CHAPTER-V

CULTIVATION TRIALS
INTRODUCTION
India possesses perhaps the richest and the most diversified flora in the world. Leaving aside the wide range of drugs used in indigenous medicine in India, about 1500-2000 species in our country are reported to be potentially medicinal. They are attributed with a number of medicinal and curative uses, properties and vernacular names in different systems of medicine are described.

Certain herbal drugs are obtained exclusively from wild sources. The process of collection of crude drugs and ethnomedicinal plants, besides being a laborious job is very expensive too, which ultimately costs more for the production of drugs and medicines. Some other factors like scarce distribution, transportation difficulties, indiscriminate collection, ignorance of untrained collectors to recognise the genuine plants have an adverse effect on the production of drugs. These difficulties in collection of medicinal plants growing wild, are mainly the reasons which suggests that the medicinal plants should be cultivated. In order to ensure a regular supply of all drugs of standard quality to the pharmaceutical industries, it is essential that herbs growing in natural state should be brought under systematic cultivation and those which are exotic should be protected.

On account of the great diversity in climate and soil types in India, it is possible to introduce into this country plants from every region of the world.

According to Chopra et al. (1948) the experimental cultivation of some of the exotic plants was started in India as long ago as the beginning of the 18th century. Yadav (1984) emphasised that the large scale cultivation of the medicinal plants in India has started only after independence with the establishment of "Central Institute of Medicinal and Aromatic Plants", in 1959. After the establishment of "All India Coordinated Project
on Medicinal and Aromatic Crops" by the Indian Council of Agricultural research, several field experiments were conducted in different agroclimatic regions of the country.

Some important experimental works on cultivation of medicinal plants are as follows: Chatterjee and Lama (1977) described cultivation trials of Cinchona in West Bengal. Gadwal (1977) conducted his experiments on commercial cultivation of Solanum crop. Sen-Sarma (1977) studied cultivation and utilization of Sandal wood. Simultaneously Sobti and kaul (1977) proposed cultivation technique of Datura inoxia and D. metel in India.


In present work, cultivation trials of some selected medicinal species i.e. Chlorophytum tuberosum, Curcuma aromatica and Commiphora mukul, are done to ascertain the best technique of cultivation in Indian conditions.
CULTIVATION TECHNIQUES
Cultivation of *Chlorophytum tuberosum*. Baker

*Chlorophytum tuberosum* is an ethnomedicinally important species which is belong to family Liliaceae. This species mostly grows in hilly areas and occurs more commonly in mixed forests and Sal forest. *C. tuberosum* is well distributed in India extending from Eastern Himalaya, Bihar, Assam, Maharashtra and M.P. In M.P. it is widely distributed and found in abundance in Mandla, Amarkantak, Balaghat, Bastar, Ambikapur and Sagar regions. In Sagar region it is found in Bahrol (Banda), Patharia and Garpehra site with respectively 13.7/m², 13.1/m² and 11.6/m² density. Plants are ethnomedicinally used by tribals and are also exported for commercial purpose. Due to over exploitation the species is under the threat of elimination.

In *Chlorophytum tuberosum*, asexual propagation is necessary to maintain cultivars because the seeds of this species show low germination percentage and in natural habitat this species is mainly propagated by tuberous roots.

Materials and Method: Experimental cultivation of *Chlorophytum tuberosum* was done under following heads.

I. Propagation technique: During the season of Kharif crops, *C. tuberosum* was propagated by vegetative means, under following steps.

A. Preparation of beds: About 2m² area is prepared as a bed, for this purpose black clayey soil is mixed with sand and used. This soil mixture was sufficiently porous so that excess water drains away, permitting adequate aeration. The soil which is used in beds, was rich in nitrogen and neutral in nature. For the lowering of pH of an alkaline soil ammonium sulphate was used and to raise the pH of acidic soil calcium nitrate was used.
B. Preplanting treatment of soil: Soil may contain weed seeds, nematodes and various fungi and bacteria harmful to plant tissue. To avoid loss from these pathogens the soil was treated before using.

Soil was heated to eliminate weeds, insects, nematodes and pathogens. In heating the soil, which should be moist but not wet, a temperature of 80°C for 30 minutes has been used and is a standard recommendation, since this procedure kills most harmful pathogens as well as nematodes and most weed seeds.

C. Manuring: In the three major elements nitrogen, phosphorus and potassium, nitrogen has the maximum control on vegetative growth. The results of growth performance studies of this species suggests that the nitrogen is most essential for the growth and development of Chlorophytum tuberosum (Table 4.1). To supply more nitrogen for growing plants organic fertilizer was used. According to Matkin and Chandler (1957) to supply nitrogen, phosphorus and potassium, for growing plants, following mixture in dry form is recommended:

1.8 kg. hoof and horns.
1.8 kg. single super phosphate
0.45 kg. potassium sulphate

As a supplement to this mixture, following liquid solution of nutrients which is given two times at periodic intervals during growing season.

Water 6 liters
Ammonium nitrate 1.1kg
Monoammonium phosphate .3kg
Potassium chloride .5kg
D. **Planting material** : In present work the crown of tuberous roots were used as planting material. The tuberous roots includes thickened growth and these function as storage organ. No nodes and internodes are visible and the buds are produced only on the crown (proximal) end and fibrous roots are commonly produced on the opposite (distal) end.

The crown was detached from the mother plant and was planted for the studies. The root cluster was divided shortly before planting.

E. **Treatment of planting material** : According to Corlson and Kiplinger (1938) growth regulators used in excessive concentration for the species may inhibit bud development. Solution of 100ppm IAA was used for treatment. The crowns were treated by dip method.

F. **Method of planting** : Direct planting or sowing of crowns in field has been found successful. The crowns were planted vertically at a depth of 1cm. in the beds in lines 10cm apart with distance of 10cm. from crown to crown. Sowing of crowns was done in the last of summer season. About 200 crowns can be sown in a bed of about 2 sq m.

G. **Use of fertilizers** : To supply nitrogen, urea was used periodically and the plantlets were watered.

H. **Irrigation** : Cultivation trials were done during rainy season and in black clayey soil hence the irrigation was not employed.

II. **Observation Procedure** : To observe growth and development of growing plants, following points were selected :

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A. **No. of days taken for sprouting** : Period from the day of sowing to the day of sprouting was recorded in days.

B. **Sprouting rate** : Percentage of sprouting was determined by following formula -

\[
\text{Germination rate (\%)} = \frac{\text{No. of sprouting crowns}}{\text{No. of total planting material}} \times 100
\]

C. **No. of days taken for flowering** : Period from the day of sprouting to day of flowering was recorded in days.

D. **No. of days taken for fruiting** : The period from the day of sprouting to day of fruiting was recorded in days.

E. **No. of days taken for maturity of seeds** : The period from the day of fruiting to the day of ripening of seeds was recorded in days. And the period from the day of sprouting to day of maturity of seeds was recorded as maturity period.

F. **Plant height at the time of maturity** : Average height of plants was recorded at maturity.

G. Average No. of leaves and average size of leaves were recorded at the time of maturity.

H. Average No. of fleshy roots and their size was recorded at the time of maturity.

I. **Weight of fresh root** : Roots were weighed just after harvesting and the weight of single fleshy root was recorded.

J. **Weight of dry roots** : Roots were washed and dried and the weights were recorded.

K. **Yield** : Total weight of dry roots in an unit area was recorded as the form of yield.
III. **Harvesting**: Tuberous roots are collected during autumn or early winter after first year of growth. The earth was dug and tuberous roots were gathered by hand picking.

IV. **Storage**: Tuberous roots, were stored as planting material, at 10°C in saw dust or vermiculite. And other roots were stored, after perfect shade drying, in cool and dry places or in cold storage.

**Observations and results**:

**Table 5.1**: Observation on growth and development of *Chlorophytum tuberosum*.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Observation points</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Observed time of sprouting</td>
<td>15-20 days</td>
</tr>
<tr>
<td>2.</td>
<td>Sprouting rate</td>
<td>70-75 %</td>
</tr>
<tr>
<td>3.</td>
<td>Observed time of flowering</td>
<td>30-45 days</td>
</tr>
<tr>
<td>4.</td>
<td>Observed time of fruiting</td>
<td>50-60 days</td>
</tr>
<tr>
<td>5.</td>
<td>Observed time for ripenning of fruit</td>
<td>10-20 days</td>
</tr>
<tr>
<td>6.</td>
<td>Observed time of maturity</td>
<td>80-100 days</td>
</tr>
<tr>
<td>7.</td>
<td>Height of plant at maturity</td>
<td>20-28 cm</td>
</tr>
<tr>
<td>8.</td>
<td>No. of leaves per plant</td>
<td>6-8</td>
</tr>
<tr>
<td>9.</td>
<td>Length of leaves at maturity</td>
<td>20-28 cm</td>
</tr>
<tr>
<td>10.</td>
<td>No. of fleshy roots per plant</td>
<td>6-8</td>
</tr>
<tr>
<td>11.</td>
<td>Length of fleshy roots at maturity</td>
<td>2.5-4 cm</td>
</tr>
<tr>
<td>12.</td>
<td>Weight of single fresh root</td>
<td>1.66-2 gm.</td>
</tr>
<tr>
<td>13.</td>
<td>Weight of single dry root</td>
<td>0.3-0.4 gm.</td>
</tr>
<tr>
<td>14.</td>
<td>Yield or weight of total dry roots/m² area</td>
<td>200 gm/m²</td>
</tr>
</tbody>
</table>
**Growth pattern:** Fasciculated tuberous roots are annual in nature. They are produced by the plant to tide over the unfavourable dry spell of the summers as they remain dormant after withering away of the herbaceous shoot.

When the favourable season comes i.e. the fall, prior to that the dormant parts are activated. A bud is produced (Generally coinciding with Akshay-Tritiya) which draw food from the old storage roots during the initial growth period. As soon as the plant established itself the old roots are disintegrates and new ones are produced by the actively photosynthesizing plant. The no. of leaves amazingly corresponds to the no. of fasciculated tuberous roots generally.
Cultivation of *Curcuma aromatica* salisb.

*Curcuma*, a genus of about 70 species of rhizomatous herbs comes under the family Zingiberaceae. *Curcuma aromatica* is an ethnomedicinally important species under the genus *Curcuma* Linn. This species is well distributed in India extending from Andhra Pradesh, Maharashtra, Orissa, Tamil Nadu, Karmataka, Kerala and M.P.

In Sagar region it is mostly growing on hilly tract especially at the slopes of Sandstone hills. It is found in Garhpehra, Chhanbila and Baraytha site with respectively 14.1/m², 10.4/m² and 5.5/m² density.

*Curcuma aromatica* produce viable seeds but they show low percentage of germination hence vegetative propagation is necessary. In natural habitats they are propagated by vegetative means.

**Materials and Method**: Experimental cultivation of *Curcuma aromatica* was done under following heads:

[I] Propagation technique:

*A. Preparation of beds*: The bed was prepared during the end of summer season. About 1x1.5 meter area was prepared as an experimental bed. In these beds red sandy or yellow clay-loam soil was used. This soil was sufficiently porous and free from weed seeds and other harmful organism.

The soil which was used in beds was moderately rich in nitrogen and phosphorus. It was slightly acidic in nature. To lower pH of alkaline soil ammonium sulphate was used and to raise the pH of highly acidic soil, calcium nitrate fertilizers was utilized. The crop of *Curcuma aromatica* cannot withstand alkalinity.
B. Preplanting treatment of soil: Preplanting treatment of soil was done by heating method. The soil was heated to a temperature of 80°C for 30 minutes.

C. Manuring: *Curcuma aromatica* needs nearly heavy manuring. Cattle manure or compost as a basal dressing at the rate of 15kg/m² area, was applied at the time of preparation of beds. To supply nitrogen and phosphorus for growing plants, the mixture of urea and single super phosphate was applied.

D. Planting material: In present experimental trial, the cuttings of selected healthy, well developed and disease free rhizomes were used as planting material. The material was collected from field sites and was stored in saw dust or sand or at low temperature in storage cabinets. In case of rhizome planting, the rhizomes were divided into small pieces and each piece bears a shoot bud. The clusters of roots were divided shortly before planting.

E. Treatment of planting material: The rhizome cuttings were treated with 0.25% solution of Agallol for 30 minutes and drained before planting.

F. Method of planting: Direct planting of rhizome cuttings in field was done by forming ridges and furrows. A spacing of 20 cm. between rows and 15 cm. between plants was adopted. The cuttings were planted vertically at a depth of 0.5cm. in furrows. About 100 cuttings were planted in beds of 1x1.5 meter area.

G. Use of fertilizers: To enhance the supply of more nitrogen for growing plants urea fertilizer was used periodically.

H. Irrigation: Irrigation was not required because the period of crop is rainy season. While depending upon the soil and rainfall, 2 or more irrigations were done.
II. Observation procedure: To observe growth and development of growing plants following heads were selected.

A. No. of days taken for sprouting.
B. Sprouting rate
C. No. of days taken for flowering
D. No. of days taken for fruiting
E. No. of days taken for ripening and maturity
F. Weight of plant at the time of maturity
G. No. of leaves
H. Length of leaves
I. No. of rhizome tubers
J. Size of rhizome tubers
K. Weight of fresh rhizome tubers
L. Weight of dry rhizome tubers
M. Yield/m²

Data of observation was recorded as it was done in case of *Chlorophytum tuberosum*.

III. Harvesting: Rhizomes of *Curcuma aromatica* were collected during early winter, after the first year growth. The land was dug and tubers were gathered by hand picking.

IV. Storage: Rhizomes were stored in sawdust at cool and dry places after perfect shade drying. Shade drying is applied when it is desirable to retain the natural colour of tuberous roots.
Observation and results:

Table 5.2: Observation on growth and development of *Curcuma aromatica*.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Observation points</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Desired time for sprouting</td>
<td>20-25 days</td>
</tr>
<tr>
<td>2.</td>
<td>Sprouting rate</td>
<td>60-70%</td>
</tr>
<tr>
<td>3.</td>
<td>Observed time of flowering</td>
<td>45-55 days</td>
</tr>
<tr>
<td>4.</td>
<td>Observed time of fruiting</td>
<td>60-70 days</td>
</tr>
<tr>
<td>5.</td>
<td>Observed time of fruit ripening</td>
<td>10-22 days</td>
</tr>
<tr>
<td>6.</td>
<td>Observed time of maturity</td>
<td>80-100 days</td>
</tr>
<tr>
<td>7.</td>
<td>Height of plant at maturity</td>
<td>30-35 cm.</td>
</tr>
<tr>
<td>8.</td>
<td>No. of leaves per plant</td>
<td>2-4</td>
</tr>
<tr>
<td>9.</td>
<td>Size of leaves at maturity. (Without petiole)</td>
<td>28-30 cm</td>
</tr>
<tr>
<td>10.</td>
<td>No. of rhizomes tubers</td>
<td>3-4</td>
</tr>
<tr>
<td>11.</td>
<td>Size of rhizomes tubers</td>
<td>2-3.5 cm</td>
</tr>
<tr>
<td>12.</td>
<td>Weight of singel fresh rhizome tuber</td>
<td>2.4-4.5 gm.</td>
</tr>
<tr>
<td>13.</td>
<td>Weight of single dry rhizome tuber</td>
<td>0.8-1.5 gm.</td>
</tr>
<tr>
<td>14.</td>
<td>Yield/m²</td>
<td>500 gm/m² area</td>
</tr>
</tbody>
</table>

Growth pattern: Rhizomes grow by elongation of the growing points produced at the terminal end and on lateral branches. Length also increases by growth in the lower part of the internode. As the plant continues to grow and the older part dies the several branches arising from one plant may eventually become separated to form individual plants of a single clone.
In case of *Curcuma aromatica* several tuberous root arising from mother rhizome. They produced by the plant to tide over the unfavourable dry spell of the summers as the remain dormant after withering away of the herbaceous shoot.

When the favourable season comes i.e. the fall, prior to that dormant parts are activated, a bud is produced which drows food from the old storage roots and rhizome during the initial growth period. As soon as the plant established it self the old root stock are disintegrates and new ones are produced by the actively photosynthesizing plant.
Propagation of *Commiphora mukul* Engl.

*Commiphora mukul* is an ethnomedicinally and economically important species, which occurs more commonly in desert areas. In Sagar region *Commiphora mukul* is found only near the fort of Dhamoni. Debris of old houses, is the natural habitat of this species, which contains more postherd and gravells. Soil of this area is blakish grey coloured.

The gum is known as Guggul, is ethnomedicinally and economically important. Gum of this plant is variously used in indigenous systems of medicine as an astringent and antiseptic. It is economically used as an incense and fixative in perfumery. Gum resins of this species are known as bdellium.

Asexual propagation is necessary to avoid long juvenile period. Plants grown from seeds go through a juvenile period in which flowering dose not occur. This species may require 5 to 10 years before flowering begins. Once it has reached the flowering stage, the plant flowers regularly. Vegetative propagation thus retains this flowering capacity and avoids the non flowering juvenile phase.

**Materials and method**: Experimental propagation of *C. mukul* by stem cuttings, was done under following steps.

1. **Propagation structure**: In propagation procedure cuttings were planted in of pots or containers. In this experimental work, erthenware pots were used for planting of cuttings. Twenty pots were used for propagation, which were filled with preplanting treated mixture of soil. Out of these 20 pots, 15 pots contained mixture of black and red soil with compost and other 5 pots contained forest soil (in which *C. mukul* is found naturally).
[II] **Preparation of cuttings**: In present work three type of stem cuttings i.e. semihard wood, softwood and herbaceous, were used.

A. Semihard wood stem cuttings are those made from partially matured woody stem. The cuttings were made 15 to 20 cm. long and the basal cut was made usually just below a node.

B. Softwood cuttings are those made from the soft, succulent and new spring growth of plant. This type of cutting is always made with leaves attached. Soft wood cuttings are 10 to 15 cm. long with one or more nodes. The basal cut was usually made just below a node. The leaves on the lower portion of the cuttings were removed, while those on the upper part were retained.

C. Herbaceous cuttings were made from herbaceous terminal portion of the shoots. They were 7.5 to 10 cm long with leaves retained at the upper end.

The cutting material was better gathered in the early morning or early part of the day and was kept in moist and cool burlap or put in large polythene bags. Soaking the cutting material in water for prolonged period to keep them fresh is desirable.

**III. Treatment and Planting**: The purpose of treating cuttings with auxin type growth hormones was done to increase the percentage of cuttings that form roots and to increase number and quality of roots produced per cuttings.

In this process firstly, cuttings were treated by IBA. At first 5 herbaceous, 5 softwood and 15 semihard wood cuttings were treated with 100 ppm solution of IBA, by basal dip method. Immediately after the treatment 5 herbaceous cuttings were planted in a single pot, 5 softwood cuttings were planted in a separate single pot and 15 softwood
cuttings were planted in 3 pots. These all 5 pots were filled with a mixture of black and red soil with compost.

Next to IBA treatment, 20 other cuttings were treated by IAA. In this process 5 herbaceous, 5 soft wood and 15 semi-hard wood cuttings were treated by 100 ppm solution of IAA by basal dip method and immediately after the treatment these cuttings were planted in 5 different pots.

During NAA treatment, 5 herbaceous, 5 softwood and 15 semi-hard wood cuttings were treated by 100 ppm solution of NAA with the help of basal dip method and were planted in 5 different pots.

To observe propagation, growth and development of Commiphora mukul in controlled condition, 25 untreated cuttings of semi-hard wood type and soft wood type were planted in 5 earthenware pots which were filled with forest soil.

IV. Environmental conditions for rooting leafy cuttings: For the successful rooting of stem cuttings, the essential environmental requirements are:

(i) Proper temperature 18°C to 27°C
(ii) Atmosphere conducive to low water loss from leaves
(iii) Ample but not excessive light
(iv) Clean, moist and well aerated rooting media.

Observations: To determine the effect of growth hormone on rooting by stem cuttings, the following observations were noted down.
### Table 5.3: Effect of IBA treatment on different type of stem cuttings

<table>
<thead>
<tr>
<th>Planting material</th>
<th>Soil type</th>
<th>No. of cuttings</th>
<th>Size of cuttings</th>
<th>Date of planting</th>
<th>Observed period for rooting</th>
<th>Rooting percentage</th>
<th>Observed period for new leaf production</th>
<th>No. of leaves per cutting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbaceous leafy cutting.</td>
<td>Mixture of red and black soil</td>
<td>5</td>
<td>10cm.</td>
<td>5-7-96</td>
<td>-</td>
<td>-</td>
<td>-(dead)</td>
<td></td>
</tr>
<tr>
<td>Softwood cutting</td>
<td>&quot;</td>
<td>5</td>
<td>10cm.</td>
<td>5-7-96</td>
<td>25 days</td>
<td>60%</td>
<td>18 days</td>
<td>3</td>
</tr>
<tr>
<td>Semihard wood cutting</td>
<td>&quot;</td>
<td>15</td>
<td>15cm.</td>
<td>5-7-96</td>
<td>20 days</td>
<td>73%</td>
<td>15 days</td>
<td>6</td>
</tr>
</tbody>
</table>

### Table 5.4: Effect of IAA treatment on different type of stem cuttings

<table>
<thead>
<tr>
<th>Planting material</th>
<th>Soil type</th>
<th>No. of cuttings</th>
<th>Size of cuttings</th>
<th>Date of planting</th>
<th>Observed period for rooting</th>
<th>Rooting percentage</th>
<th>Observed period for new leaf production</th>
<th>No. of leaves per cutting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbaceous leafy cutting.</td>
<td>Mixture of red and black soil</td>
<td>5</td>
<td>10cm.</td>
<td>5-7-96</td>
<td>-</td>
<td>-</td>
<td>-(dead)</td>
<td></td>
</tr>
<tr>
<td>Softwood cutting</td>
<td>&quot;</td>
<td>5</td>
<td>12cm.</td>
<td>5-7-96</td>
<td>28 days</td>
<td>40%</td>
<td>25 days</td>
<td>3</td>
</tr>
<tr>
<td>Semihard wood cutting</td>
<td>&quot;</td>
<td>15</td>
<td>15cm.</td>
<td>5-7-96</td>
<td>22 days</td>
<td>66.6%</td>
<td>18 days</td>
<td>6</td>
</tr>
</tbody>
</table>
### Table 5.5: Effect of NAA treatment on different type of stem cuttings

<table>
<thead>
<tr>
<th>Planting material</th>
<th>Soil type</th>
<th>No. of cuttings</th>
<th>Size of cuttings</th>
<th>Date of planting</th>
<th>Observed period for rooting</th>
<th>Rooting percentage</th>
<th>Observed period for new leaf production</th>
<th>No. of leaves per cutting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbaceous leafy cutting</td>
<td>Mixture of red and black soil</td>
<td>5</td>
<td>10cm.</td>
<td>5-7-96</td>
<td>30 days</td>
<td>20%</td>
<td>45 days</td>
<td>1</td>
</tr>
<tr>
<td>Softwood cutting</td>
<td></td>
<td>5</td>
<td>12cm.</td>
<td>5-7-96</td>
<td>28 days</td>
<td>20%</td>
<td>25 days</td>
<td>2</td>
</tr>
<tr>
<td>Semihardwood cutting</td>
<td></td>
<td>15</td>
<td>15cm.</td>
<td>5-7-96</td>
<td>22 days</td>
<td>33.3%</td>
<td>20 days</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 5.6: Observations recorded for control

<table>
<thead>
<tr>
<th>Planting material</th>
<th>Soil type</th>
<th>No. of cuttings</th>
<th>Size of cuttings</th>
<th>Date of planting</th>
<th>Observed period for rooting</th>
<th>Rooting percentage</th>
<th>Observed period for new leaf production</th>
<th>No. of leaves per cutting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softwood cutting</td>
<td>Forest soil</td>
<td>10</td>
<td>12cm.</td>
<td>5-7-96</td>
<td>28 days</td>
<td>20%</td>
<td>20 days</td>
<td>4</td>
</tr>
<tr>
<td>Semihardwood cutting</td>
<td>&quot;</td>
<td>15</td>
<td>15cm.</td>
<td>5-7-96</td>
<td>22 days</td>
<td>80%</td>
<td>15 days</td>
<td>8</td>
</tr>
</tbody>
</table>
**Result**: The data on rooting response of different stem cuttings is given in Table 5.3, 5.4, 5.5 and 5.6. The data of Table 5.3 clearly indicates that more than 65% softwood and semi hard wood cuttings rooted with treatment of IBA, while all the herbaceous leafy cuttings were died. The data of Table 5.4 and 5.5 are clearly indicates that IAA and NAA treatment decreased percent of rooting respectively as 53.3% and 35%. Untreated control semi hard wood and softwood cuttings, which were planted in forest soil, also rooted profusely with luxuriant growth and percent rooting being as high as 75% (Table 5.6).

Above results suggested that the soil type found at Dhamoni forest, is most suitable for the better rooting of this species. Soil of this area, where *C. mukul* is found, is blackish-grey coloured with more postherd and gravells. This soil is slightly acidic in nature and less rich in nitrogen but more rich in phosphorus.

The results also suggested that semi hard wood cuttings are the best propagating materil for vegetative use and softwood cuttings are moderately suitable for vegetative propagation. The herbaceous cuttings show clearcut hindrance in vegetative propagation. The results also indicate that treatment of IBA is better for planting the cuttings in common soils.
DISCUSSION
It was realised during study that the plants of *Chlorophytum tuberosum* are mainly propagated by crowns of tuberous roots in natural habitats. According to Bisen (1994) the seeds of *Chlorophytum* spp. show low percentage of germination, hence this species may be propagated by cuttings of root stock. In present work cultivation trial of *Chlorophytum tuberosum* clearly indicates that the crowns of tuberous roots of this species are the main propagating organs because only crown bears shoot bud and other parts of root tubers are not having any shoot bud.

Results of cultivation trial also suggest that the growth and development of *Chlorophytum tuberosum* is much better in black-clayey-loam soil which is rich in nitrogen and has nearly neutral pH value.

It was also realised during study that in natural habitats *Curcuma aromatica* produce viable seeds but the rate of germination was low. In natural habitats they are mainly propagated by rhizomes. Nambari et. al. (1982) considered that the propagation of *Curcuma aromatica* may be also done by cuttings of mother rootstock. The genus *Curcuma* Linn. commonly bear rhizomatous root stock but the root stock of this species is tuberous.

In present work cultivation trial of *Curcuma aromatica* has clearly indicated that the rhizomes are the main propagating organs of this species. The results of cultivation trial has also suggested that the growth and development of *C. aromatica* is much better in red-sandy soil which has moderate amount of nitrogen and phosphorus and is mildly acidic in nature.
Commiphora mukul was found to be able to grow in its natural environmental conditions and soil of Dhamoni forest only. No plant was found to grow in any other environmental conditions of the taken study sties. This suggested that Commiphora mukul require a very specific type of environment and soil for the proper growth which is found only in forest of Dhamoni. The debris of old houses is the natural habitat of this species. Soil of this area has more amount of phosphorus and is mildly acidic in nature.

The results of study on propagation of C. mukul have also suggested that the growth of this species is much better in soil of Dhamoni forest which contain more posthered and gravells. It was also realised during study that the semihard wood cuttings are best suitable for propagation of the species.

Experiments on cultivation of some other species i.e. Asparagus recemosus, Curculigo orchioides, Rouwolfia serpentina and Withania sominfera were also done but the results of these trials were not satisfactory hence the brief account of these trials is presented in tabular form (Table 5.7).

Data of table 5.7 are clearly indicates that Asparagus racemosus is propagated by seeds and also by the root crown. While germination rate of root crown is much better than germination rate of seeds hence they should be cultivated by crowns. The plants of Curculigo orchioides are propagated by cuttings of rhizome which bears lateral buds. Upright growing above ground shoots and flowering parts are produced either terminally from the rhizome tip or from lateral branches. The section of rhizome which bears lateral bud is the propagating organ of this species. Rouwolfia serpentina can be propagated by seed, stem cuttings and also by root cuttings. In this case propagation of the species is
much better by stem cuttings than other methods. The seeds of *Withania somnifera* were
germinated when they were sown in nursery but after sometimes due to excess of water
they could not survive. This result suggest that plants of *Withania somnifera* require
much porous soil which could maintain excess of water and permitting adequate aeration.
Table 5.7: Observations on cultivation of some other medicinal species

<table>
<thead>
<tr>
<th>Name of species</th>
<th>Planting material</th>
<th>Soil type</th>
<th>Treatment</th>
<th>Desired time for germination</th>
<th>Germination rate</th>
<th>Period of crop</th>
<th>Produce</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Asparagus racemosus</em></td>
<td>Tuberous root</td>
<td>Red-sandy</td>
<td>Agallol</td>
<td>20-25 days</td>
<td>70%</td>
<td>Two years</td>
<td>Root tubers</td>
</tr>
<tr>
<td><em>Asparagus racemosus</em></td>
<td>Seeds</td>
<td>Red-sandy</td>
<td>Bavistin</td>
<td>15-20 days</td>
<td>50%</td>
<td>Two years</td>
<td>Root tubers</td>
</tr>
<tr>
<td><em>Curculigo orthooides</em></td>
<td>Rhizome cutting</td>
<td>Red-sandy</td>
<td>-</td>
<td>20-30 days</td>
<td>40%</td>
<td>Two years</td>
<td>Rhizome</td>
</tr>
<tr>
<td><em>Rauwolfia serpentina</em></td>
<td>Seeds</td>
<td>Black-silt</td>
<td>Bavistin</td>
<td>15-20 days</td>
<td>55%</td>
<td>Two years</td>
<td>Root</td>
</tr>
<tr>
<td><em>Rauwolfia serpentina</em></td>
<td>Stem cuttings</td>
<td>Black-sandy</td>
<td>IBA</td>
<td>15-25 days</td>
<td>80%</td>
<td>Two years</td>
<td>Root</td>
</tr>
<tr>
<td><em>Rauwolfia serpentina</em></td>
<td>Root cuttings</td>
<td>Black-sandy</td>
<td>IAA</td>
<td>15-20 days</td>
<td>70%</td>
<td>Two years</td>
<td>Root</td>
</tr>
<tr>
<td><em>Withania somnifera</em></td>
<td>Seed</td>
<td>Black-sandy loam</td>
<td>Bavistin</td>
<td>18-24 days</td>
<td>65%</td>
<td>-</td>
<td>- (dead)</td>
</tr>
</tbody>
</table>


