

CULTURE AND PROPAGATION OF *RAUWOLFIA SERPENTINA*, BENTH. IN EAST PAKISTAN

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Status of Supplies

The world-wide reputation of *Rauwolfia serpentina* in the treatment of hypertension and mental ailments has brought in its train the question of commercial availability of the roots of the plant. So far the roots have been mostly collected from the natural wild growth of the plant, and Java and India have been the main supply sources of the drug. Due to heavy and irresponsible collection, however, it is reported that Java has been denuded of the plant, and the Balai Penjelidekan Thenik Pertanian Bogor are lately taking measures for its restoration in the island.

Rauwolfia serpentina also occurs in Ceylon, Burma, Siam, Sumatra, the Andaman Islands, and East Pakistan, but the roots obtained from these countries vary in the relative content of their individual and total alkaloids. Although this variability has some effect on the biological activity, the material from these countries definitely is usable provided it is properly identified.¹

A. J. Feucl in his paper² on the genus *Rauwolfia* stated, that the future was likely to see a steady and probably increasing demand of *Rauwolfia* roots, and to meet this demand several lines of development were suggested, viz., (a) fostering of existing growths and cultivation in the districts where the plant is indigenous in order to supplement wild material, (b) exploitation of plants from areas hitherto untapped, (c) use of alternative species as sources of reserpine and possibly of other alkaloids, (d) chemical and pharmacological study of species not so far examined.

In India, the Forest Department have arranged to survey the Indian forests with reference to (a), but the results of the survey have not yet been published. In Pakistan also, a grant was sanctioned by the Pakistan Council of Scientific and Industrial Research to the Dacca University for the survey of medicinal plants including *Rauwolfia*. The result of this survey has not yet been published either. We are thus still very much in the dark about the extent of the sources of *Rauwolfia* roots for commercial exploitation in tonnage requirement from the wild natural growth of the plants.

Necessity of Cultivation

Although it may be possible for a country with

sufficient natural growth of the plant to rely on this source, for high tonnage requirement and uniform supply of the material, recourse to planned cultivation of the *Rauwolfia* species would be desirable. Consequently, even in India, cultivation of the species has been started and reported yields vary from 1000 to 2000 lbs. per acre.

On the basis of published information on the culture of *Rauwolfia serpentina* and or other species, certain broad facts can be summarised as follows:- (i) Propagative materials are seeds, root cuttings and stem cuttings. (ii) Germination of the seeds varies from 25% to 40%, the fresh seeds giving better results than the old. (iii) A light well-drained soil with a top-dressing of farm-yard manure provides the best conditions for cultivation. (iv) From its far flung geographical distribution and its manifest edaphic tolerance, one may expect *Rauwolfia* to lend itself readily to successful cultivation under a wide range of conditions.

The necessity for the cultivation of *Rauwolfia serpentina* in Pakistan has assumed increasing importance with recent researches on the separation of more active substances from the root material.^{3,4} *Rauwolfia serpentina* grows wild in East Pakistan, but with the increasing demand the natural sources will be rapidly depleted. The plants do not occur gregariously but are widely scattered. This would make for a high collection cost and also render plant liable to extinction in the course of a few years. To meet this difficulty and ensure regular supplies of a uniform quality, it would be necessary to encourage large scale cultivation of the species for commercial exploitation.

Experimental Cultivation in Pakistan

In view of the considerations referred to above, a scheme "Investigation into the Possibility of Culture of *Rauwolfia serpentina*, Benth." was submitted by the author to the Pakistan Council of Scientific and Industrial Research in 1954. The scheme was sanctioned and is now in its fourth year. The results of investigations carried out in the experimental plantation under this scheme are summarised below:-

1. Experiments to study the yield of roots under three different spacings between plants, viz., (a) 1' × 1', (b) 1½' × 1', and (c) 2' × 2', have

shown that the spacing of $1\frac{1}{2}' \times 1'$ is most suitable for the cultivation of *Rauwolfia serpentina*, keeping in view the yield of roots and interculture operation. This spacing is now being practised here and is recommended to other growers of *Rauwolfia serpentina* plants. The spacing gives a yield of 1500 to 3000 lbs. of roots per acre.

2. For the vegetative propagation of the plants of *Rauwolfia serpentina*, stem, root and leaf cuttings have been experimented with. It has been found that while both stem and root cuttings can be used successfully for the vegetative propagation of the species, the leaf cutting has no propagative value. Five hundred and forty pieces of stem cuttings were planted in plot 4, on 8th and 9th June 1958. The cuttings sprouted but, due to an unexpected spell of drought, most of them died later on. Following this, another 300 pieces of stem cuttings were planted and started sprouting. Ultimately 30 cuttings established themselves into full-fledged plants, giving 10% success. In 1959, with the advent of the northwester (April), 625 stem cuttings were planted. Out of these cuttings 72 could establish themselves into full-fledged plants, giving 12% success. At the same time 10,000 root cuttings were planted, and it was observed that 2,771 sprouted and produced as many established plants, so that here the success was 36%. From our observations on the sprouting of the stem and root cuttings carried out so far, it may be concluded that root cuttings are better propagative material of the plant than the stem cuttings.

3. For the propagation of the plants of *Rauwolfia serpentina* with seeds, freshly ripened fruits, dried fruits and peeled seeds (i.e. the seeds in three different states) were used in order to determine their relative suitability. These experiments established that the peeled seeds are most suitable for propagation. They germinate quickly and the percentage germination of the seeds is also high. The peeled seeds are therefore now being used by us for the propagation of the plants.

Sowing Time for Optimum Germination

Germination tests on the seed of *Rauwolfia serpentina* have been carried out all round the year by monthly sowing to determine the most suitable time of the year which gives a maximum percentage germination of the seeds of this species. The results obtained so far are shown in the table. Allowing for variations due to non-determinable factors, it may be concluded from the data presented in this table that sowing in the period immediately preceding the monsoon (i.e. March and April)

| Date of sowing | No. of seeds sown | Date of germination | Time of germination* | No. of seedlings | Percentage |
|----------------|-------------------|---------------------|----------------------|------------------|------------|
| 1.9.1957 | 1640 | 18.9.1957 | 17 days | 225 | 14% |
| 1.10.1957 | 500 | 18.10.1957 | 17 " | 125 | 25% |
| 1.11.1957 | 500 | 21.11.1957 | 20 " | 120 | 24% |
| 9.12.1957 | 200 | 31.1.1958 | 22 " | 40 | 20% |
| 13.1.1958 | 500 | 3.3.1958 | 53 " | 100 | 20% |
| 3.2.1958 | 400 | 13.3.1958 | 39 " | 85 | 21% |
| 1.3.1958 | 500 | 24.3.1958 | 23 " | 42 | 8% |
| 1.4.1958 | 500 | 3.5.1958 | 32 " | 50 | 8% |
| 1.5.1958 | 500 | 19.5.1958 | 18 " | 72 | 14% |
| 1.6.1958 | 500 | 21.6.1958 | 20 " | 50 | 10% |
| 1.7.1958 | 500 | 17.7.1958 | 16 " | 240 | 48% |
| 1.8.1958 | 500 | 15.8.1958 | 14 " | 136 | 29% |

*It may be noted that although a definite number of days has been given as 'the time of germination', it has been observed that the seeds continue to germinate for much longer periods, so much so, that even after an interval of a year, seedlings have been known to appear in the seedbeds.

gives the lowest percentage germination, the optimum germination being obtained in the closing months of the monsoon with a record of 48% in July.

Besides this trial, the seeds of *Rauwolfia serpentina* were also germinated for transplantation of seedlings. Four thousand nine hundred seeds of this species were sown in the seedbeds in April 1958 and were found to take 18 to 30 days for germination. The maximum and minimum percentages of germination in the various seedbeds were 16 and 5, respectively, while the average was 12. The corresponding data for percentage germination of 26,200 seeds sown in the month of May are: maximum 64% and minimum 13% with an average of 35%.

Further with the advent of the northwester and during the current monsoon, i.e. from May to July 1959, altogether 38,180 seeds were put to seedbeds for germination to obtain seedlings for transplantation in the fields used for the scheme "Large Scale Plantation of *Rauwolfia serpentina*." It was observed that during the month of May the time of germination was 13 days, the maximum germination was 45%, minimum was 37% and the average 41%. Similarly, during the month of June when 24,410 seeds were put to seedbeds, the maximum germination was 75%, the minimum 31% and the average 50%, and the time of germination 10 days. Again during the month of July when 7,200 seeds were put to seedbeds, the

maximum germination was 66%, the minimum 63%, and the average 65%, the time of germination being 12 days.

The above data from 1st September 1957 to 31st July 1959 shows that the germination of the seeds is rather erratic. This is because the process of germination was taking place under the natural conditions of moisture, temperature and aeration and other soil conditions existing at the time in the seedbeds. To obtain consistent values of germination percentage of the seeds, the germination must be conducted under uniform and controlled conditions of temperature, moisture, aeration and substratum, which can only be obtained in a modern type of "Scientific germinator".

Conclusions

These variations do not vitiate the main conclusion that the best time for obtaining seedlings of *Rauwolfia serpentina* is to start the seedbed sowing in the beginning of May, i. e. with the advent of the northwester, and continue the operation throughout the monsoon and even till October. Of course, the higher average percentage germination will be obtained during the four months of the monsoon, i. e. May, June, July and August.

As to the comparative efficiency of the propagative materials, it is concluded from our observation so far that the peeled seeds are the best material, and among cuttings, the root cuttings are better than the stem cuttings while leaf cuttings have no propagative value.

Some useful instructions for prospective cultivators are given in the Appendix.

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References

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Appendix: Instructions for Cultivation

On the basis of experience gained in the course of investigations described in the paper, the following instructions are offered for the cultivation of *Rauwolfia serpentina* in East Pakistan and similar climatic areas.

(i) Preparation of Seedbeds

(a) The site of a seedbed should be so selected that the land is free from waterlogging and receives ample sunshine and air. A site having east and south ends open would be most suitable.

(b) The site should be cleaned and freed from grass roots and roots of other plants, and then dug up to a depth of at least 9" by a 'kodali' or a shovel. Cow dung or farmyard manure and leaf mould should be mixed with the dug-out soil and the seedbeds prepared to fine tilth. In a seedbed of 10' x 5', one maund of the manure and one maund of leaf-mould should be mixed.

(ii) Sowing of Seeds

After the preparation of the seedbed, the seeds should be sown in lines 4" apart between lines and 2" apart in the line. The seeds should not be sown very deep, a depth of about 1/2" being suitable. After sowing the seeds in the lines, the surface of the seedbed should be smoothed by hand. Thereafter, the beds should be copiously watered. During the monsoon, it may not be necessary to water the beds frequently, but if there is no rain for several days, the watering should be repeated. During the monsoon, the seeds should start germinating after a fortnight, but in the dry period and in the cold season, germination takes longer, some times as long as six weeks. Similarly, in monsoon the percentage of germination is very high going upto a maximum of 80%, but deteriorates as the season gets drier and colder. Usually one seed per hole is sown, and about 1 lb. of seed is needed for a seedbed of the dimensions given earlier.

(iii) Care of the Seedbeds during Growth of the Seedlings

Particular attention should be given to keep the seedbeds free from any weed, grass, etc., even after the seeds have germinated. It has been found that if a seedbed is not kept free from weeds, the germination is very poor, and the seedlings succumb to superior competition of grasses and weeds. It is essential for best results that the seedbed should be kept neat and clean from the very day of seed sowing till the seedlings are removed

for transplantation. Besides this care of the seedbeds, they should be watered whenever required, keeping in mind that they must never be allowed to get bone-dry and hard. The seedlings will be ready for transplantation when they are six weeks old and have six to eight leaves.

(iv) *Preparation of Site for Transplantation of the Seedlings*

As *Rauwolfia serpentina* cannot tolerate any waterlogging, the kind of field on which tea is grown should be ideal for *Rauwolfia serpentina* plants; it can be grown not only on valley land but also on the slope of the hill.

Before transplanting, the area to be transplanted with seedlings should be selected and prepared. It should be freed of weeds and grass and then one handful of mixed manure should be put in each hole. The mixed manure is prepared by thoroughly mixing one maund of rotten cow-dung, $\frac{1}{2}$ maund of bone meal, $2\frac{1}{2}$ seers of ammonium sulphate, and one maund of leaf mould, to be thoroughly mixed before application. After putting the mixed manure in each hole, the site will be ready for transplantation of the seedlings.

(v) *Uprooting the Seedlings (from the Seedbed) for Transplantation*

Before removing the seedlings, the seedbed should be watered so as to moisten the soil. The seedling should be removed not by 'pulling', but with the help of a 'niri' or 'khourpi', starting from one end of each line.

Starting from one end of the seedbed, the seedlings should be lifted gradually, one at a time, with minimum disturbance of the roots and keeping some lumps of soil adhering to the roots of the seedling in order to avoid injury to the roots. Seedlings thus lifted should be arranged on a tray. Care should be taken not to expose the seedlings to the strong light of the sun. If they are to be stored before planting, this storage should be in a cool, shady place, and if necessary they should be sprayed with water by mist sprayer. The best time for transplantation of seedling is early morning or late afternoon.

(vi) *Transplantation*

As the plant is small and has a weak stem, it has a sort of straggling habit. It has been found by experiment that the best method of planting is $1\frac{1}{2}$ ' apart between lines and 1' apart in lines.

On the site selected for the plantation, lines $1\frac{1}{2}$ ' apart should therefore be drawn, preferably in the north to south direction. Then on each line holes should be dug one ft. apart. After the seedlings have been brought on the site of the transplantation field, individual seedlings should be placed and arranged one in each of the holes in the lines. Then the seedlings should be carried in the holes with the ball of the earth along with their roots up to the first pair of leaf from the ground and the soil round the root of seedlings tightly pressed. When transplantation is completed, the transplanted seedlings should be watered. After this, if there is a shower of rain each day or on alternate days, watering would not be necessary, but during a droughty period watering is essential.

It may be mentioned here that cloudy and drizzly days are preferred for the transplantation of seedlings. In such weather transplantation can be carried out throughout the day.

(vii) *Care after Transplantation*

The transplanted lines and especially the region around each plant should be kept free from weeds and grasses during the early stage of the growth of plants, and in order to give a neat and tidy appearance to the plantation, the space (about 1') between plants in the lines should also be freed from untidy growths, especially during the early stage of growth of the plantation. Mulching of the root region of each line should be done once in a fortnight or in 3 weeks. Any gaps due to the withering of transplanted seedlings should be filled up by transplanting fresh seedlings. Generally it takes the seedlings 3-4 days to recover from the shock of transplantation, and within a week the plantation should look as established. As the plant grows in height, it will straggle due to the weak nature of the stem, and it will be necessary to put earth in the root region to make a ridge, the lines containing the plants would be ridges and the space between the lines would be furrows. The plants will start flowering when they are about 3 months old, and the flowering and fruiting would be continuous. For future plantation, the seeds (which are blackish when ripe) should be collected and seeds extracted regularly.

(viii) *Harvesting*

It has been found by experiments that the most economical harvesting age in respect of yield per acre and alkaloidal content is between 12 months and 18 months after transplantation. It has been estimated from our experimental plots that the yield of roots varies between 1500 lbs. and 3000 lbs. per acre.

It must be mentioned here that in the foregoing description seeds have been considered as the propagating material. However, *Rauwolfia* plants can also be propagated by root cuttings and stem cuttings, and therefore replantation of harvested plantations should not be a very difficult matter, at least in comparison to a fresh plantation, because in harvesting (during the process of digging and uprooting of plants) quite a number of ends of roots are bound to remain in the soil. These bits

of roots will germinate and shoot out new plants as soon as they get suitable moisture and temperature conditions with the onset of the monsoon. Quite a number of ripe fruits will also drop underneath each plant and these too will germinate as soon as they get proper conditions for their germination. What will be necessary to complete a replantation is to fill up the gaps among these self-sown plants by fresh seedlings at the proper time and season.