION

1. Several methods of vegetative propagation of Cinchona were tried in a South Indian plantation. The most successful methods consistent with economy, are (a) the modified Jaffna method of patch budding and (b) the side graft (Nakamura method).

2. The seasonal conditions of the tract were fovourable for vegetative propagation spread over seven to eight months of the year.

With experience gained, 81 to 95 percent success was obtained by budding in the open field, and 47 to 74 percent by side grafting in the open field and nursery respectively.

3. By selection of promising clones on the basis of bark analysis of standing tress, extensive areas of vegetatively propagated material could be raised economically.

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